第八届国际传感器科学研讨会—中国分会

会议手册

2023年3月29—31日

中国·南京

I3S-CN 2023

主办单位：MDPI；中国仪器仪表学会分析仪器分会

承办单位：南京大学；生命分析化学国家重点实验室（南京大学）；
江苏省化学化工学会分析化学专业委员会

主办单位：

中国仪器仪表学会分析仪器分会
Analytical Instrument Branch of China Instrument and Control Society

MDPI
Academic Open Access Publishing
since 1996

承办单位：

南京大学
NANJING UNIVERSITY

生命分析化学国家重点实验室
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会议组织：

大会主席：

鞠熀先 教授
南京大学
生命分析化学
国家重点实验室

主席简介：

鞠熀先教授，生命分析化学国家重点实验室主任。1982–1992 年在南京大学获理学学士、硕士与博士学位后留校任教，1996–1997 年为加拿大 Montreal 大学博士后，1999 年任南京大学教授，2003 年获国家杰出青年科学基金，2005–2014 年国家自然科学基金创新研究群体项目负责人，2007 年教育部“长江学者”特聘教授、“新世纪百千万人才工程”国家级人选，2009 年为“973”计划项目首席科学家，2011 年获国务院政府特殊津贴，2015 年国际电化学会会士、英国皇家化学会会士。他的研究方向为分子诊断与生物分析化学，主要研究领域为纳米生物传感、生物分子识别、细胞分析化学和临床分子诊断。

鞠教授在 J. Am. Chem. Soc., Angew. Chem. Int. Ed., Nat. Commun.,Adv. Mater.,Adv. Funct. Mater., Chem. Rev., Chem. Soc. Rev., Acc. Chem. Res., Chem. Sci., Anal. Chem., ACS Nano, Clin. Cancer Res., Clin. Chem. 等刊发表论文共 725 篇 (SCI 刊物 670，>5 刊物 446；授权专利 26 件，中文专著教材 7 部、英文专著 4 部，中英文专章 20 篇)。

分会主席：

（按姓氏字母排序）

戴海鹏（南京大学，主题：物联网与传感网络）
居为民（南京大学，主题：遥感科学及应用）
胡俊辉（南京航空航天大学，主题：传感器与执行器）
李润伟（中科院宁波材料技术与工程研究所，主题：可穿戴传感器）
鲁　平（华中科技大学，主题：光学传感器）
张永光（南京大学，主题：遥感科学及应用）

会议组织：

学术委员会：

（按姓氏字母排序）

常凌乾 教授 北京航空航天大学
胡军副 教授 清华大学
吕朝锋 教授 浙江大学
林正得 教授 中科院宁波材料所
林宗宏 副教授 国立清华大学
陆宁云 教授 南京航空航天大学
路鑫超 副教授 中科院微电子所
刘庆文 特别研究员 上海交通大学
刘相红 教授 青岛大学
刘志洪 教授 武汉大学
牛湘衡 副教授 江苏大学
李昕明 研究员 华南师范大学
曲晓刚 研究员 中科院长春应化所
宋爱国 教授 东南大学
舒学文 教授 华中科技大学
史　文 副研究员 中科院化学所
田　禾 教授 清华大学
王　侃 副教授 上海交通大学
王军波 教授 中科院空天信息创新院
王　平 教授 浙江大学
王　雪 教授 清华大学
王　玮 教授 北京大学
王　颖 教授 同济大学
徐　杨 教授 浙江大学
严如强 教授 西安交通大学
岳　洋 教授 南开大学
张　磊 副教授 南京邮电大学
张明亮 副研究员 中国科院半导体所
张检发 副教授 国防科技大学
张晓兵 教授 湖南大学
张袁健 教授 东南大学
张祖兴 教授 南京邮电大学
张宝昌 教授 北京航空航天大学
赵伟伟 副教授 南京大学

咨询委员会：

（按姓氏字母排序）

Prof. Dr. Milan Antonijevic（Chair of I3S 2003）
陈洪渊 院士（Chair of I3S 2004）
Prof. Dr. Michael J. Schoening (Chair of I3S 2005)
Prof. Dr. Luigi Zeni (Chair of I3S 2019)
Prof. Dr. Nunzio Cennamo (Chair of I3S 2019)
Prof. Dr. Gianaurelio Cuniberti (Chair of I3S 2021)
Dr. Larysa Baraban (Chair of I3S 2021)

会议信息：

一、会议时间：

2023 年 3 月 29—31 日

二、会议地点：

江苏省，南京市，白金汉爵大酒店（南京栖霞区玄武大道 888 号）

三、会议安排：

- 28 日报到
- 29—31 日会议

四、会务组成员联系方式：

姓名	手机号	负责内容
李 卉	13828736562	总联络人
韩晓雨	15725086069	紧急联络人
姚中芹	18618347174	紧急联络人

会议背景：

随着识别新体系的发现或合成、纳米材料及其特性研究的重大进展，和信号传递原理的不断创新，传感器科学已成为当今科学界最热门的研究领域之一。为促进传感器科学的发展，推广其在各领域的应用，MDPI 出版社及旗下《*Sensors*》在 2003 年创办了“国际传感器科学研讨会（I3S）”系列会议，后分别在法国巴黎、中国南京，德国尤里希，瑞士巴塞尔，西班牙巴塞罗那，中国台湾，意大利那不勒斯举办了第 1—7 届会议。原定于 2020 年 6 月 3—5 日在德国德累斯顿举行的第八次国际传感器科学研讨会因新冠疫情改在 2021 年 5 月 17—28 日网上召开。鉴于中国学者因疫情缺席这次网上会议，经出版社与中国相关编委讨论决定，2023 年 3 月 29—31 日在南京召开“第八届国际传感器科学研讨会—中国分会（I3S-CN 2023）”。

会议主题：

第八届国际传感器科学研讨会—中国分会主题：

- 生物传感器和生物电子学
- 化学传感器
- 物联网和传感器网络
- 可穿戴传感器
- 生物成像
- 光学传感器
- 传感器和执行器

遥感科学研讨会主题：

- 遥感，数据采集和处理
- 遥感应用

会议特邀嘉宾：

李景虹 院士
清华大学

报告人简介：

中国科学院院士、第十二届、十三届全国政协委员，化学系学术委员会主任，清华大学分析中心主任。近年来致力于分析化学、生物分析化学、化学生物学、纳米分析化学、单细胞分析化学、纳米电化学及环境能源电化学等领域的教学科研工作。以通讯作者在 Nature Nanotechnology, Nature Biomedical Engineering, Nature Protocol, J. Am. Chem. Soc., Angew. Chem., Anal. Chem. 等学术刊物上发表 SCI 论文 400 余篇，应邀在 Acc. Chem. Res.，Chem. Rev., Chem. Soc. Rev. 等期刊发表综述，论文被他引 >56,000 次，H-index 122。2014-2022 年连续入选汤森路透全球高被引科学家。以第一完成人获国家自然科学奖二等奖、教育部自然科学奖一等奖、中国分析测试协会科学技术一等奖等。任 Chem. Soc. Rev., ACS Sensors, Biosensors Bioelectronics, Small Methods 等期刊编委。

报告主题：重大突发公共卫生事件中的化学测量学

段洪涛 教授
中国科学院南京地理与湖泊研究所

报告人简介：

段洪涛，曾荣获中科院院长特别奖（2007），全国青年地理科技奖（2013）、中科院青年创新促进会优秀会员（2016）等荣誉称号。2016 年获江苏省杰出青年基金支持。长期从事湖泊水色遥感研究，已主持国家水专项课题（1 项）、国家自然科学基金项目（3 项）、江苏省杰出青年基金（1 项），中科院知识创新工程方向性项目（2 项）等，作为子课题负责人或者课题骨干承担了国家 863 计划、国家支撑计划、国际基础性工作专项、国家高分专项、水专项等科研任务。目前发表 SCI 论文 70 余篇，含 II 区以上 30 篇；第一 / 通讯作者 SCI 论文 20 余篇。

报告主题：湖泊水环境关键参数遥感模型构建与应用

会议特邀嘉宾：

樊磊 教授
西南大学

报告人简介：

樊磊，西南大学地理科学学院教授，博导，中科院遥感地球所与法国农科院联合培养博士，法国农科院博士后。参与研发了被动微波卫星植被含水量产品（L-VOD）及基于 L-VOD 的全球森林碳储量年际产品。专注于利用微波遥感手段估算森林碳储量及其对气候变化、人类活动的响应，以第一 / 通讯作者发表 Nature Geoscience，Nature Plants，Science Advances，Remote Sensing of Environment 期刊论文多篇。

报告主题：基于 L-VOD 的全球森林碳储量与气候变化响应研究

胡俊辉 教授
南京航空航天大学

报告人简介：

胡俊辉 , 东京工业大学博士 , 浙江大学硕士和学士。南航教授 , 长江学者 , IAAM Fellow。研究方向为超声传感与作动。总共发表论文和公开专利 300 多篇（项），其中 SCI 期刊论文 100 多篇，英文专著 Ultrasonic Micro/Nano Manipulations 的唯一作者。 曾获日本电子情报通讯学会 IEICE 论文奖（第一作者）。国际会议主旨 / 邀请演讲 30 余次，并多次担任国际会议大会荣誉主席 / 大会主席 / 科学委员会成员等职。4 家国际学术期刊编委，全国材料与器件智库电子信息材料与器件专家委员会副主任委员。

报告主题：超声催化型单传感器电子鼻的原理、系统集成和算法

会议特邀嘉宾：

刘盛春 教授
哈尔滨工程大学

报告人简介：

黑龙江省超构材料物理与器件省重点实验室创始人、主任。黑龙江大学光纤技术研究所所长。2014-2016 年任美国密西根大学访问研究员，担任多个国际著名期刊审稿人，国家自然基金委评审专家，国家重点研发专项材料与先进制造组评审专家，国防基础科研评审专家，海军重大装备评审专家，科技部人才项目评审专家。从事光纤声学传感器与光声超构材料研究。发表文章 101 篇，其中在 Nature Communications、Advanced Science、Applied Physics Letters、 Optics Letter 等杂志发表 SCI 检索 45 篇（第一或者通信作者 29 篇），EI 文章 27 篇，获得专利 17 项（国防专利一项），申请专利 2 项，出版著作一部。在零色散螺旋超材料领域取得了突破性进展，文章发表在 Nature communications 上。

报告主题：基于高折射率声学超材料复合的光纤声传感

毛兰群 教授
北京师范大学

报告人简介：

教授，博士生导师。理学博士 (华东师范大学)，博士后 (日本东京工业大学)。2002 年 10 月至 2021 年 1 月，在中国科学院化学研究所工作，任研究员，博士生导师；2021 年 1 月起，在北京师范大学化学学院工作。曾获国家杰出青年科学基金资助、入选国家“万人计划”科技创新领军人才、主持基金委创新群体等项目。以第一完成人身份，曾获国家自然科学二等奖 (2015 年度)、北京市科学技术一等奖 (2012 年度)。现主持基金委重大项目，任 ACS Sensors 副主编。

报告主题：脑化学中的传感科学

会议特邀嘉宾：

牛利 教授
广州大学

报告人简介：

牛利，博士，教授，博士生导师，广州大学分析科学技术研究中心主任，广州市敏感材料与器件重点实验室主任。已发表科研论文 410 余篇，他人引用 19000 余次，出版中英文专著 4 部。

报告主题：柔性可穿戴器件—结构设计及应用

邱玉宝 研究员
中国科学院
空天信息
创新研究院

报告人简介：

邱玉宝，中国科学院空天信息创新研究院研究员 , 博士生导师；可持续发展大数据国际研究中心数字环境研究室主任，学术建设委员会委员；负责科技部重点研发专项国际合作重点项目、中科院先导 A 类子课题等多项国家 / 省部级课题，获省部级科技进步二等奖 2 项，第一届 “ScienceDB 科学数据奖” 个人成就奖等。近 5 年来发表论文 80 余篇，获发明专利 8 项，参与编写书 4 部。现担任 Remote Sensing 等期刊编委；任数字丝路（DBAR）国际科学计划秘书处长及高寒区（HiMAC）工作组共同主席；国际地球观测组织（GEO）寒区环境监测计划客座研究员；国际数字地球学会中国国家委员会数字极地专业委员会 秘书长；国际科技数据委员会（CODATA）中国全国委员会 , 青年委员。

报告主题：被动微波大气影响及校正应用研究

会议特邀嘉宾：

吴帆 教授

上海交通大学

报告人简介：

吴帆，上海交通大学计算机科学与工程系教授、博导、系主任，2020 年国家自然科学基金杰出青年科学基金获得者。2004 年获南京大学学士学位，2009 年获美国纽约州立大学布法罗分校博士学位，2009 至 2010 年在美国伊利诺伊大学香槟分校担任博士后研究员，2010 年加入上海交通大学计算机科学与工程系。在无线网络与移动计算、端智能计算、博弈论算法与应用等领域取得了一系列科研成果，已发表学术论文 200 余篇。曾获教育部自然科学奖一等奖、ACM 中国新星奖、CCF- 腾讯犀牛鸟卓越奖、CCF-Intel 青年学者提升计划等。研究项目得到了科技部、国家自然科学基金委、上海市科委、阿里巴巴、腾讯公司等的资助。

报告主题：移动端智能计算

徐静娟 教授

南京大学

报告人简介：

徐静娟 1990 年毕业于武汉大学化学系；1997、2000 年在南京大学分别获得硕士和博士学位。2003 被聘为副教授；2006 被聘为南京大学教授；2007/2008 年度美国康奈尔大学访问教授。2007 年入选教育部“新世纪优秀人才支持计划”，2010 年获得国家杰出青年科学基金资助；2013 年获得中国青年女科学家奖；2014 年入选英国皇家化学会会士; 2014 获批教育部长江学者特聘教授。现为 Analytica Chimica Acta 的编辑。研究方向：光、电化学生物分析。已发表论文 500 余篇。曾获国家自然科学二等奖 1 项，教育部自然科学一等奖 2 项。

报告主题：单细胞电化学分析

会议特邀嘉宾：

夏兴华 教授
南京大学

报告人简介：

夏兴华博士，南京大学化学化工学院教授，长江特聘教授，国家杰出青年。现任生命分析化学国家重点实验室副主任，为十余刊物编委。1986、89 年分别获厦门大学化学系学士和硕士学位，1991 年赴德国波恩大学访问，1996 年获该校博士学位。随后，在德国慕尼黑国防军大学、德国马普协会柏林 Fritz-Haber 研究所、荷兰乌特列支大学任博后。2001 年回国后在光电生物传感、等离激元增强光谱电化学与微纳流控生化分析等方面开展研究。先后主持国家级和省部级项目 30 余项。已在多个期刊发表论文 430 余篇; 撰写专著 4 章，合作翻译《电化学》专著一部，申请中国发明专利 30 件（授权 25 件）。2011 年获教育部自然科学优秀成果一等奖 1 项。

报告主题：等离激元增强光谱电化学分析

张晓兵 教授
湖南大学

报告人简介：

张晓兵，湖南大学教授，博士生导师，英国皇家化学会会士 (FRSC)，长江学者特聘教授，国家杰出青年科学基金获得者，国家“万人计划”科技创新领军人才，国家百千万人才工程入选者。现任湖南大学学术委员会副主任、湖南大学化学化工学院院长。在小分子与纳米荧光探针领域，尤其是固态发光探针与成像分析方面取得了系列创新性的研究成果，主持的“荧光探针性能调控与生物成像应用基础研究”荣获 2020 年国家自然科学奖二等奖。在 PNAS、Nature Commun. J. Am. Chem. Soc., Angew Chem. Int. Ed. 等杂志发表学术论文 30 余篇。现任 Spectrochim. Acta A、《中国科学 - 化学》、《化学学报》、《分析化学》、《分析测试学报》等期刊编委。

报告主题：荧光探针性能调控与活体精准成像应用

会议邀请嘉宾：

（按姓氏首字母排序）

毕　赛　青岛大学
（报告题目：基于 DNA 纳米技术的生物传感与成像分析新方法）

曾景斌　中国石油大学
（报告题目：多模式 / 多通道病原体快检新技术和新方法）

陈　斌　西安交通大学
（报告题目: 基于激光散斑 / 高光谱一体化耦合成像的激光皮肤手术个性化精准诊疗）

郭霞生　南京大学
（报告题目：超声微流控芯片中的物理机制）

雷君君　广东工业大学
（报告题目：声流：用于流体和粒子操纵的执行器）

刘宜伟　中科院宁波材料技术与工程研究所
（报告题目：柔性可穿戴应力 / 应变敏感材料、传感器件与应用）

鲁　平　华中科技大学
（报告题目：光声探测技术）

倪文军　中南民族大学
（报告题目：用于声传感的纤维膜复合器件）

宋继彬　北京化工大学
（报告题目：活体比率成像与分子测量）

孙晴晴　郑州大学
（报告题目：低功耗柔性电子器件的全溶液法制备及其在生物传感器的应用研究）

王　磊　中科院深圳先进技术研究院
（报告题目：介入手术机器人的力觉传感器网络研究）

魏大程　复旦大学
（报告题目：3D 共形覆盖石墨烯膜用于柔性触觉传感器）

会议邀请嘉宾：

武红鹏 山西大学
（报告题目：石英增强光声光热光谱技术研究及应用）

应佚伦 南京大学
（报告题目：纳米孔道单分子电化学智能传感）

张美宁 中国人民大学
（报告题目：植入型电极电分析化学）

张　珽 中科院苏州纳米技术与纳米仿生研究所
（报告题目：柔性可延展智能感知器件与应用）

张袁健 东南大学
（报告题目：氮化碳信号转换与分子传感）

仉　华 河南师范大学
（报告题目：荧光识别信号调节与生物传感）

朱　琨 南京航空航天大学
（报告题目：低成本主动稀疏城市感知）

会议日程：

3 月 29 日 306 厅		
上午	08:30-08:45	开幕式
	08:45-09:25	大会报告
	09:25-11:45	生物成像
下午	12:00-14:00	午休
	14:00-18:00	生物传感器和生物电子学
	18:00-20:00	晚宴
3 月 30 日 306 厅		
上午	08:30-12:00	化学传感器
下午	12:00-14:00	午休
	14:00-16:00	光学传感器
	16:35-17:10	大会报告
	17:10-17:30	闭幕式
3 月 30 日 402 厅		
上午	08:30-10:10	传感器和执行器
	10:30-12:00	可穿戴传感器
下午	12:00-14:00	午休
	14:00-15:55	物联网和传感器网络
3 月 31 日 402 厅		
上午	08:30-12:10	遥感科学研讨会

会议日程：

3 月 29 日 上午—306 厅

- 开幕式
- “生物成像”分会（负责人：鞠熀先）

时间	报告人	单位	题目
8:30-8:45	开幕式		
8:45-9:25	李景虹	院士 清华大学	重大突发公共卫生事件中的 化学测量学
9:25-9:55	夏兴华	南京大学	等离激元增强光谱 电化学分析
9:55-10:15	宋继彬	北京化工大学	活体比率成像与分子测量
10:15-10:35	茶歇 + 海报		
10:35-10:55	孙晴晴	郑州大学	低功耗柔性电子器件的全溶液法制备及其在生物传感器的应用研究
10:55-11:15	郭英姝	齐鲁工业大学	生物膜仿生载体在肿瘤细胞成像及诊疗中的研究
11:15-11:30	钱若灿	华东理工大学	基于 DNAzyme 的细胞表面工程与调控
11:30-11:45	余 辉	上海交通大学	表面等离子体共振成像 生物传感技术

会议日程：

3 月 29 日 下午—306 厅

- “生物传感器和生物电子学”分会（负责人：鞠熀先）

时间	报告人	单位	题目
14:00-14:30	毛兰群	北京师范大学	脑化学中的传感科学
14:30-14:50	仉 华	河南师范大学	荧光识别信号调节与生物传感
14:50-15:10	张袁健	东南大学	氮化碳信号转换与分子传感
15:10-15:25	张 彦	济南大学	柔性功能纸芯片的构建与光电生物传感分析
15:25-15:40	彭花萍	福建医科大学	金纳米团簇电化学发光探针设计及传感应用
15:40-15:55	梁阿新	北京理工大学	新型生物传感器研制及其在生物分析与医学检测中的应用
15:55-16:20	茶歇 + 海报		
16:20-16:50	牛 利	广州大学	柔性可穿戴器件—结构设计及应用
16:50-17:10	应佚伦	南京大学	纳米孔道单分子电化学智能传感
17:10-17:30	毕 赛	青岛大学	基于 DNA 纳米技术的生物传感与成像分析新方法
17:30-17:45	王 婷	南京邮电大学	柔性界面上的生物感知
17:45-18:00	杜 衍	中科院长春应用化学研究所	新型探针技术用于病原体便携式体外诊断
18:00-20:00	晚宴		

会议日程：

3 月 30 日 上午—306 厅

- “化学传感器”分会（负责人：鞠熀先）

时间	报告人	单位	题目
8:30-9:05	张晓兵	湖南大学	荧光探针性能调控与活体精准成像应用
9:05-9:25	陈 斌	西安交通大学	基于激光散斑 / 高光谱一体化耦合成像的激光皮肤手术个性化精准诊疗
9:25-9:45	张美宁	中国人民大学	植入型电极电分析化学
9:45-10:00	田蒋为	中国药科大学	荧光阵列传感器构建及其在肾损伤进程识别与药物评价中的应用
10:00-10:20	茶歇 + 海报		
10:20-10:50	徐静娟	南京大学	单细胞电化学分析
10:50-11:10	曾景斌	中国石油大学	多模式 / 多通道病原体快检新技术和新方法
11:10-11:30	王蔚芝	北京理工大学	基于活性多肽的高选择性识别测量
11:30-11:45	陈 怡	东南大学	微纳序构等离激元薄膜材料构建及生物传感应用
11:45-12:00	桑雨倩	清华大学	基于单颗粒示踪的细菌集群行为的时空分析

会议日程：

3 月 30 日 上午—402 厅

- “传感器和执行器”分会（负责人：胡俊辉）
- “可穿戴传感器”分会（负责人：李润伟）

时间	报告人	单位	题目
8:30-9:00	胡俊辉	南京航空航天大学	超声催化型单传感器电子鼻的原理、系统集成和算法
9:00-9:20	郭霞生	南京大学	超声微流控芯片中的物理机制
9:20-9:40	雷君君	广东工业大学	声流：用于流体和粒子操纵的执行器
9:40-9:55	马凯鸣	大连理工大学	基于二维电子气结构的 GaN 霍尔传感器
9:55-10:10	王 旭	南京林业大学	基于碳材料 /PDMS 多层结构的电容柔性触觉传感器制备方法与特性研究
10:10-10:30	茶歇 + 海报		
10:30-10:50	魏大程	复旦大学	3D 共形覆盖石墨烯膜用于柔性触觉传感器
10:50-11:10	张珽	中科院苏州纳米技术与纳米仿生研究所	柔性可延展智能感知器件与应用
11:10-11:30	刘宜伟	中科院宁波材料技术与工程研究所	柔性可穿戴应力 / 应变敏感材料、传感器件与应用
11:30-11:45	梁 波	浙江大学	导电水凝胶生物传感界面高精度修饰方法研究与应用
11:45-12:00	张 强	中科院长春应用化学研究所	生理信息在线监测

会议日程：

3 月 30 日 下午—306 厅

- “光学传感器”分会（负责人：鲁平）
- 闭幕式

时间	报告人	单位	题目
14:00-14:20	倪文军	中南民族大学	用于声传感的纤维膜复合器件
14:20-14:50	刘盛春	哈尔滨工程大学	基于高折射率声学超材料复合的光纤声传感研究
14:50-15:10	武红鹏	山西大学	石英增强光声光热光谱技术研究及应用
15:10-15:30	鲁 平	华中科技大学	光声探测技术
15:30-15:45	黄小丹	常州机电职业技术学院	多光谱窄带宽表面晶格共振传感器
15:45-16:00	潘宇峰	华中科技大学	基于光声光谱的高灵敏度二氧化氮检测
16:00-16:10	徐畅	北京理工大学	可变分辨率的压缩感知高光谱计算成像方法
16:10-16:35	茶歇 + 海报		
16:35-17:10	闭幕报告		
17:10-17:30	闭 幕 式		

会议日程：

3 月 30 日 下午—402 厅

- “物联网和传感器网络”分会（负责人：戴海鹏）

时间	报告人	单位	题目
14:00-14:30	吴 帆	上海交通大学	移动端智能计算
14:30-14:50	王 磊	中科院深圳先进技术研究院	介入手术机器人的力觉传感器网络研究
14:50-15:10	朱 琨	南京航空航天大学	低成本主动稀疏城市感知
15:10-15:25	周 剑	南京邮电大学	基于多源迁移学习的水质预测方法
15:25-15:40	吴亚萍	南京工业大学	基于时序神经网络的密码猜测模型
15:40-15:55	伍晓明	清华大学	基于碰撞能量收集的自主传感器节点
请前往 306 厅享用茶歇并参加闭幕式			

会议日程：

3 月 31 日 上午—402 厅

- 遥感、数据采集和处理；遥感应用
- 负责人：居为民、张永光

时间	报告人	单位	题目
8:30-9:00	段洪涛	中科院南京地理与湖泊研究所	湖泊水环境关键参数遥感模型构建与应用
9:00-9:30	邱玉宝	中科院空天信息创新研究院	被动微波大气影响及校正应用研究
9:30-10:00	樊 磊	西南大学	基于 L-VOD 的全球森林碳储量与气候变化响应研究
10:00-10:30	茶歇 + 海报		
10:30-10:50	吴祖航	国防科技大学	利用星地联合观测揭示 2021 年强台风“烟花”的降水微物理特征
10:50-11:10	吕凡超	南京气象科技创新研究院	基于地面电磁测量的雷暴高能辐射研究
11:10-11:30	周玥彤	北京航空航天大学	基于毫米波雷达的非视域移动目标检测方法
11:30-11:50	徐于月	南京大学	我国各流域 2002-2016 年地下水储量时空变化特征及原因分析
11:50-12:10	周艳莲	南京大学	近三十年全球植被生产力对干旱的敏感性增加

已接收摘要

DNA Methylation Sensors and Artificial Intelligence Techniques †

Gerardo Alfonso Perez and Javier Caballero Caballero Villarraso

Universidad de Cordoba

† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Technological advancements in recent years have created an explosion of genetic data. For instance, sensors detecting DNA methylation data have expanded their capabilities greatly with in recent years. The first generation Illumina methylation sensors were able to detect approximately the methylation levels of 27,000 different CpGs islands, which was by itself a technological achievement. Second generation sensors were able to drastically increase data availability reaching approximately 450,000 CpGs and third generation machines nearly double this amount reaching 850,000 CpGs. This increase in the amount of data that sensors can detect is clearly a scientific and technological advancement but it has created the need for tools able to manage such large volume of data. In this regard it seems natural to combine this type of sensor with the processing capabilities of artificial intelligence techniques. More specifically we have used DNA methylation data obtained from second generation sensors as inputs for techniques such as neural networks and support vector machines to detect the presence of neurological illnesses such as Alzheimer disease. One of the challenges when using non-linear approaches is to actually identify the relevant CpGs filtering out noise or unrelated data. The combination of third generation sensors and artificial intelligence techniques can generate accurate forecasts for this type of illnesses.

Rapid and Online Detection of Water Toxicity Based on Microbial Electrochemical Sensor: Optimization Strategies and Practical Applications †

Zhipeng Mao [1], Yuxuan Zang [2], Fan Zha [3], Lin Luo [1], Baoguo Wang [1], Hongyu Zhao [2], Bo Cao [2] and Yue Yi[1]

[1] Beijing Institute of Technology

[2] Beihang University

[3] Infore Environment Technology Group

† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Microbial electrochemical sensor (MES) is capable to detect water toxicity and has the advantages of low cost, easy operation, rapid response, and online detection. However, the sensitivity of MES is relatively low. To address this limitation, key parameters, including inoculum, control mode, and configuration, were optimized. The results demonstrated that mixed culture MESs exhibited obvious individual differences in the sensitivity of water toxicity detection, which was due to that microbial communities are usually different among different MESs. To solve this problem, a pure culture MES was developed with *Shewanella loihica* PV-4. Comparing with mixed culture MESs, the sensitivity of S. *loihica* PV-4 MESs were improved by 78%–132%. This phenomenon was due to that S. *loihica* PV-4 formed a looser biofilm and secreted a lower content of extracellular polymeric substances (EPSs). To further reduce the EPS contents, the control mode of MES was optimized, and the sensitivity of S. *loihica* PV-4 MES was increased by 6.1 times when MES was operated with constant potential (CP) mode instead of external resistance (ER) mode; this was due to the eliminated offset current and lower resistance of anodic biofilm under CP mode. A novel configuration was designed by using computational fluid dynamics analysis, further enhancing the sensitivity. Based on these results, the prototype of water toxicity detection based on MES was established, and was used for long-term water quality monitoring. These studies provide a solid foundation for the practical application of MES, and are beneficial for the development of water quality monitoring.

Study of A Multichannel Electrochemical Biosensor for SARS-CoV-2 Antigen and Study of Recognition Mechanism †

Axin Liang and Aiqin Luo

School of Life Science, Beijing Institute of Technology

† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Since the outbreak of Corona Virus Disease 2019 (COVID-19), accurate, efficient, fast and convenient screening methods for Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) have always been the most important part of epidemic prevention and control. Existing detection methods are mainly based on the continuous multiple detection of a single SARS-CoV-2 antigen, which has the risk of delaying diagnosis, cannot meet the needs of early screening, and greatly increases the cost. In this project, a new method for the highly sensitive simultaneous detection of multi-sample SARS-COV-2 antigens is designed, which provides an efficient way to carry out specific screening of SARS-CoV-2 antigens with SARS-CoV-2 spike proteins and nucleocapsid proteins as objects. Firstly, an electrochemical signal amplification detection system is designed by using multifunctional nanomaterials. Then, a multi-channel molecularly imprinted electrochemical sensor is designed to realize the specific recognition of the target. Finally, the molecular dynamics simulation combined with the experiment is used to reveal the recognition mechanism of molecularly imprinted sensor for target protein. The strategy in this project is expected to improve the efficiency of SARS-CoV-2 screening, benefiting for the development of early and rapid screening tools for COVID-19.

A glucose/O_2 Biofuel Cell Integrated with Exonuclease-Powered DNA Walker for Self-Powered Sensing of MicroRNA †

Xiao Zhao

Institute of Chemical and Life Sciences, Nanjing University of Posts and Telecommunications

† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Enzymatic biofuel cell (EFC) based self-powered sensors have received extensive attention in recent years due to its advantages including no requirement of external power source, easy miniaturization, simple instrumentation, and easy operation. To establish the relationship between the concentrations of enzymatic-reaction-irrelevant analytes and the output signals of EFC based self-powered sensors, the development of efficient strategy for constructing EFC based self-powered sensors is of great importance. We report here a novel self-powered sensor for sensitive detection of miRNA-141 by introducing an exonuclease-powered DNA walker into a glucose/O_2 biofuel cell. With the aid of the exonuclease-powered DNA walker, the amount of glucose oxidase immobilized on the bioanode can be facilely tailored by varying the concentration of microRNA-141, so a glucose/O_2 biofuel cell is employed as a self-powered sensor for sensitive and slective detection of microRNA-141. Due to the great signal amplification of exonuclease-powered DNA walker, the self-powered sensor shows high sensitivity and low detection limit (45 aM) for detecting miRNA-141. In addition, the self-powered sensor has wide dynamic range (100 aM–0.1 nM), good selectivity, and accepted storage stability. The combination of EFC and DNA walker lays the foundation for the construction of portable sensors.

A LAMP Device for A Rapid and Cost-Effective Detection of Bacterial Pathogens †

Sumeyra Vural-Kaymaz [1] and Meltem Elitas [2]

[1] Faculty of Engineering and Natural Sciences, Sabanci University, 34956, Istanbul, Turkey
[2] Sabanci University Nanotechnology Research and Application Center, 34956, Istanbul, Turkey
† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Detection and identification of bacterial pathogens plays a crucial role for on-field diagnosis in clinics, food safety, agriculture, farming, and security. Majority of the nucleic acid detection methods are labor intensive, time consuming, require specialized equipment and trained users. However, field-deployable pathogen diagnostics require low-cost, rapid, reliable, robust, and simple-to-use techniques. Here, we developed a rapid, specific, and sensitive platform for visual detection of *E.coli* pathogen using a loop-mediated isothermal amplification (LAMP) reaction including phenol red reagent. In this approach, we use a colony of *E. coli* cells as an input and obtain colorimetric detection as an output at 65 °C in 30 min. We exclude nucleic acid extraction from a bacterial colony. Our LAMP-based diagnosis relies on amplification of *malB* gene which is conserved across diverse lineages of *E.coli* but nor for another gram-negative bacteria. Our device consists of a vacuum thermos cup, low-cost electronic components, a polydimethylsiloxane (PDMS) sample well, a fast prototyped case that covers electronic components and power supply connection (70 g, ~32 Euro). We demonstrated that the steady-state temperature error of the system is less than 1%. We characterized sensitivity of our system using *E. coli* colonies in different sizes (1 mm–2.5 mm) in the colony LAMP and colony PCR reactions. Moreover, we prepared serial dilutions of *E.coli* genomic DNA (1%, 10%, 100%) and performed conventional LAMP assay. Our LAMP platform provided rapid, specific, and sensitive *E. coli* detection using a colony-LAMP assay, which is feasible for studies in the field or resource-limited settings.

A Novel Acupuncture Needle-Based Transistor Microsensor for in Vivo Monitoring of Neurotransmitter †

Yutao Li

Hubei university of Chinese medicine
† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Chemical communication via neurotransmitters is central to brain functions. Nevertheless, in vivo real-time monitoring of neurotransmitters released in the brain, especially the electrochemically inactive molecules, remains a great challenge. In this work, a novel needle FET microsensor based on an acupuncture needle is proposed, which is capable of real-time monitoring dopamine molecule as well as neuropeptide Y in vivo. The FET microstructure was fabricated by successively wrapping an insulating layer and a gold layer on the top of the needle, where the needle and the Au served as the source and drain, respectively. After assembling reduced graphene oxide (RGO) between the source and drain electrodes, the specific aptamer was immobilized on the RGO, making this needle-FET biosensor highly selective to real-time monitor neurotransmitters released from rat brain as well as in a Parkinson's diseases model. The excellent sensitivity of the needle-FET biosensor enabled sub-nanomolar dopamine to be detected in rat brains in a real-time manner with minimal damage, which is the lowest among in vivo analyses. In addition, this needle-shaped FET could be polished, refreshed, and re-functionalized for repeated use with guaranteed detection quality. By constructing a FET sensing interface on an acupuncture needle, this work provides a new sight in the FET domain and establishes a new method for probing electrochemically inactive molecules in vivo.

A pH-sensitive Field-Effect Transistor for Monitoring of Cancer Cell External Acid Environment †

Ling Xiao, Yu-Tao Li and Guo-Jun Zhang

Hubei University of Chinese Medicine

† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: The external acid environment of cancer cells is different from that of normal cells, making a profound impact on cancer progression. Here we report a simple poly-L-lysine-modified graphene field-effect transistor (PLL@G-FET) for in situ monitoring of extracellular acidosis around cancer cells. PLL is a well-known material with good biocompatibility and is rich in amino groups that are sensitive to hydrogen ions. After a simple drop-casting of PLL on the reduced graphene oxide (RGO) FET surface, the PLL@G-FET was able to realize the real-time monitoring of the localized pH change of cancer cells after the cancer cells were grown on the device. The PLL@G-FET sensor achieved a Nernstian value of 52.9 mV/pH in phosphate buffer saline from pH 4.0 to 8.0. In addition, the sensor exhibited excellent biocompatibility as well as good anti-interference ability in the cell culture medium. Furthermore, the device was used to real-time monitor the extracellular pH changes of MCF-7 cells under the intervention of different concentrations of drugs. This developed pH-sensitive FET provides a new method to study the extracellular acid environment in situ and helps us to enhance our understanding of cancer cell metabolism.

Ag Nanoparticles with Ultra-Thin Au Shells-Based Lateral Flow Immunoassay for Colorimetric and SERS Dual Mode Detection of SARS-CoV-2 IgG †

曾景斌 , 梁鹏辉

China University of Petroleum

† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: In order to accurately diagnose the disease progression of SARS-CoV-2 infection, immunoglobulin detection is the essential link, among which, SARS-CoV-2 IgG detection is one of the most important means. In this paper, the Ag nanoparticles with ultra-thin Au shell (AgMBA@Au) nanotag embedded with 4-mercaptobenzoic acid (MBA) was manufactured and integrated into the lateral flow immunoassay (LFIA) system to provide excellent Raman scattering signal and detectability for antibody testing to develop a sensitive and quantitative LFIA for colorimetric and SERS dual mode detection of SARS-CoV-2 IgG. The rabbit anti-human antibody is modified on the AgMBA@Au nanotag, and the test line is sprayed with SARS-CoV-2 spike protein. The presence of antibodies is determined by the color change on the test line (T-line). In addition, by measuring the characteristic Raman peak intensity of MBA in the immunoprobe captured by the coated antigen, the quantitative detection of SARS-CoV-2 IgG is realized. The detection limit (LOD) of SERS-based LFIA for SARS-CoV-2 IgG is 0.522 pg/mL. Subsequently, we collected 98 vaccinated and 9 unvaccinated serum samples. The test results are almost the same as the commercially available ELISA kits, and are significantly better than the commercially available colloidal gold kits. Therefore, this dual-mode LFIA immunosensor has good sensitivity and reproducibility, can be used for the screening and traceability of the early immune response of SARS-CoV-2, and has the potential to study the diagnostic or prognostic utility of IgG in serum.

An Integrated Microsystem of Magnetic Separation and FET Sensing for Specific Detection of Tumor-Derived Exosomal MiRNA10b †

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Abstract: Tumor-derived exosome (TD-Ex) serves as a crucial early diagnostic biomarker of pancreatic cancer (PC). However, accurate identification of TD-Ex from PC is still a challenging work. In this paper, a detection microsystem that integrates magnetic separation and FET biosensor is developed, which is capable of specifically separating TD-Ex of PC from the plasma and detecting exosomal miRNA10b in a sensitive and specific manner. Dual antibody (GPC-1 antibody and EpCAM antibody) were simultaneously immobilized on carboxyl-functionalized magnetic beads, after which the PC -derived exosomes were magnetically isolated and enriched due to specific recognition of two antibodies with the surface antigens on the exosomal surface. On the other hand, a peptide nucleic acid (PNA)-functionalized reduced graphene oxide field-effect transistor (RGO FET) biosensor was subsequently utilized to specifically detect the exosomal miRNA10b, which is highly expressed in PC derived exosomes. This system could achieve a low detection limit down to 100 fM, and specifically identify miRNA10b from single-base mismatched miRNA. In addition, 20 clinical plasma samples were tested with this microsystem, and the results indicate that it could effectively distinguish PC patients from healthy individuals. The assay combines specific capture and enrichment of PC derived exosome- with sensitive and specific detection of exosomal miRNA, showing its potential to be used as an effective scheme for PC early diagnosis.

$Bi_2O_3/CuBi_2O_4$ Enabled Photoelectrochemical Sensing for the Healthcare, Environment Monitoring, and Food Safety †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Aflatoxin attracts an ever-growing concern due to its serious harm. Current detection methods lack sensitivity and anti-interference capacity, which can be addressed by introducing high-performance photoelectrochemical photocathodic biosensors. Here, we synthesized a $Bi_2O_3/CuBi_2O_4$ Z-scheme heterojunction and constructed a photoelectrochemical biosensor for the healthcare, environment monitoring, and food safety. The $Bi_2O_3/CuBi_2O_4$ Z-scheme heterojunction demonstrated a high surface area and good visible light response. The photoelectrochemical sensor showed a wide linear range from 1.4 pg/mL-280 ng/mL, recoveries of 84.6%-117% in wheat, peanut, lake water, and urine by spiked experiments. The satisfied repeatability, reproducibility, stability, and specificity of the $Bi_2O_3/CuBi_2O_4$-based PEC biosensor indicated a promise for application in healthcare, environment monitoring, and food safety. A high agreement of detection results was recorded between this photoelectrochemical biosensor and high-performance liquid chromatography-tandem mass spectrometry. This work is envisioned to allow effective mycotoxin detection.

Chemically Mediated Artificial Neuron †

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Abstract: Current brain-machine interface (BMI) mainly relies on electrophysiological signal for interpreting and transmitting neuronal information. In contrast, in biological systems, neurotransmitters are chemically-based inter-neuron messengers contributing to intelligent behaviors. This communication modality mismatch might lead to incomprehensive or even incorrect interpretation of neuronal information. Here, we report a chemically mediated artificial neuron that can receive and release the neurotransmitter dopamine (DA) adaptively. The artificial neuron detects DA via a DA sensor, processes the sensory signals with synaptic plasticity using a memristor device, and stimulates the DA release through a heat-responsive hydrogel. The system responds to DA exocytosis from rat pheochromocytoma (PC12) cells and releases DA to activate PC12 cells, forming a chemical communication loop like interneurons. Moreover, the artificial neuron enables DA to trigger the controllable movement of a mouse leg, transmitting information to an afferent nerve. Such an artificial neuron, when benchmarked against an electrically-mediated artificial neuron, enables the chemical BMI using neurotransmitters as interfacial messengers. This paves the way for neuron rehabilitation, cyborg construction, and consciousness control.

Co-Reactant Mediated Low Potential Electrochemiluminescence Platform and Its Immunosensing Application †

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Abstract: Screening high performance anodic electrochemiluminescence (ECL) systems with low triggering potential is a promising way to broaden their applications. Herein, a novel co-reactant mediated high performance low potential Au nanocluster (AuNC)-based ECL system has been successfully developed. Benefiting from the isopropyl substitution and hydroxyl addition to the triethylamine (TEA), the BSA-AuNC/2-(diisopropylamino)ethanol (DIPEA-OH) ECL system achieved higher energy efficiency at a lower potential of 0.75 V. In addition, compared with BSA-AuNC/TEA system, the ECL intensity and quantum yield (ΦECL) with DIPEA-OH as co-reactant increased 22.34-fold and 13-fold (as high as 68.17%), respectively. Based on the high performance of the AuNC/DIPEA-OH ECL system, a sandwich-type immunosensor has been constructed for highly selective SARS-CoV-2 N protein assay. In the absence of any complex signal amplification strategies, the ECL immunosensor for SARS-CoV-2 N protein detection showed a linear range of 0.001–100 ng/mL and a detection limit of 0.35 pg/mL. Moreover, the ECL platform had good reproducibility and stability, and exhibited acceptable detection performance in the detection of actual serum samples. This work establishes a framework for indepth design and study of anode ECL co-reactants for AuNCs and other luminophore, and expands the potential application of ECL sensors in the clinical diagnosis of COVID-19.

Construction of ECL Biosensor Based on Au/GDY and GDYO QDs for MiRNA-21 Detection with 3D DNA Walker Amplification †

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Guangxi Minzu University

† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: MicroRNAs (miRNAs), as regulators of gene expression and cellular function, have emerged as important biomarkers for the diagnosis of cancer. Graphdiyne oxide quantum dots (GDYO QDs), as derivatives of graphdiyne (GDY), have excellent biological activity due to their active acetylene units. Herein, an ECL biosensor for miRNA-21 detection based on Au/GDY and GDYO QDs with 3D DNA walke amplification was constructed. As the electrode substrate material, Au/GDY can not only bond with the aptamer CP through the Au-S bond, but also enhance the conductivity of the interface. In the presence of miRNA-21, the CHA process was initiated and the signaling probes were introduced into the electrode surface, producing abundant double-stranded H1/H2. Furthermore, GDYO QDs were electrostatically adsorbed to the amino-bearing H4 terminus. H3/H4 undergoed complementary base pairing with H1/H2 through HCR to form a 3D DNA walker amplification technology. With the increase of miRNA-21, the 3D DNA walker was activated, leading to the recycling of the target, and more GDYO QDs appear on the electrode surface, resulting in the ECL signal. Under the optimal conditions, the proposed electrochemical biosensor exhibited an excellent performance for amplification detection of miRNA-21 in the range from 10 pM to 1 mM with a detection limit of 0.9 pM. It provides a selective and sensitive platform for clinical analysis of miRNAs, with great potential for early cancer diagnosis.

Controllable Patterning of Conductive Hydrogel and Its Biosensing Applications † 导电水凝胶生物传感界面高精度修饰方法研究与应用

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: We proposed a controllable patterning strategy for porous MXene hydrogel applying a metal-assisted electro-gelation method in this paper. A high spatial resolution down to micro-meter level is achieved utilizing the method, enabling high-performance hydrogels with more complex architectures, showing multiple applications in wearable physical and biochemical sensing fields.

导电水凝胶融合导电性和柔软性，可以匹配人体组织的机械力学性能，在过去几年里引起了可穿戴设备、可植入生物传感器和人工皮肤等领域的极大的关注。本研究围绕生物传感器中的导电水凝胶电子界面展开研究，探究了金属离子辅助电凝胶化机制，提出了导电水凝胶高精度修饰方法，拓展了导电水凝胶在生理生化传感与机器触觉传感领域的高灵敏高分辨应用。

Developing a Smart Textile Sensor for Monitoring Electromyography(EMG) Bioelectrical Signals †

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Abstract: Electromyographs are universally applicable diagnostic systems that can record, amplify, and measure the bioelectric activity of muscles and nerves under various circumstances. To monitor the muscle activity gel dependent silver/silver chloride surface electrodes are predominantly used. But these electrodes show several disadvantages such as skin irritation and inflexibility which makes long-term monitoring unsuitable. Because of these and other reasons, the demand for dry biopotential electrodes is increasing. This study aims to develop a textile-based dry electrode with optimum size and shape for electromyogram measurement compared to the conventional electrode. This includes investigating the dimensions, materials, production techniques, and structure of the electrodes. Targeted properties are functionality, comfort, and textile characteristics. Three electrodes with the best configuration and with the lowest skin-electrode impedance will be used for the construction of the textile. Two of the electrodes are measurement electrodes and the third one is the reference electrode. The electromyogram signal acquired using the developed electrodes as well as the functional electrodes will be analyzed using the BioPak student lab. Finally, to make the device portable, the textile electrode will be integrated with a microcontroller and an advanced Myo-ware muscle sensor. Data will be collected from 10-15 healthy participants of both genders with normal body mass index.

Development of Immunoassays to Detect Phthalates in Environmental Water Sources †

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Abstract: Phthalates are widely used as plasticizers for various consumer products. Dibuthyphthalate (DBP) and diethylphthalate (DEP) belong to the most widely applied phthalates. They contaminate various environmental objects and cause significant risks for human health. Therefore, simple and cost-effective methods to detect phthalates are in demand. Immunoassays such as enzyme-linked immunosorbent assay (ELISA) and fluorescence polarization immunoassay (FPIA) are efficient analytical approaches that meet the above requirements. The aim of this work is to develop immunoassays for quantitative determination of phthalates and their metabolites in environmental water samples. For this purpose, the obtained polyclonal antibodies against the conjugates of cationized bovine serum albumin and amino derivatives of phthalates were used. The preparations were tested in terms of their affinity and selectivity. Fluorescein-labeled tracers were synthesized from the amino derivatives of DBP or DEP with various fluorescein-containing labels and applied in the FPIA. The study included comparisons of mono- and di-substituted phthalates as immunogens and detectable analytes in various combinations. For the chosen antibodies, ELISA and FPIA protocols were developed and optimized. The reached limits of detection for the both assays were near 100 ng/mL. In contrast to ELISA with two hours duration, the time for FPIA performance was 1 min per each tested sample, and the assay can be performed using a portable detector under out-of-lab conditions. Environmental water samples taken in Moscow region, Russia were successfully tested by the proposed immunotechniques.

Electrochemical Sensors for Plant Signal Molecules †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: The one of the key breakthrough for the research of botany or agricultural technology in future is the development and application of high precision, intelligent, and field-deployable sensors, especially for the plant signal molecules. Plant signal molecules, such as Hydrogen peroxide, NO, Ca^{2+}, auxin (mainly indole-3-acetic acid), salicylic acid, abscisic acid, cytokinin, and jasmonates, etc, play important roles in regulating plant growth and development, and coping with the environment. It is very important for the basic research of botany and the development of intelligent agriculture to obtain the dynamic changes of plant signal molecules in plants in *situ*, in *time*, and intelligently. The electrochemical method provides a convenient way for in *situ* or real-time detection of them in plants because of its easy operation, high sensitivity, and selectivity for detecting and quantifying. Therefore, the constructions of in *situ* intelligent electrochemical sensors for plant signal molecules not only promote the basic research of botany, but also contribute to the development of smart agriculture, which is of great significance.

Hierarchical Porous MOFs as Microreactor for Self-Powered Biosensing of MicroRNA Integrated with Signal Amplification †

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Abstract: Enzymatic biofuel cell (EBFC) generally suffered from limited loading efficiency, low catalytic activity or poor stability of bioenzymes, which greatly restricted the development of EBFCs. Herein, hierarchical porous MOF is constructed by structural etching and used as biocatalytic microreactor to construct a "signal-on" EBFC-based self-powered biosensor for the ultrasensitive detection of microRNA-21 (miRNA-21) integrated with topological DNA tetrahedron-mediated dual signal amplification. Glucose dehydrogenase (GDH) and NAD+ cofactor are co-immobilized into zeolitic imidazolate framework system (ZIF-L) by one-pot method. Then the tannic acid (TA) controlled-etching expands the size of the pores in NAD+/GDH-ZIF-L and enables the enzyme reorientation in their lower surface energy form, therefore enhancing the cofactor-dependent enzyme biocatalysis compared with that in homogeneous solution. Meanwhile, topological DNA tetrahedron associated with ZIF-L microreactor acts as miRNA-responsive lock to restraint the glucose anodic oxidation. After addition of target miRNA-21, miRNA-triggered release of DNA tetrahedron can be amplified by exonuclease III (Exo III)-catalyzed additional unlocking cycles and the released DNA tetrahedron further triggers the cathodic hybridization chain reaction (HCR) reaction for two-stage signal amplification. Consequently, the "signal-on" self-powered biosensor for the ultrasensitive and selective detection of miRNA is realized by integrating NAD+/GDH-ZIF-L-TA-based EBFC with two-stage signal amplification strategy. The as-proposed self-powered biosensor shows ultrahigh sensitivity with the detection limit of 2 aM and realizes the accurate disease identification, which hold great potential in clinical applications.

Miniature Microwave Biosensor for Early Diagnosis of Skin Diseases †

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Xidian University

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Abstract: For a long time, skin diseases have caused great trouble to people's health. Malignant skin diseases such as melanoma, the most dangerous skin cancer, can even be life-threatening, which caused more than thousands of deaths in the U.S. every year. Timely diagnosis of malignant skin diseases is of great significance to prevent the deterioration of the disease. Traditional detection methods for early detection of skin diseases mostly relies on biopsy, which often takes long time for inspection and may cause damage to human body during biopsy. Unlike traditional detection methods, microwave biosensor effectively improves the detection efficiency of skin diseases and it can detect the skin noninvasively due to the penetration of microwave. The unhealthy skin can be distinguished through its reflection characteristics of microwave signal. Compared with other detection technologies such as X-rays and MRI, microwave biosensor has smaller size and lower detection cost, which is suitable for the demand of point-of-care test(PoCT). With the development of integrated circuit technology and Internet of things(IoT), microwave biosensor will play an important role in the field of wearable health monitoring devices and mobile health, and the detection efficiency of skin diseases will be greatly improved. In this work, we introduced the research progress of microwave biosensor for early diagnosis of skin disease, and several representative microwave biosensors were introduced. We also introduced the front research direction of microwave biosensors. In the end, we demonstrated the great application potential of microwave biosensor in medical testing in the future.

MXene and Their Composites for Photoelectrochemical Biosensors †

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Abstract: Here, we demonstrate the integration of titanium carbide ($Ti_3C_2T_x$) MXenes in photoelectrochemical biosensors designed to detect cancer biomarkers such as CD44 and PSA in an aqueous system. Photoelectrochemical (PEC) sensors have established themselves as a flexible analytical tool that integrates well with many existing applications. However, recombination between charge carriers is a bottleneck problem that reduces the overall signal reliability of the PEC biosensor. We demonstrate the potential of MXene-$Ti_3C_2T_x$ as a conductive substrate and as an analytical platform for in-situ engineering of an efficient hybrid composite system capable of realizing fast charge transfers and greater signal sensitivity and wider detection ranges compared to conventional biosensor systems. $Ti_3C_2T_x$ as model material was allowed to partially oxidize with different photo-active nanomaterials such as $NiWO_4$ and $BiVO_4$, where the construction heterojunction had a unique, intimate configuration with formed TiO_2 (oxidized MXenes), resulting in an energy level-cascade that permits minimal charge-carrier recombination besides robust photocatalytic redox activity. The improved photoactivity and strong heterojunction arrangement resulted in a sensitive signal capable of identifying CD44 in a broad concentration window ranging from 2.2×10^{-4} ng mL^{-1} to 3.2 ng mL^{-1}, with a detection limit of 1.4×10^{-2} pg mL^{-1}. In the case of PSA, a detection range of 1.2 fg mL^{-1} to 0.18 mg mL^{-1} and a detection limit of 0.15 fg mL^{-1} were observed.

On-Site Detection of Water Toxicity Based on Freeze-Dried Electrochemically Active Bacteria †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Our previous studies have reported water toxicity detection with suspended electrochemically active bacteria (EAB) as the sensing element, which exhibits high sensitivity and has great prospects in the early warning of water pollution. However, these studies depend on fresh EAB suspension, which fails to detect water toxicity on-site due to time-consuming microbial cultivation. To solve this problem, the study first investigated the freeze drying of EAB cells, the rehydration of freeze-dried EAB, and on-site detection of water toxicity with rehydrated EAB. EAB model strain *Shewanella oneidensis* MR-1 was used in the study. Results demonstrated that the optimal cryoprotectant for freeze-dried *S. oneidensis* MR-1 was 7.5% skimmed milk powder. Comparing with fresh *S. oneidensis* MR-1, rehydrated *S. oneidensis* MR-1 exhibited similar EET performance (74.7% ± 0.3%) and slightly lower water toxicity sensitivity (65.8% ± 2.2%) with the optimal cryoprotectant. On-site detection of water toxicity was realized by using rehydrated *S. oneidensis* MR-1, and the detection limit of typical toxic pollutants achieved 0.5 mg/L. The on-site detection is capable to resist common interferences and shows high accuracy in practical applications.

Plasmonic Imaging: from Single Particle Imaging to Single Molecule Sensing †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Surface plasmon resonance (SPR) biosensors are the gold standard for measuring the kinetics of molecular binding. With the advancement in optical technology, SPR microscopy has been developed and found unique applications in single-cell and single-particle analysis. This plasmonic imaging platform is label-free, real-time and quantitative, which provides an alternative to complement the fluorescence microscopy. Our group has been working on plasmonic imaging to further improve the sensitivity for single-molecule imaging, and to apply it for ultrasenstiive single-molecule biosensing. In this talk, I will introduce the basic concepts of plasmonic imaging, present the recent advancements in this field, and report some of the ongoing projects in our group.

Sensing Science in Brain Chemistry †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Development of new sensing strategies and methodologies to directly, selectively, and sensitively record chemical signals of neurons during brain functions has drawn increasing attention because information on the dynamics of chemical signals is very essential to understanding the chemical essence involved in brain functions, for example, neurotransmission and diagnosis and therapy of brain diseases. However, the chemical and physiological complexity of the central nervous system (CNS) unfortunately make this pursuit very challenging to the conventional sensing/analytical protocols. Aiming at this challenge, we have been working on sensing science in live brain ranging from mechanistic development (mainly with rationally modulating electrode/brain interface) to in vivo understanding brain chemistry. This topic will focus on our recent attempts on sensing science in live brain based on rational design and regulation of electrode/brain interface and its application for in vivo understanding brain chemistry.

Spectrum-Resolved Electrochemiluminescence to Multiplex Immunoassay and DNA Probe Assay †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: The investigation on electrochemiluminescence (ECL) multiplexing bioassays mainly focus on simultaneously detecting either proteins or nucleic acids. To overcome the limitation of short-waveband for spectrum-resolved ECL multiplexing bioassay, herein, a highly-monochromatic (FWHM < 40 nm) and bandgap-engineered ECL luminophore, i.e., mercaptopropionic acid-capped & Zn^{2+}-mediated AIE assembly of Au NCs (Zn2+-AIE-AuNCs), of strong emission as well as the maximum emission wavelength at 485 nm is developed. The highly-monochromatic and bandgap-engineered ECL (485 nm) of Zn^{2+}-AIE-AuNCs can multiplex with the single-waveband and surface-defect-involved ECL (775 nm) of dual-stabilizers-capped CuInS2@ZnS NCs (CIS@ZnS-NCs), enabling spectrum-resolved ECL multiplexing strategy with different NCs luminophores of a similar particle size as tags. This ECL multiplexing strategy can be utilized to simultaneously detect antigen and DNA probe together without any additional signal amplification procedure and obvious spectroscopic cross-talk, in which the highly-monochromatic ECL from Zn^{2+}-AIE-AuNCs is utilized to dynamically determine CEA from 1 pg/mL to 50 ng/mL with a limit of detection (LOD) of 0.3 pg/mL, while the single-waveband ECL from CIS@ZnS-NCs is employed to linearly detect wild-type p53 from 1 pM to 50 nM with a LOD of 0.5 pM. The ECL immunoassay of the proposed strategy is free from the interference of synchronously conducted DNA probe assay, and vice versa, which would open an avenue to couple immunoassay and DNA probe assay together for clinical disease identification.

Structural Modulation of 2D Carbon Nitride for Electrochemiluminescent Biosensing †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: As an emerging luminophore, metal-free 2D carbon nitride demonstrates the advantages of low-cost, high biocompatibility and stability, easy functionalization, strong electrochemiluminescent (ECL) emission, and an unambiguous luminescence mechanism. Many ECL biosensors based on carbon nitride have been developed, with very promising performances. As chemical tailoring of 2D materials can effectively control the properties thus guiding their applications, our group recently explored the modulation of a diverse range of carbon nitrides with different dopants and nanostructures of nanosheets, nanofibers, and quantum dots. It not only tunes the optical properties of carbon nitride but also offers an effective way to engineer the surface properties of carbon nitride. Both of them are important in addressing the challenges of biosensing such as the development of new strategies for higher sensitivity and selectivity that involves signal transducer and multiscale interfaces.

Tandem Cas13a/crRNA Mediated CRISPR-FET Biosensor: A One-for-All Check Station for Virus without Amplification †

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Hubei University of Chinese medicine

† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Path towards field-effect transistor (FET) application from lab to clinic has delivered a compelling push in biomedical domain, yet ultrasensitive and timely pathogen identification without PCR remains a long-lasting challenge. Herein, we create a generic check station termed as “CRISPR-FET”, first incorporating CRISPR/Cas13a system within FET modality, for accelerated and unamplified detection of viral RNA. Unlike conventional FETs bearing target-specific receptors, this sensor holds three unique advances: (**i**) An ingenious sensing mechanism is used which converts the signal of large-sized analyte into the on-chip cleavage response of immobilized CRISPR reporter, enabling signal generation events to occur all within the Debye length; (**ii**) The multipurpose inspection of CoV ORF1ab, CoV N gene, and HCV RNA unveils the potential for a "one-for-all" scalable FET-based molecular diagnostics; (**iii**) It is shown that Cas13a-crRNAs targeting different sites of viral genome can be deployed in tandem to amplify the FET response, empowering the detection limit down to 1.56 aM, which is a world-record level of sensitivity in FET for direct viral gene sensing. Notably, a brilliant clinical applicability was made in the distinguishment of HCV-infected patients from normal controls. Overall, this study sheds new insight into FET-based nucleic acid sensing technology, and invokes a vision for its possible future roles in various viral disease diagnosis.

ZIF-67 MOF Derived Co-Based CeO2 Electrochemical Sensor for Dopamine †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: In the field of biosensing and disease diagnosis, rapid and sensitive detection of dopamine (DA) is crucial. In this work, Co_3O_4/CeO_2 composites with porous framework structure were synthesized by hydrothermal method, and Co_3O_4 with porous structure was synthesized by temperature-controlled calcination of the precursor template Zeolitic imidazolate framework-67 (ZIF-67). The specific surface area and pore size of the calcined Co_3O_4 material were changed and more active sites were exposed, which led to a better combination with CeO_2 to achieve good catalytic performance and excellent synergistic properties. The porous structure of Co_3O_4 not only prevents the agglomeration of CeO_2 nanoparticles, but also uniformly disperses them on the surface. The modification of Co_3O_4/CeO_2 on the surface of glassy carbon electrode (GCE) showed good electrocatalytic activity, and its performance was measured by electrochemical methods to be superior to that of pure Co_3O_4 and CeO_2.The results showed that the measured limit of detection (LOD) of Co_3O_4/CeO_2/GCE for DA was 0.13 μM (S/N=3) with a linear range of 0.1 μM-60 mM, along with good interference immunity and reproducibility. This work provides a novel scheme of Co_3O_4 and CeO_2 composites to obtain excellent dopamine sensors that can be extended to other biosensing applications.

便携式病原体分子诊断 †

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Abstract: 病原微生物导致的各类感染已经严重威胁全人类的公共卫生。其中，便携式的病原体分子诊断技术能够快速准确地检出病原体，对于提高基层医疗机构和现场检验检疫等方面有着重要的作用。我们利用蛋白质工程技术创新性设计高效具有信号传导功能的蛋白质，首次将其作为信号探针，并结合核酸分子工程技术，利用市场中现有的现场即时检测（POCT）的检测平台血糖仪和验孕试纸，实现对多种病原体基因以及蛋白质、小分子的普适性超灵敏超特异性识别。我们攻克了核酸与 hCG 蛋白偶联的技术难题，将病毒、癌细胞的基因探针标记于 hCG 上，以 hCG 作为信号探针，从而直接利用验孕试纸对待测物进行“是 - 与 - 否”或半定量 POCT 比色分析。我们开发了基于验孕试纸的现场半自动检测系统，实现了 SARS-CoV-2 的紧急检测。该方法快速、经济、灵敏，最低的检测浓度为 0.5 copy/μL。该方法具有很好的特异性，其他病毒基因，甚至高度相似的严重急性呼吸综合征冠状病毒（SARS-CoV）均不会干扰检测。我们基于链交换反应以及 DNA 纳米花探针，开发了一种免分离“信号开”的核酸检测策略，用于诊断乙型肝炎病毒（HBV）的耐药基因突变。该方法具有以下优点：1）灵敏度高，可检测低至 2 copy/μL 的基因；2）特异性好，能够高度区分 HBV 的野生型基因（rtWT）与 rtL180M 耐药突变型基因；3）可实现临床样本的检测，其结果与荧光法、直接测序法的检测结果一致，证明该方法的可靠性；4）通过对 L180M-3wj-DNA NF 探针在冻干后室温存储的稳定性和溶液状态下 4 °C存储的稳定性考察，表明探针的活性在一个月后仍分别保持原来的 82.3% 和 87.6% 的活性。鉴于其广普性，该平台可用于检测各种病原体和人类疾病相关的遗传变异。

化学和生物过程在线监测系统 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 本文报道我们团队研制的 32 通道化学和生物过程在线监测系统。该系统采用高效电容耦合非接触电导传感器测定化学或者生物反应引起的介质导电性能变化，并自动化绘制出反应动力学曲线。由于兼有光学原理分析方法和电化学原理分析方法的优点，该系统既可以实时在线报告实验室单纯溶液（如缓冲溶液和培养基）中的化学和生物过程，也可以实时在线报告复杂流体、半流体介质（如血液、酸奶、肉浆、污水、污泥）中的化学和生物过程，因此有望为化学、生物、环境、医药、化工、食品等众多学科的发展提供一种实用性较好的分析平台。

基于微流控生物传感器的尿液生物标志物检测展望 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 我国慢性非传染性疾病以心脑血管疾病、癌症、慢性呼吸系统疾病为主，导致的死亡人数占总死亡人数的比例超过 80%，并呈现出患病率高、知晓率低的特点。慢性病的发生远早于临床症状的出现，加强体液中慢性病极早期生物标志物的监测，对慢性病的预防和有效控制极其重要。血液是当前疾病生物标志物的主要来源，然而由于机体稳态机制的调节，在病变初期，血液往往会维持各项指标的相对稳定，不利于疾病的极早期诊断。尿液蛋白质组学研究发现，阿尔茨海默病、心肌梗塞、非小细胞肺癌、脑部肿瘤、抑郁症等疾病发生、发展的极早期即可在尿液中检测到非常细微的特异性变化，因此，尿液生物标志物检测将成为健康监测和慢性病预警的有效手段。

当前尿液中疾病生物标志物研究主要依赖于高效液相色谱 - 质谱联用技术 (UPLC-MS) 分析尿液中微量蛋白种类和含量的异常变化，通常样本检测时间约需 30 h，包括 1 h 系统设置、1~2 h 样品预处理、24 h UPLC-MS 分析和 1~2 h 数据处理，成本高且耗时。基于微流控技术的生物传感器可集成电化学生物传感、电化学发光免疫分析或拉曼光谱等技术，并与物联网、大数据和人工智能关联，实现尿液样品高效预处理，以及尿液生物标志物的快速检测、传输、存储和综合分析，有望实现低成本、高效便捷的尿液生物标志物检测，为健康监测和慢性病预警的研究和临床应用助力。

基于纳米通道限制仿生纳米酶 / 生物酶级联反应的持续高强度化学发光 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 我们报道了一种新型的纳米通道限域仿生纳米酶 / 生物酶级联反应系统，用于产生持久高强度化学发光（CL）。多金属氧酸盐（PMoV2）和葡萄糖氧化酶（GOx）共同固定在核壳介孔二氧化硅（CSMS）微球的纳米通道中，形成仿生纳米反应器，在葡萄糖和鲁米诺存在的情况下，介孔通道中 GOx 催化反应生成 的 H2O2 用于 PMoV2 催化 CL 反应，借助于纳米级限域效应，产生持久高强度 CL，平台期超过 12 小时，并成功应用于人血清样品中的葡萄糖检测。该研究提供了一种基于纳米酶 / 生物酶级联反应的新型辉光型 CL 系统，在生物测定和多相催化等领域具有潜在应用价值。

基于高稳定性钙钛矿纳米晶体的侧流免疫层析法用于人血清癌胚抗原荧光 - 比色双信号检测 †

舒韵

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 近几十年来，侧流免疫层析条带（LFICS）由于其简单、快速、灵敏度和特异性等优势，越来越多地被用作现场即时诊断（POCT）的工具。为了满足不同的检测要求，开发了不同信号标记的试纸条，之前大部分 LFICS 工作侧重于单信号快速读出检测物，为了提高准确性，越来越多的研究工作更倾向于 LFICS 多信号的读出。在此，我们基于高稳定性钙钛矿纳米晶体（CsPbBr3/OPA+OAm NCs）与金纳米颗粒开发了一种 LFICS，通过读出荧光与比色双信号快速检测肿瘤标志物癌胚抗原（CEA）。由于金纳米颗粒紫外吸收峰与钙钛矿纳米晶体的发射峰在 520 nm 处重叠产生荧光内滤效应，钙钛矿的绿色荧光被猝灭作为荧光信号进行定量分析，而日光下金纳米颗粒的比色信号可用于定性分析，从而实现人血清中 CEA 快速灵敏检测。该 LFICS 具有高灵敏度、低检出限、高选择性和环境储存稳定性等优势，在今后的 POCT 诊断中具有良好的应用前景。

新型光纤肽基生物传感器超灵敏检测前列腺抗原 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 前列腺特异性抗原 (PSA) 是前列腺肿瘤的首选生物标志物，亦被认为是乳腺癌潜在的有效标志物。我们首次报道了一种新型多肽基光纤化学发光生物传感器，成功应用于生物样本中 PSA 的超灵敏检测。该传感器制备简单，化学发光检测的信号标签通过 Au-S 键引入传感器，利用 AuNPs 的大表面积和链霉亲和素 - 生物素信号放大，极大提高了检测灵敏度。光纤不仅作为生物识别元件载体，亦用于化学发光信号高效传导，利于便携式设备的小型化。结果表明，该传感器具有较宽的线性范围和较低的 LOD 0.30 pg/mL，可用于复杂生物样品的目标物分析。

类氧化酶 $MnFe_2O_4/MoS_2$ 用于同时电化学检测抗坏血酸、多巴胺和尿酸 †

吴鹏

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 本文采用一锅溶剂热合成方法，制备了具有类氧化酶性质的 $MnFe_2O_4/MoS_2$ 纳米复合材料（MMF），并采用了丝网印刷碳电极（SPCE）作为工作电极同时电化学检测抗坏血酸（AA）、多巴胺（DA）和尿酸（UA）。在电化学检测过程中材料在表面用大量活性团簇替换阳离子以及 MoS2 的高表面活性提供了非常高的吸附性能。结果测得，单独对 AA，DA 和 UA 的 MMF 检测限（LOD）分别为 0.17 mM，0.41 μM 和 0.14 μM；同时检测 AA、DA 和 UA 的 LOD 分别低至 0.90 mM、0.16 μM 和 3.05 μM。并且所制备的 MMF 对分析物的检测表现出良好的抗干扰能力和再现性。

纳米孔道单分子电化学智能传感 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 生命体通过构建具有亚立方纳米体积的纳米孔道，对单个蛋白质分子、多肽分子乃至单个氨基酸进行识别，是最有效、最灵敏的单分子传感器。通过模拟仿生，构建限域纳米孔道，有望实现对单个生物分子的传感分析与测序，使传感具有检测灵敏度高、无需标记、高通量等优势，空间分辨可达亚纳米尺度、时间分辨可达亚毫秒尺度。因此，纳米孔道可为单分子传感提供极高的空间分辨能力。新概念纳米孔道传感不仅仅需要生物化学方法的开发，更需要信息技术的突破，通过生物化学技术与信息技术融合研究，构建仿生纳米孔道智能，发展单分子信息大数据的获取、分析、挖掘和知识发现等底层支撑技术，提升单分子数据资源的利用能力。本文研究了新的复杂信息提取方式，获取了纳米孔道离子流信号的瞬时频率，发展了单分子时频谱学分析技术，阐明了纳米孔道电流中低频域区频率特征值的物理化学特性，提出了单分子频率指纹图谱的数学模型，建立起孔道内离子指纹图谱的谱学分析方法，实现了对突变 Aerolysin 纳米孔道内离子相互作用网络特性的预测。该方法有助于精准探测纳米孔道单分子动态相互作用，以期应用于 DNA ／蛋白／糖等单分子测序、单分子精准合成、信息存储编译、药物研发、疾病检测等方面。

低功耗柔性电子器件的全溶液法制备及其在生物传感器的应用研究 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 溶液法作为绿色增材制造工艺，可以有效利用功能电子油墨（>80% 的利用率）实现多种功能器件的集成，并应用于柔性电子电路的高效、大面积制备，在可穿戴医疗传感器、电子皮肤和柔性显示领域具有广阔的应用前景。我们前期研究主要围绕功能电子材料优化与柔性印刷电路集成方面，开发了室温印刷电子油墨，解决了导电油墨热处理引法柔性基板形变而使得器件失效的问题。此外，通过基板表面亲疏液处理，进一步实现了高分辨、高性能电子电路的大面积制备。基于此，我们采用溶液法研究了低功耗柔性电子电路的功能材料设计和电路集成方面的工作。低功耗电子器件的设计开发对于降低集成电路功耗具有重要的研究意义和应用价值。薄膜晶体管作为集成电路的基本单元，通过降低其工作电压可以有效降低集成电路的功耗。其中，聚合物高介电材料对于实现溶液法制备低功耗薄膜晶体管具有重要的研究意义。然而聚合物介电层性能对光、热以及有机溶剂等敏感、导致性能不稳定等问题严重限制了其在低功耗薄膜晶体管中的应用。基于此，我们开发了新型低温交联、耐溶剂、可溶液法加工高介电聚合物材料，例如聚硅氧烷和聚酯高介电材料，探究了材料介电特性、耐溶剂特性以及其对不同半导体材料的普适性，有效降低器件工作电压到 5V 以内，实现了柔性低功耗电子器件的高性能、大面积制备。此外，我们进一步拓展了低功耗薄膜晶体管在细菌检测方面的应用，实现了微量液滴中细菌数量的高灵敏度检测。

等离激元增强光谱电化学分析 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 局域表面等离子体共振 (LSPR) 是纳米结构表面自由电子随能量匹配的入射光而发生集体震荡的一种现象，在纳米结构表面产生显著增强的电磁场，能显著增强相邻分子的荧光、拉曼、红外等信号，同时其产生的热电荷能参与界面电子转移和反应。我们探索了如何利用 LSPR 特性构建高性能的光谱电化学分析，包括：1）为解决现有红外光谱灵敏度和空间分辨率不足的问题，我们构建了内反射红外系统，利用理论结合实验的方法在红外光学窗上构建了中红外区有等离激元共振特性的微纳米结构，研制的表面增强红外光谱分析平台可实现高灵敏界面分子识别、反应过程的监测；同时，我们将原子力显微探针技术与等离激元共振结构结合，构建了高灵敏和高空间分辨红外光谱分析平台，实现了优于 10 nm 的空间分辨成像和数百分子的检测灵敏度。2）利用界面电场或半导体能级实现 LSPR 热电荷分离与参与界面电化学反应，构建了灵敏的光电电化学传感器。3）利用双极电极成像系统实现了单细胞成像。

微纳序构等离激元薄膜材料构建及生物传感应用 †

Yi Chen

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 贵金属等离激元超晶格薄膜由二维规则排列的纳米粒子作为基本构成单元，具有微观有序的阵列结构和宏观独特的光学与机械性能，在柔性光电器件和高灵敏检测装置等领域具有重大应用前景。本研究聚焦于新型贵金属基二维自组装柔性检测材料的构建，实现了新型二维纳米粒子超晶格薄膜的大面积可控性构筑；通过对新型二维超晶格薄膜的结构特征、机械性能和光学性能进行实验表征和理论模拟，研究并揭示了不同纳米粒子形貌和尺寸、聚合物配体性质、粒子间距离对其光学性能、表面增强拉曼效应（SERS）和电磁场增强热点均匀性分布的影响因素；通过优化超晶格薄膜的微观结构提高了其拉曼增强效应和场强热点均匀性；通过实验和计算机模拟从机理层面探讨了表面等离激元共振（LSPR）光学性能与拉曼增强效应的关系；研究发现可通过调节纳米粒子的结构参数来调控超晶格薄膜的等离激元共振耦合性能，因此可以控制超晶格薄膜的光学性能和 SERS 检测灵敏性，实现高效的生物医学检测应用。

Systematic and Long-Term Technical Validity of Toxicity Determination and Early Warning of Heavy Metal Pollution Based on Electrochemically Active Bacteria †

Baoguo Wang, Ziyue Zhao, Zhipeng Mao, Yue Yi and Aiqin Luo

Beijing Institute of Technology

† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Water toxicity determination based on electrochemically active bacteria (EAB) has great prospects in the early warning of water pollution. Heavy metals are one of the main sources of water pollution. However, only idealized tests with a few types of heavy metals were performed in previous studies. In this study, an automatic water toxicity determination system with high technical maturity of seven was established. Systematic toxicological assessment of common heavy metals with EAB was performed by using the system. Additionally, surface water toxicity determination and heavy metal pollution monitoring was investigated. Results demonstrate that all the common heavy metals exhibit acute toxicity on EAB, and lineally inhibit EAB currents in the range of 0.1 mg/L to 0.5 mg/L. The toxicity of the tested heavy metals is different with a rank of Cd>Tl>Cu>Pb>Zn>Ni>Hg>As. The comprehensive toxicity is complex with the coexistence of heavy metals. The toxicity interaction mainly exhibits antagonism or addictive effects in binary heavy metal mixtures, while synergism in some ternary heavy metal mixtures. The system is capable to determine surface water toxicity accurately and monitor heavy metal pollution rapidly. Furthermore, the system exhibits good repeatability and long lifetime. This study first provides a systematic and basic database of heavy metal toxicity determined with EAB, and proves that EAB are capable of long-term surface water toxicity determination and on-site early warning of heavy metal pollution.

A Novel Real-Time TMAO Detection Method Based on Microbial Electrochemical Technology †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Trimethylamine N-oxide (TMAO) is considered to be a novel biomarker of cardiovascular diseases. However, the traditional TMAO detection method has failed to meet the requirements of real-time and point-of-care tests. Herein, a novel TMAO detection method based on microbial electrochemical technology is established, which realizes the direct conversion of TMAO concentration into electrical signals. Attached Shewanella loihica PV-4 was first proven to be capable of simultaneous inward extracellular electron transfer and TMAO reduction. The TMAO detection method showed a wide linear range of 0 to 250 μM, a high sensitivity of 23.92 μA/mM, and a low limit of detection of 5.96 μM. In addition, the TMAO detection process was accomplished within 600 s, with an acceptable accuracy of 90% in the real serum, showing high feasibility in clinical applications.

A CRISPR-Based and Post-Amplification Coupled SARS-CoV-2 Detection with a Portable Evanescent Wave Biosensor †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: The continuing pandemic of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, which causes coronavirus disease 2019 (COVID-19), has spread globally and its reliable diagnosis is one of the foremost priorities for protecting public health. Herein a rapid (1 h), easy-to-implement, and accurate CRISPR-based evanescent wave fluorescence biosensing platform for detection of SARS-CoV-2 is reported. The collateral effect of Cas13a is combined with a universal autonomous enzyme-free hybridization chain reaction (HCR) by designing a cleavage hairpin reporter, which is cleaved upon target recognition, and hence releasing the initiator sequence to trigger the downstream HCR circuits. Detection of HCR assemblies is accomplished by first adsorbing to the desthiobiotin-modified optical fiber, followed by fluorescence emission induced by an evanescent field. Three Cas13a crRNAs targeting the genes of S, N and Orf1ab of SARS-CoV-2 are programmed to specifically target SARS-CoV-2 or broadly detect related coronavirus strains, such as MERS-CoV and SARS-CoV. The HCR amplification coupled Cas13a-based biosensing platform is capable of rapid detection of SARS-CoV-2 with attomolar sensitivity. This method is further validated by adding target RNA of SARS-CoV-2 in negative oropharyngeal swabs. The good discrimination capability of this technique demonstrates its promising potential for point-of-care diagnosis of COVID-19.

柔性功能纸芯片的构建与光电生物传感分析 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 速发展的现场诊断和环境分析迫切需要发展灵敏、快速、便携的即时检测设备 [1,2]。纸，具有成本低廉、轻量便携、易功能化、设计灵活等优点，是理想的传感器基底材料之一 [3,4]，基于此，本工作利用铅笔在纸基材上绘制石墨导电桥和驱动电极，借助蜡打印技术制备空间分隔的双极电极体系，结合杂交链反应构建了灵敏检测 M.SssI 甲基化转移酶的纸基电化学发光传感器。首先，制备具有良好电催化活性和化学稳定性的 Pt@CeO2 用于功能化修饰 DNA2，引入至双极电极电化学发光传感器的阳极。目标物存在时，HpaII 限制性内切酶无法识别剪切双链 DNA，电化学发光共反应促进剂 Pt@CeO2 保留在电极表面，氧化速率提高，结合独立两极电荷平衡的特性，阴极背景信号降低，电化学发光信号响应得到增强。本工作所制备的基于手绘石墨双极电极的传感器制造工艺简单，且避免了目标物识别体系与阴极信号输出单元的交叉干扰，准确度高，具有良好的稳定性、可重复性和较宽的检测线性范围，为开发用于早期疾病诊断和发病机制研究的纸基传感器提供了新思路。

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基于声表面波的主动式微混合器混合机理的新研究 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 针对实现微混合器中流体高效混合的问题，我们采用声表面波驱动流体，设计了声表面波器件并对其进行了模态和谐响应分析，分析了声表面波驱动流体混合的潜在机理。在本项研究中，我们研究了声表面行波（TSAW）和声表面驻波（SSAW）对流体的影响，并对声流力驱动流体混合进行了全面分析。研究发现，TSAW 微混合器，在声作用区域产生贯穿通道的单涡流，SSAW 微混合器则是产生对称的双涡流，并且 SSAW 微混合器混合效率高于 TSAW 微混合器。分析发现，TSAW 主要在微通道一侧驱动流体，而 SSAW 通过微通道两侧的声流力叠加作用驱动流体。

构建一种电化学发光传感器用于不同表型循环肿瘤细胞的超灵敏检测 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 外周血中循环肿瘤细胞（CTCs）是癌症转移、发展并迅速恶化甚至导致死亡的根源，因此，CTC 作为“液体活检”的重要靶标能够为癌症早期筛查、转移发现、肿瘤复发追踪及疗效监测等提供及时可靠的依据 [1,2]。然而，CTC 数量极少，异质性大，检测设备复杂使 CTC 捕获效率及检测灵敏度受限，因此筛选高效的 CTC 富集探针、开发多重信号放大策略的高灵敏微型传感器是实现肿瘤早期病变快速、便捷筛查亟需解决的问题。本文基于 PPy@Fe3O4-Au 多靶标空心管状磁性纳米复合物高效富集 CTC，GO@HMPB-Pt@Luminol 级联信号放大 Luminol 信号构建一种通用型电化学发光免疫传感器超灵敏检测不同表型 CTC（如下图）。

Single Structural Layer Nanopore Measurements †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: The working principle of nanopore measurements is exploiting the interactions between the nanopore-confined electric field with the molecule and measuring the transient ionic current changes from the translocating molecule for correlating the structure information of the molecule. Single structural layer nanopores are defined as nanopores made in single layer materials and/or by single molecules, which can offer high precision for the pore structure. We have recently developed top down made single-layer MoS2 nanopore fabrication methods and bottom up constructed single macrocycle nanopore strategy, and prepared nanopores from single atomic vacancies to chemically defined single macrocycle nanopores. The single structural layer nanopores can be used to develop new approaches for controlling ion transport and new applications in single molecule measurements. Single structural layer nanopore research has promoted the development of artificial nanopores in the aspects of extreme fabrication precision, the non-linear transport understanding and measurement resolution.

A Pressure-Sensing and Magnetic Enrichment-Based Method for the Detection of SARS-COV-2 N Protein †

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Abstract: Diagnosis and treatment of infectious diseases at an early stage is of great importance in controlling the spread and progression of the disease. In this work, a immunoassay based on magnetic enrichment and pressure sensing for the detection of the SARS-COV-2 N protein (COV-2 NP) was constructed. Therein, COV- 2 NP was first preenrich by Fe3O4@SiO2 nanoprobe to obtain the Fe_3O_4@SiO_2-COV-2 NP. Subsequently, the Pt nanoprobe was immunoconjugated by Fe_3O_4@SiO_2-COV-2 NP to form the sandwich-type immunocomplex Fe_3O_4@SiO_2-COV-2 NP-Pt. Based on the peroxidase properties of Pt, Fe_3O_4@SiO_2-COV-2 NP-Pt was placed in a hermetically sealed reaction system connected to a carbon nanotube-based aerogel pressure sensing system. The quantification of the target was achieved by establishing a working curve between the concentration of COV-2 NP and the reading of the pressure sensor by the change in air pressure caused by the Pt-catalyzed decomposition of H_2O_2 to produce O_2. The linear range of the method detecting for COV-2 NP was 0.1–50 ng/mL with a LOD of 68.9 pg/mL.

Surface Engineering of Nanoporous Metal-organic Frameworks for Chemical Sensing †

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Abstract: Chemical sensors play significant roles in myriad areas, such as medicine, industrial processes and indoor air quality monitoring systems. Although they have been used in a variety of areas, the improvements in their performances would open up a range of new opportunities. As a novel class of crystalline porous materials, metal-organic frameworks (MOFs) have been considered potential candidates as sensory materials for chemical sensing [1]. The applications of MOFs in chemical sensors require the development of microfabrication techniques to integrate them into signal transduction devices. In this work, we developed a robust deposition technique that enables high-quality MOF thin film deposition with a controllable thickness [2]. In addition, we pioneered direct, resist-free patterning of MOFs by X-ray and e-beam lithography, which allows high-quality patterning with record sub-50-nm resolution [3]. Several MOFs-based chemical sensors have been implemented into signal-transduction schemes, including quartz crystal microbalances, surface acoustic waves, and diffraction gratings [4,5]. These sensors have shown sensitive and selective sensing performances towards various volatile organic compounds. The effects of MOF pore size, pore opening, surface functionality, and structural flexibility on the sensing performances are systematically investigated. The promising results would be beneficial for the integration of MOF-based sensors in the application of array-sensing technology.

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荧光阵列传感器构建及其在肾损伤进程识别与药物评价中的应用 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 肾脏是人体重要器官，当受到内外界有害因素（如物理损伤、药物、细菌感染等）的刺激时，会导致不同程度的肾损伤，包括风险期、伤害期、衰竭期、功能丧失期、肾病终末期。因此，准确识别肾病的发展进程有助于及时干预和有效治疗。目前临床诊断肾损伤是以血肌酐、尿素氮为“金指标”的肾滤过功能评价方法，存在滞后性、专属性差和准确性低等问题，而肾穿刺检查具有创伤性。课题组基于肾损伤发生发展的病理学特点，构建了若干种荧光阵列传感体系，利用多通道荧光信号对尿液中蛋白进行快速检测，借助多元统计分析方法，实现了肾损伤进程准确识别；基于不同药物诱导肾细胞损伤的物质差异与时效关系，获得了临床 50 种肾毒性药物的荧光指纹图谱，探究了中药马兜铃酸的肾毒性机理，评价了黄葵胶囊对肾损伤的保护和干预作用，为肾损伤精准诊断、药物安全性评价以及肾损伤新药研发提供了新思路与新方法。

Au/Ag_2S Dimeric Nanoparticles for Highly Selective Colorimetric Detection of Mercury(Ⅱ) Based on Precipitation Transformation †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Although many plasmonic nanosenosrs have been developed for the detection of mercury(II) (Hg^{2+}), few of them is feasible for the analysis of real samples with very complex matrices because of insufficient method selectivity. To address this challenge, we propose an epitaxial and lattice-mismatch approach to the synthesis of a unique Au/Ag_2S dimeric nanostructures, which consist of an Au segment with excellent plasmonic characteristics, and a highly stable Ag2S portion with minimum solubility product ($Ksp(Ag_2S) = 6.3 \times 10^{-50}$). The detection relies on the chemical transformation of Ag_2S to HgS upon reaction with Hg^{2+}, leading to a red shift in the plasmonic band of the connecting Au NPs. The concurrent color changes of the solution from modena to navy correlate well with the concentration of Hg^{2+}, thus enables a naked-eye readout and UV-vis quantitation of the Hg^{2+} concentration. This method shows superior selectivity towards Hg^{2+} over other interfering ions tested because Hg^{2+} is the only ion that can react with Ag_2S to form HgS with even smaller solubility product ($Ksp(HgS) = 4 \times 10^{-53}$). The practicability of the method was verified by analyzing the Hg^{2+} in sewage water samples without sample pretreatment with satisfactory recoveries (93.1%–102.8%) and relative standard deviations (1.38%–2.89%). We believe this method holds great promise for real-time and on-site detection of Hg^{2+} in environmental water samples with complex matrices.

Biocompatible Microelectrode for In Vivo Sensing with Improved Performance †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: In vivo electrochemistry has been of great concern in both chemistry and neuroscience communities due to its capability to track the dynamics of neurochemicals with a high spatiotemporal resolution. For in vivo sensing, a carbon fiber microelectrode (CFE) is generally implanted into the brain of animals and the electrode inevitably suffers from nonspecific adsorption of biomacromolecules and mechanical mismatch, which often triggers foreign body responses, leading to decreased sensitivity and prolonged response time for in vivo measurements. To resolve these problems, we developed an ultrathin cell membrane-mimic film of ethylenedioxythiophene tailored with zwitterionic phosphorylcholine (EDOT-PC) electropolymerized onto the surface of carbon fiber microelectrode (CFE) not only resists protein adsorption but also maintains the sensitivity and time response for in vivo monitoring of dopamine. Furthermore, inspired by nature, we also developed a robust polydopamine-engineered biointerfacing, to tailing zwitterionic molecules (i.e., sulfobetaine methacrylate, SBMA) through Michael Addition. The SBMA-PDA biointerface can resist nonspecific binding of proteins in complex biological fluids while enhancing interfacial electron transfer and electrochemical stability of the electrode. On the other hand, we find that pure PEDOT:PSS fibers (i.e., support-free) exhibit high conductivity, fast heterogeneous electron transfer, and suitable charge storage and injection capabilities, and can thus directly act as microelectrodes not only for chemical and electrophysiological recording in the same extracellular microspace, but also for electromodulation of neural microcircuit activity. Moreover, the microelectrodes mechanically match with neural tissues, exhibiting less foreign body responses.

Construction of g-C_3N_4-In_2O_3 Heterojunction with Localized Electric Field Enhancement for Effective Formaldehyde Sensing †

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Abstract: g-C_3N_4 nanosheet supported with In_2O_3 nanocube was synthesized as the sensing material to fabricate a high-performance formaldehyde gas sensor. XPS and work function characterizations revealed that type II heterojunction was successfully constructed between g-C_3N_4 and In_2O_3. The directional transfer of photoexcited charge carriers contributed to accumulation of high concentration electron in plasmonic In_2O_3. The light matter interaction induced non-centrosymmetric localized electric field enhancement around In_2O_3 nanocube, facilitating the interaction with adsorbed HCHO and improving sensor performance of g-C_3N_4-In_2O_3 heterojunction. The adjustable size of In_2O_3 nanocube in the g-C_3N_4-In_2O_3 heterojunctions enabled tunable localized electric field intensity and spatial distribution, thus the modulated sensor performance. The formaldehyde response for g-C_3N_4-In_2O_3 with optimal size of In_2O_3 nanocube (60 nm) reached 860 ppm, nearly 8 times higher than that of pristine In_2O_3 (114 ppm). Notably, the sensor based on g-C_3N_4-In_2O_3 heterojunction exhibited low sensing limit of 50 ppm, excellent selectivity, repeatability, fast response rate and a fair logarithmic function toward formaldehyde concentration. This research provides an effective strategy for achieving a formaldehyde sensor with fast response and high sensitivity.

Electron Transfer Mediated Electrochemiluminescence Sensing Strategy of Gold Nanoclusters for Single Copper Ion Level Detection †

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Abstract: Herein, we proposed that the electron transfer (ET) could be used as a novel sensing regulation factor for the construction of ECL sensing platform. As a proof-of-concept, the quenching effect of Cu^{2+} on the ECL of the pre-oxidation treated L-methionine-capped AuNC (Ox-Met-AuNC) was investigated in details. It was shown that after electrochemical excitation of the ECL probe, the excited-state electron could transfer from AuNCs to the coordinate Cu^{2+} effectively, which prevented the electron in the LUMO of Met-AuNCs from returning to its HOMO and thereby quenched the ECL emission of Ox-Met-AuNCs. Since the ECL intensity of Ox-Met-AuNCs is sensitively affected by the ET process, a highly sensitive ECL sensing platform for Cu^{2+} has been developed without any other signal amplification technique. A preferable linear dependence curve was acquired in the detection range from 1.0×10^{-18} to 1.0×10^{-14} M with an extremely low detection limit (LOD) of 2.3×10^{-20} M with high selectivity. More importantly, a record LOD at the single copper ion level has been realized by this method. Furthermore, the actual sample detection for Cu^{2+} exhibited satisfactory results. Therefore, this study enriches a mechanistic application that may drive further rational design of ECL sensors.

Highly Sensitive and Wearable Strain Sensor Based on Carbon Materials for Smart Applications †

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Abstract: Wearable sensors are attracting wide attention due to their versatile applications. Carbon materials have combined superiorities such as good electrical conductivity, structural flexibility, light weight, thermal stability, as well as scalable production, enabling them to be potential as sensing materials for wearable sensors. High sensitivity is critical for flexible sensor performance, which is also urgently demanded for their multifunctional applications. In this poster, we firstly have reported a facile method to fabricate highly sensitive carbon hybrid fibers consisting of a graphene fiber backbone and carbon nanotube (CNT) branches. Furthermore, we have constructed flexible tactile sensor by coating reduced graphene oxides (RGO) on the surface of polyurethane (PU) sponge. Due to the well-designed architecture, the assembled sensors exhibit satisfactory performance. These works provide feasible strategies for the fabrication of strain/tactile-sensitive sensors, achieving the full realization of monitoring human physiological signals and architecting a real-time human–machine controlling system.

Molecularly Imprinted Photoelectrochemical Sensing Based on Direct Z-scheme 1D/2D Bi2S3/$Bi_2O_2CO_3$ Heterojunction for Detecting Aflatoxin B1 †

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Abstract: A Bi_2S_3/$Bi_2O_2CO_3$ direct Z-scheme heterojunction-based molecularly imprinted photoelectrochemical sensor for sensitive and specific detection of aflatoxin B1 (AFB1) has been fabricated. Bi_2S_3 fibers grow over two-dimentional $Bi_2O_2CO_3$ disk via topotactic transformation by adding thiourea under hydrothemal conditions to form a heterojunction to enhance photocurrent response. Upon visible light irradiation, the Z-scheme charge transfer and the internal electric field formed at the interface between Bi_2S_3 and $Bi_2O_2CO_3$ hinder the recombination of photogenerated charge carries, causing high photocurrent response. Aiming at the poor selectivity of PEC sensor, molecularly imprinted polymer (MIP) is introduced to attain the specific recognition of AFB1. Utilizing the MIP and PEC as recognition and signal conversion elements, respectively, the prepared sensor shows a wide linear range of 0.01–1000 ng/mL. The integration of MIP and PEC supplies a promising strategy for detection of other contamination in food and environment.

On-site marine Oil Spillage Monitoring Probes Formed by Fixing Oxygen Sensors into Hydrophobic/Oleophilic Porous Materials for Early-stage Spottypollution Warning †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: An efficient on-site marine oil spillage monitoring probe was developed by fixing oxygen consumption sensors into hydrophobic/oleophilic oil-absorbing porous materials. The impact of thickness and characters of the porous materials, the types of spilled oil, and the presence of salts and vibration in water on the parameters of the obtained signals was investigated. The probe could be used to detect the various representative types of spilled oils including lubricating oil, corn oil, soybean oil, n-hexane, petroleum ether and toluene, even in simulated sea water vibrating at different levels, having over 33 times reduced reliable low detection limit (RLDL) in detecting soybean oil in water (from 36.5 g L^{-1} to 1.1 g L^{-1}). The response time and signal-to-noise ratios (SNRs) of the probe varied greatly with the dynamic absorbing speed and oxygen barrier property of the spilled oils in the porous material, respectively. The probe showing the highest SNR of 190 dB for a 50 g L^{-1} on-site soybean oil spillage and the fastest response time of 9 s for a 50 g L^{-1} on-site toluene spillage in water may potentially be used as a key component in near-shore marine oil spillage monitoring systems to provide early-stage pollution warning. On-site marine oil spillage monitoring probes formed by fixing oxygen sensors into hydrophobic/oleophilic porous materials for early-stage spottypollution warning.

Point-of-Care Testing of Chloramphenicol in Food Production Using Smartphone-Based Electrochemical Detector †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Antibiotic abusement in food processing could threaten human health via either direct pathogen or drug-resistant infection. In order to contain this situation, it is of vital significance to identify trace level of antibiotics in foodstuff in a point-of-care inspection manner. Here, inspired by the pioneering chloramphenicol (CAP) sensor by Ju et al., a smartphone-based electrochemical system was developed for the quantitation of CAP, a model antibiotic adopted worldwide. The differential pulse voltametric reduction of CAP was measured facilely on a piece of gold-deposited screen-printed electrode, which was docked onto a palm-sized detector with remote directives from a mobile App of Bluetooth handshaking and digital display. Under optimal conditions, the target CAP could be determined in a range from 1 nmol/L to 5 μmol/L with a detection limit of 0.25 nmol/L. Further tests on emulate samples demonstrated the miniaturized device could handle the food-screening scenarios with accuracy, convenience and quick responsiveness.

Properties of 3,4-Substituted Squaric Acid Derivatives and Their Application in Cell Viscosity Bioimaging †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Squaric acid dyes are structurally rigid quaternary ring systems with unique optoelectronic properties that have been widely used in many fields, including photoconductivity, data storage, light-emitting field-effect transistors, solar cells, and fluorescent probes. However, the current squaraine derivatives are all designed based on 2,4-substitution, and to the best of our knowledge, studies on 3,4-substitution derivatives have not been reported. Herein, we synthesized a series of 3,4-substituted squaraine derivatives and explored their properties. The results show that such squaraine derivatives have good photostability and specific response to viscosity. Finally, we successfully used it for bioimaging of cellular viscosity. This work provides an important experimental basis for the development of more squaraine derivatives with excellent properties.

Thin-Membrane-Based Potentiometric Sensors for Sensitive Detection of Polyions †

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Abstract: The responses of the polyion electrodes developed so far to decreasing levels of polyions are considerably slower because these polyion responses are based on classical non-equilibrium steady-state mechanism.[1–3] In this work, a novel protocol for development of sensitive and rapid polymeric membrane polyion sensitive electrodes has been explored. In contrast to the traditional polyion electrodes which usually have a sensing membrane thickness of ~200 µm, a thin membrane electrode with a membrane thickness of 5 µm is proposed to detect polyions. By using such thin membrane configuration, the diffusion of polyions from the organic boundary layer into the bulk of the membrane can be effectively blocked. The induced accumulation of polyions in the membrane boundary layer largely enhances the obtained potential response. It has been found that the proposed electrode shows a remarkably improved sensitivity and measuring time over conventional potentiometric polyion sensors based on the thick membranes. By using protamine as a model of polyions, the new concept offers a detection limit nearly two orders of magnitude lower than those obtained by the traditional thick-membrane polyion electrodes for potentiometric measurements of polyions. Determination of heparin with this novel technique has been demonstrated. The proposed polyion sensing platform offers a great promise in the sensitive and rapid detection of polyions as well as in other polyion-involved bioanalyses.

可见光门控 DASAs 化学传感器：比色法检测 Al^{3+} 和对 Zn^{2+} 的荧光传感 †

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Abstract: 近年来，各种光开关分子被用于构建成化学传感器，其主要策略是将响应官能团与光开关分子相结合。与传统的化学传感器相比，光开关分子的引入能使化学传感器具有特定的门控特性。在本项工作中，我们将席夫碱萘响应官能团与光开关分子 DASAs 进行了有效融合，制备了一种新型的可见光门控的 DASAs 化学传感器 (Figure 1, ND-O)。开环态的 ND-O 具备典型的可见光 / 热可逆的光致变色性能，但是不具备离子传感的性能；在可见光的激活下，开环态 ND-O 转变为闭环态 ND-C，并使其具备了比色法检测 Al^{3+} 和对 Zn^{2+} 荧光传感功能。经过多种离子的复杂环境测试，其表现出高度的灵敏性和选择性。

Keywords: 光致变色；DASAs; 传感器；Zn^{2+}; Al^{3+}

基于智能手机的可打印纸基 " 化学鼻 " 用于细菌挥发物分析检测 †

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Abstract: 食源性病原菌的快速、可视化分析检测对于食品安全和公共卫生具有重要意义。在本研究中，我们设计合成了一系列咪唑鎓盐功能化的二乙炔（DA）单体，并配制了可打印 DA 墨水，利用 DA 单体的自组装和光聚合特性，将 DA 分子打印于纸上，通过 254 nm 紫外光引发聚合后制备了可变色聚二乙炔纸基传感器。该传感器可对病原菌代谢过程中释放的有机代谢气体产生由蓝到红的比色响应，从而实现对病原菌快速、可视化分析检测。通过计算机以及 Android 手机端对变色前后的 RGB 值进行分析和处离，初步实现了对大肠杆菌和金葡菌活性的定性和定量分析检测。本研究可为快速、简便分析检测食源性治病菌提供新的方法和理论依据。

基于氧化铈 - 石墨炔复合材料修饰电极的制备及双氧水检测 †

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Abstract: 本文通过水热法合成了 CeO_2 纳米材料，将其与石墨炔 (GDY) 超声混合后修饰于玻碳电极 (GCE) 表面，构建了一种高选择性、灵敏检测 H_2O_2 的传感平台。CeO_2 作为过氧化物模拟酶，能够催化 H_2O_2 还原生成 H_2O 和 O_2；石墨炔具有良好的导电性和独特的片层结构，有利于电子迁移并为 CeO_2 的负载提供了位点。实验表明，当 H_2O_2 的浓度在 0.5 μM 到 5.0 mM 范围内，传感器的响应信号与浓度呈现良好的线性关系，检测限可达 0.107 μM，与现有的检测技术相比性能更好。将传感器用于苹果汁中 H_2O_2 含量检测，回收率为 97.3%–104.8%，表明该传感器能够快速、灵敏地检测果汁样品中的 H_2O_2 含量，具有实际应用价值。

Keywords: H_2O_2；电化学传感器；CeO_2；石墨炔

基于石墨烯 /COF 复合材料的全固态镉离子选择性电极 †

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Abstract: 固体接触层能够通过提供稳定的相界面电位，提高全固态离子选择性电极的稳定性和标准电极电位 (E0) 的重现性 [1]。我们以石墨烯 /COF 复合材料 [2] 作为固体接触层构建了 Cd^{2+}-ISEs。石墨烯 / COF 复合材料兼具双电层电容和氧化还原电容固体接触层的优点，所构建的电极具有良好的重现性 (同批次 / 不同批次 E0 的标准偏差分别为 0.28 mV 和 0.37 mV) 和电位稳定性 (电位漂移值为 1.2 ± 0.2 μV/h)。此外，电极对 Cd^{2+} 呈现出优异的选择性和良好的能斯特响应，能斯特响应斜率为 31.3 ± 0.3 mV/dec (n = 3), 线性范围为 10^{-7}–10^{-3} M，检测限可达 6.8×10^{-8} M。本文所制备的电极在离子检测方面具有较好的应用前景。

基于离子迁移的聚合物膜离子选择性电极高精度检测海水 pH †

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Abstract: 海洋酸化问题日益突出，及时监测海洋 pH 变化十分重要。然而，由海洋酸化引起的 pH 变化较为微小，表层海水 pH 下降约 0.002 个 pH 单位 / 年，因而要求分析方法具有高的精密度。目前，传统 pH 电极检测精密度无法达到 0.001 个 pH 单位，难以用于海洋酸化监测。因此，本工作发展了基于离子迁移的聚合物膜离子选择性电极高精度检测新模式。以聚合物膜 H+ 离子选择性电极为识别元件，以离子迁移电极为信号转换元件，将 H+ 离子的浓度信息转换成电流信号，提高聚合物膜离子选择性电极的检测精密度，实现对 0.001 个 pH 单位变化的高灵敏检测，满足海洋酸化监测的精密度需求。

天然硅酸盐衍生的纳米酶制备方法及其环境污染物检测应用 †

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Abstract: 作为一种模拟酶仿生材料，具有类酶催化特性的纳米酶，在化学传感检测领域表现出广阔的应用前景。然而，由于纳米酶自身存在催化特异性不足的缺陷，使其在真实应用场景中抗干扰性差，很难发挥有效作用。本文以天然硅酸盐矿物（埃洛石）为前驱体，制备得到了具有独特纳米管状结构的硅酸锰纳米酶材料。该纳米酶自身较强的类氧化酶活性，不仅实现了比色传感信号的放大，还能通过纳米管增强环境污染物的电化学信号放大，从而实现对真实场景下环境污染物的抗干扰、双重检测。这种基于天然硅酸盐矿物衍生的硅酸锰纳米酶，对氯酚、双酚 A、有机磷农药及 H_2O_2 具有较好的识别能力，在水体、土壤及食品等环境污染物检测方面表现出优异的性能。

自清洁聚合物膜电位型传感器的制备 †

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Abstract: 聚合物膜离子选择性电极是电化学传感器的一个重要分支，已广泛应用于环境监测和临床化验等领域。然而，当将此类电极与复杂样品（如海水）长时间接触时，电极膜表面会发生有机物和细菌的大量吸附，此吸附会导致电极响应性能降低甚至丧失 [1]。本研究以硅烷偶联剂 KH-550 改性的纳米二氧化钛为抗菌材料 [2]，在聚合物膜表面制备自清洁涂层，构建具有良好抗污损性能的自清洁聚合物膜电位型传感器，提高此类电极抗污损能力。结果表明，所构建的传感器具有良好自清洁性能。

基于银纳米粒子的比色和表面增强拉曼散射双模式香兰素检测方法 †

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Abstract: 基于香兰素和 3,3’,5,5’- 四甲基联苯胺 (TMB) 还原托伦试剂生成不同类型银纳米粒子 (AgNPs)，设计了比色法和表面增强拉曼散射 (SERS) 双模式检测香兰素的方法。香兰素还原得到 Ag45 NPs，无色，最大吸收在 350 nm，TMB 还原得到 Ag100 NPs，粉红色，最大吸收在 490 nm。当托伦试剂和 TMB 浓度不变时，随着香兰素浓度的增加，溶液由粉红色变为无色，在 350 nm 处吸光度增加，而在 490 nm 处吸光度下降，比色法检出限为 0.411 μM。此外，Ag45 NPs 可作为 SERS 基底，用于香兰素的超灵敏检测，检出限为 2.58×10^{-11} M。该可视化、快速、高灵敏度的双模式香兰素方法在食品安全评估中具有很大潜力。

基于表面增强拉曼散射技术的烟碱检测方法研究及应用 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 本文成功合成了一种含有内标分子 4- 氨基苯硫酚 (PATP) 的核 - 分子 - 壳结构 (Au@PATP@Ag NRs) 作为 SERS 基底材料用于烟碱的定量检测。我们第一次在烟碱的定量检测中引入内标分子，用来纠正信号波动，提高对烟碱定量分析的可靠性。同时，获得的 Au@PATP@Ag NRs 将双金属协同效应与棒状结构可调节的等离子体共振优势相结合，大大提高烟碱检测的灵敏度。该 SERS 活性底物具有 2.17 × 107 的高增强因子，对烟碱的检测限为 3.12×10^{-9} M，线性检测范围为 10^{-8}–10^{-3} M。成功将其应用于卷烟和卷烟烟雾中烟碱的检测，证明 Au@PATP@Ag NRs 在 SERS 检测烟碱方法中的实际应用性。

基于二维石墨烯碳上铁单原子超灵敏 H_2O_2 电化学催化剂及其 O–O 桥式吸附理论 †

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Abstract: 单原子催化主要集中在其分散的高密度催化位点上，但针对目标反应实现独特催化机理的精细设计研究却少得多。本文合成了一种固定在二维 N 掺杂石墨烯（Fe-SASC/G）上的铁单原子位催化剂，并将其用作电化学检测过氧化氢的仿生传感器，显示出 3214.28 μA $mM^{-1}cm^{-2}$ 的极高灵敏度，远高于一维固定在碳纳米线上的铁单原子催化剂（6.5 μA $mM^{-1}cm^{-2}$），是目前报道的所有铁基催化剂中灵敏度最高的。该传感器还成功地用于原位监测 A549 活细胞释放的 H_2O_2。进一步系统地研究了其作用机理。有趣的结果表明，Fe-SASC/G 二维石墨烯上单个 Fe 原子催化位点之间的距离与 H_2O_2 的双氧键长度非常匹配，以促进 -O-O- 的桥吸附，实现同时的 2 电子转移，而锚定在 Fe-SASC/NW 中遥远的一维纳米线上的单个 Fe 原子只允许氧原子的末端吸附用于单电子转移。这些结果表明，Fe-SASC/G 作为一种先进的电极材料，在选择性、灵敏的仿生传感器和其他电催化应用中具有巨大的应用前景，同时为更深入的单原子催化机制提供了科学见解。

纳米酶 – 生物质碳复合材料修饰电极的制备及辣根过氧化物酶电化学传感分析应用研究 †

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Abstract: 本文以废弃核桃壳为生物质原料，通过 KOH 活化和碳化制备了一种核桃壳基生物质碳材料（WSBPC），通过层层涂布法和沉积法制备基于 Nafion/ 辣根过氧化物酶（HRP）/ 纳米金 / 生物质碳（Au/WSBPC）/ 碳离子液体电极（CILE）为工作电极的电化学酶传感器。通过紫外和红外光谱验证电极表面 HRP 的生物结构并未改变，保证了其催化能力。选用 pH 5.0 的 PBS 作为支持电解质，实现了 Nafion/HRP/Au/WSBPC/CILE 的直接电化学，求解了相关的电化学参数。研究了 Nafion/HRP/Au/WSBPC/CILE 对三氯乙酸和溴酸钾的电催化性能，分别计算得到米氏常数（KMapp）为 616.43 mmol/L 和 0.36 mmol/L，线性检测范围为 10.0–1000.0 mmol/L 和 0.1–1.1 mmol/L，检测限为 3.33 mmol/L 和 0.03 mmol/L。

$CsPbBr_3$@SiO_2-Aushell NPs with Colorimetric, Fluorescent and Photothermal Properties for Multimodal Lateral Flow Immunoassay of SARS-Cov-2 IgG †

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Abstract: Immunoglobulin detection, especially for IgG, contributes to studying the disease progression of SARS-Cov-2 and the mechanism of infection, which is a great complement of conventional nucleic acid detection to diagnosing SARS-CoV-2. Lateral flow immunoassay (LFIA) has attracted widespread attention due to its convenience, real-time readout, cost-effectiveness and portability. In this work, we propose a poly(ethylene imine) mediated approach for the synthesis of multifunctional CsPbBr3@SiO2-Aushell nanoprobes. The use of SiO2 shell can not only improve the stability and reduce the biotoxicity of CsPbBr3 quantum dots (QDs), but also decrease the fluorescence quenching degree to a certain extent as a result of the resonance energy transfer between CsPbBr3 and Aushell. The multifunctional nanoprobes integrate the fluorescence of CsPbBr3 QDs and the colorimetric and photothermal properties of Au hollow nanoparticles. Then we introduced the CsPbBr3@SiO2-Aushell nanoprobes into the LFIA system for three-mode detection of SARS-Cov-2 IgG. The minimum detectable IgG concentration by naked eye is 40 ng/mL. The limit of detection (LOD) is 4 ng/mL for fluorescent mode and 1.9 ng/mL for photothermal mode, which are an order of magnitude better than that of colorimetry. Therefore, this method has potential application in practical detection of SARS-Cov-2 and provides a guideline for the design of other multi-mode probes.

Wireless Charger Placement with Anisotropic Directional Charging Model †

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Abstract: This paper studies the problem of wireless charger PLacement with Anisotropic direcTional charging model under cOol charging constraints (PLATO). We focus on the anisotropic power receiving property of rechargeable devices and avoid overcharge during the charging process for the cool charging constraints. Our aim is to maximize the overall charging utility of all rechargeable devices by determining the positions, orientations, and power levels of chargers, given a fixed number of chargers and a set of devices on a 2D plane. To address PLATO, we propose a $(1/2-\epsilon)$ approximation algorithm through the following steps. First, we use a piecewise constant function with distance and angle to approximate the nonlinear charging power, and discretize the receiving area of each device into several subareas. Then, we present a Dominating Coverage-Angle Set (DCAS) extraction method to reduce the continuous search space to a limited one without performance loss, and transform PLATO into a mixed integer nonlinear programming optimization problem. Finally, we propose an approximation algorithm to address it. Simulation and experimental results show that our algorithm outperforms four comparison algorithms by at least 15.11%.

A Byte Pair Encoding based Sub-word Level LSTM Model for Password Guessing †

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Abstract: Text password is the primary method for identity authentication. Since easy-to-remember passwords are often chosen with specific rules in practice, those passwords are vulnerable for password guessing attacks. The study of password guessing not only enhances understanding of password security, but also promotes the improvement of password library security. This paper proposes a new password guessing method built on the Byte Pair Encoding (BPE) word segmentation technique and Long Short-Term Memory (LSTM) neural network. First, the BEP is designed to segment the training password set into sub-word level, while the dropout technology is adopted to further increase the word segmentation diversity. Then, the processed passwords are fed to train the LSTM to predict and generate new passwords, while the temperature parameter based random sampling strategy is introduced to further increase the creativity of generated passwords. Compared with the state-of-the-art character-level LSTM model, our sub-word level LSTM model trained with the MySpace password set has achieved the matching rate with an increase of 4.3% and 1.4% on the phpBB and RockYou test sets, respectively.

Abnormal Detection of Cash Out Groups in IoT Based Payment †

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Abstract: With the rise of online/mobile transactions, the cost of cash out in group has decreased and the cost of detection has increased. In the world of online/mobile payment in IoT, merchants and credit cards could be applied and approved online resulting in the form of QR code, but not physical card or Point of Sale equipment, making it easy to be controlled by a group of fraudsters. In China mainland where the credit card transaction fee is lower than retail loan rate on average, the credit card cash out are attractive for people with the need of investment or business operation, which is unlawful if over a certain amount after investigation. Because cash out will bring fees to the merchants while bringing money to the credit cards' owners, it's hard to confirm as nobody would declare or admit it. Further, it's more difficult to detect cash out groups rather individual, while cash out groups are more hidden and leading to bigger transaction amount. We propose a new method for detection of cash out groups. The proposed method covers 145 merchants from 195 known risky merchants in group acquiring by 4 banks as acquirers, which shows that this method can find out cash out groups mostly (74.4%). In addition, it reveals other 178 cash out merchants in group within the same four acquirers including 30,586 merchants totally. The results and framework are already adopted and absorbed into the design for a cash out group detection system in IoT based payment.

Air Quality Prediction with Dynamic Spatio-Temporal Hypergraph Convolutional Networks †

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Abstract: Air quality has an important impact on people's daily life. Poor air quality prevents people from going out and may lead to terrible diseases. With the development of the Internet of things (IoT) technology and sensor technology, a large amount of sensor data can be used to predict future air quality. However, traditional approaches often ignore the dynamic contextual relationships of air quality and the intrinsic connections between different pollutants. To this end, we propose a dynamic spatio-temporal hypergraph convolutional network (DSTHGCN) to predict future air quality. We first construct a dynamic graph using wind field data and the distance data of different sensors. Then we construct a hypergraph using the intrinsic connections between different pollutants, such as PM2.5, PM10, and O3. Finally, we extract the spatial and temporal dependencies using a graph convolution network and gated recurrent units, respectively. We conduct extensive experiments based on large-scale real-world datasets. Results show that our proposed DSTHGCN model outperforms the state-of-the-art baselines.

An Occupancy Based Building Performance Study: A Co-Simulation Approach †

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Abstract: Existing building simulation research integrating numerous building parameters that usually describe static or steady occupancy profiles. It frequently leads to a shortened building simulated model as well as minimizes the simulation run-time and complexity. Thus, this study reflected an occupancy-grounded building simulation study for a prototype office building located in three different climatic zones. Primarily, an agent-based Occupancy Simulator (OS) has been employed to simulate the occupant movement and presence to generate the stochastic occupancy schedule. Later, an occupant behaviour-Functional Mock-up Unit (obFMU) combined with a BPS tool has been implemented to model a wide-ranging behaviour along with the indoor environmental data throughout the co-simulation approach. As a reliability of the co-simulation approach, the study also offers a validation work using an occupant's survey and customize sensor data (for ambient data monitoring) for an office building located in Chittagong, Bangladesh. Subsequently, error metrics have been calculated and verified as per ASHRAE and FEMP guidelines. Thus, the research provides a stochastic scenery of occupant presence, movement, and zone-wise figures of indoor environmental records. It helps the researchers, policymakers, or practitioners to identify the human comfort, movement as well as energy-saving intention.

Keywords: climatic regions; office building; occupant behaviour; BPS; co-simulation

An RLNC Distributed Recoding Protocol Applied to a LoRa Architecture for Smart Cities over IoT Devices †

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Abstract: A LoRa wireless communication architecture is proposed for censusing and data processing in Smart Cities, taking advantage of RLNC recoding properties over packet segments to decrease redundant traffic in the system. At this point, the physical layer mechanisms ACM may not adapt modulation and error correction coding in time; residual errors cause packet losses at the upper layer that will be recovered with RLNC network coding. Thanks to RLNC coding algorithms in erasure channels, redundancy can be injected into packet transport, allowing receivers to recover quickly from packet loss, avoiding the costly RTT round-trip times incurred by relying on the traditional acknowledgment-based scheme. The system establishes a mapping of packet segments to a finite field (Galois field) scheme, which allows exploiting the algebraic properties of the system to exercise data recovery with information that has not been decoded and eliminate linearly dependent redundant flow. The proposed scheme will take advantage of the low complexity of a GF (2) encoding to implement it in IoT terminals with low computational capacity sensors. These data will be recorded in binary extensions and with terminals with high processing capabilities to add more degrees of freedom at the time of the final decoding of the data.

Impact Energy Scavenging for Autonomous Wireless Sensor Applications †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: The need of scavenging ambient vibration energy to power the electronic devices arises in many fields. Many nonlinear devices are developed to broaden the response frequency band of vibration energy scavengers. This paper focuses on an impact based frequency up-conversion technique to scavenge low frequency vibration energy using piezoelectric cantilever. To maximum the energy transmission efficiency, the dynamic response of the cantilever to the impact input with half sinusoid profile is analyzed. The simulation results show that the careful design of impact period will benefit to increase the output energy of the piezoelectric cantilever. Therefore, a cantilever impact structure is proposed whose spring constant can be designed for impact period adjustment. To avoid the crack happening on the piezoelectric material when the impact input is strong, two stop structures are placed at the free end of piezoelectric cantilever to limit the deflection. The theoretical analysis results show that the maximum shearing stress and the normal stress on the cantilever decreases to 67.2% and 34.4%, respectively. A prototype of impact energy scavenger is developed. When driven by hand-driving with frequency of 3.2 Hz, the peak-to-peak output voltage reaches 55 V. To improve the output power of the energy scavenger, 5 piezoelectric cantilevers are integrated in the scavenger. When a 1 mF capacitor is used as electric energy storage component, the energy scavenger powers a wireless temperature sensor with power consumption of 60 mW, which can generate 6 mJ energy in 820 ms by hand-driving.

Magnetic Resonance Multiphase Flow Metering and Testing System for Oil Fields †

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Abstract: On-line measurement and testing of oil/gas/water multiphase flow is extremely important in petroleum production, but it is difficult to solve the problem due to the lack of methods and sensors. This paper proposes an online, green, high-precision multiphase flow measurement and testing method based on magnetic resonance (MR) technology, and develops a highly integrated, multi-functional sensor system that could be applied to the extreme environment of oil fields. With the help of the static state volume fraction testing and flowing state flow rate measurement method, the segmented magnet structure and dual antenna structure for fluid measurement are proposed to transmit and receive MR signals at high frequencies, and analyzes T2 spectrum and its attenuation speed by the integrated interpretation algorithm to obtain the flow rate and composition. The sensor system can be used in petroleum exploitation, oil and gas testing, oil and gas gathering and transportation, and crude oil trade. It realizes non-separation, online flow measurement, property testing, and temperature and pressure monitoring of complex fluid in harsh environments. This technique is an application of online MR technology in solving industrial technical problems. Indoor and field tests of the prototype show that the device realizes high-frequency acquisition and high-precision flow online measurement. The sensor has the advantages of high intelligence, high precision (cc = 0.974), high frequency (0.5 times/s), low cost, no pollution, etc., and is not affected by physical parameter change such as salinity and emulsification. It is integrated with AI virtual metering and IoT for unattended field work.

PEACE: Towards Optimizing Monitoring Utility of Unmanned Aerial Vehicles with Annoyance Constraints †

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Abstract: For UAV monitoring tasks, capturing high-quality images of target objects is important for afterward recognition. Concentrating on this, many prior works study placement/ trajectory planning for UAVs to maximize the quality of captured images. However, all of them overlook a fact that UAV surveillance may cause a huge annoyance/fear on living objects. In this paper, we address the problem of oPtimizing monitoring utility of unmanned aerial vEhicles with AnnoyanCE constraints (PEACE), briefly is, maximize overall monitoring utility of given objects without violating any annoyance constraint. To tackle this problem, we establish the monitoring model according to photography and annoyance model according to psychology. Based on these two models, we formally formulate PEACE problem and prove its NP-hardness. Then, we leverage two techniques, i.e., discretization and Dominating Monitoring Set (DMS) extraction, to transform it into a combinatorial optimization problem and prove the new problem satisfying submodularity and subject to multiple linear constraints. Thus, we present a 1/3-ε approximate algorithm to address it. To further improve the efficiency, we propose a distributed algorithm, through partitioning the whole area into multiple subareas and considering each subarea independently, to reduce the computational effort without sacrificing the approximation ratio. We conduct simulations and field experiments to evaluate the proposed algorithm, and the results show that our algorithm outperforms comparison ones by at least 29.42%.

Safe Placement of Multi-antenna Wireless Chargers †

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Abstract: This paper studies the problem of Safe Placement of MultI-anteNNa WirEless ChaRgers (SPINNER), that is, given a set of wireless rechargeable devices and a set of wireless chargers wherein each charger is equipped with multiple directional antennas, scheduling both the power level and the strategy (the position and the orientations of antennas) of each charger, such that the overall charging utility can be maximized and all the locations in the field satisfy electromagnetic radiation (EMR) constraints. In this paper, we consider two different scenarios, that is, Safe Placement of MultI-anteNNa WirEless ChaRgers with a Given Position Set (SPINNER-G) and Safe Placement of MultI-anteNNa WirEless ChaRgers with Arbitrary points (SPINNER-A). First, we adopt a piecewise constant function to approximate the nonlinear charging power function and partition the 2-D field into a limited number of subareas. Thus, the number of EMR constraints is limited. Then, for SPINNER-G, we propose a Maximal Coverage Set (MCS) extraction method to further limit the number of orientations of chargers. For SPINNER-A, we construct Maximal Intersection Condition (MIC) set to limit the searching space for the positions and orientations of chargers. Then, for SPINNER-G and SPINNER-A, we propose two linear programming based greedy schemes, both of which achieve an approximation ratio of $1/2 - \epsilon$. Simulations and field experiments show that our algorithms outperform three comparison algorithms by at least 34.44%.

The Typology of the Women's Movement Identity in Afghanistan After the Year 2001'Bonn Conference' †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: The Afghan women's movement after the Bonn first conference, with the coming and introduction of new system and presence of the international community in the country, it gained new prosperity and was able to raise its demands at the highest level of the society and with the help of international institutions to force them to obey. On the contrary, it has not been very successful at the lower levels of society and rural areas in a way that we are witnessing more violence and more misogyny in the country. According to some of the researchers, the demands of the activists of this movement are not based on the needs of the women and socio-economic condition of the country and are limited to a specific group of women. The purpose of this study is to explain what social groups of activists in the women's movement in Afghanistan consist of and what their views are on the situation of the women. In this study, after analyzing the interviews of 80 activists women, we found that the Afghan women's movement is a movement by educated and intellectual women that are living in the capital and other major cities or abroad and they believe in gender inequality and oppression of Afghan women that are led and they want the gender equality and the promotion of women in society.

Keywords: women's movement; feminism; identity; attitude

Water Quality Prediction Method based on Multi-Source Transfer Learning for Water Environmental IoT System †

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Abstract: Water environmental Internet of Things (IoT) system provides the possibility for accurate water quality prediction. In the same water area, water flows and exchanges between multiple monitoring points, resulting in adjacency effect in the water quality information. However, traditional water quality prediction methods only use the water quality information of one monitoring point, ignoring the information of nearby monitoring points. In this paper, we propose a water quality prediction method based on multi-source transfer learning for water environmental IoT system, in order to effectively use the water quality information of nearby monitoring points to improve the prediction accuracy. First, a water quality prediction framework based on multi-source transfer learning is constructed. Second, the prediction parameters of multi-source transfer learning are optimized. Finally, the proposed method is applied in the actual water quality dataset of Hong Kong. The experimental results demonstrate that the proposed method can make full use of the water quality information of multiple nearby monitoring points to train several water quality prediction models and reduce the prediction bias.

The Study on the GaN Schottky diode based on the TCAD Simulation and Experiment †

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Abstract: Since semiconductors are the core of the science and technology industry, in recent years, the United States has gradually increased its restrictions on Chinese enterprises' semiconductors, accelerating the introduction of domestic chips and accelerating the localization process of domestic semiconductor equipment, parts and materials. The development trend of domestic semiconductors is bound to be high efficiency, high reliability, low cost and new materials. GaN (Gallium Nitride) has better advantages in band gap width, thermal conductivity, electron migration rate breakdown electric field and other parameters due to its unique structural characteristics. GaN Schottky diode (SBD) has faster switching speed, lower on-voltage and better high-frequency performance. This study focuses on the combination of TCAD simulation and experiment for GaN based Schottky diodes.

A 5G Perspective of an SDN-Based Privacy-Preserving Scheme for IoT Networks †

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Abstract: The ever-increasing needs of Internet of Things networks (IoTn) present considerable issues in computing complexity, security, trust, and authentication, among others. This gets increasingly more challenging as technology advances, and its use expands. As a consequence, boosting the capacity of these networks has garnered widespread attention. As a result, 5G, the next phase of cellular networks, is expected to be a game-changer, bringing with it faster data transmission rates, more capacity, improved service quality, and reduced latency. However, 5G networks continue to confront difficulties in establishing pervasive and dependable connections amongst high-speed IoT devices. Thus, to address the shortcomings in current recommendations, we present a unified architecture based on software-defined networks (SDNs) that provides 5G-enabled devices must have complete secrecy. IoT networks. Through SDN, the architecture streamlines network administration while optimizing network communications. A mutual authentication protocol using elliptic curve cryptography is introduced for mutual authentication across certificate authorities and clustered heads in IoT network deployments based on IoT. Again, a dimensionality reduction intrusion detection mechanism is introduced to decrease computational cost and identify possible network breaches. However, to leverage the method's potential, the initial module's security is reviewed. The second module is evaluated and compared to modern models.

A Future Approach for Energy Harvesting in Trains Using Piezoelectricity †

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Abstract: An energy harvesting is a process for getting the energy from the natural free resources such as vibration due to the motion. In the last decades increased the need for the renewable energy sources for using into the different life activities such as airspace filed, transportation filed and many other fields. This research displays a new vision for the railway trains; this would be accomplished by using the piezoelectric material properties. These materials would have the ability to generate electricity after applying a mechanical kinetic stress which would be useful for supplying the train with the required energy. Also, this work presents the circuit diagram for proposed approach in details. This method has a potential utility from human footsteps to generate optimal electrical energy. This paper presents an energy harvesting system where human footsteps activities were benefitted to build and design a piezoelectric transducer. These transducers were connected in series and parallel and installed under rubber track floor to generate voltages when pressed by human footstep activity.

A Study on the Components used in Radio Frequency Identification (RFID) System and its Challenges †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Radio Frequency Identification (RFID) system is an essential wireless technique of identification of physically placed objects in certain state spaces. The RFID system is the most emerging technology these days which is becoming the alternate for the barcode. Hence this technology is receiving a lot of attention comparatively over the past few years. The RFID system technology is used to automatically identify any item or a package. The automatic identification can be done with the help of the RFID Tags and the RFID Reader units. The RFID tag contains a transponder that can transmit wireless information over a short distance. The information is then received by the device called the RFID Reader and is further processed through middleware infrastructure. Lots of the RFID system applications are being used in various fields like Hospitals (Healthcare centers), Engineering, and Livestock's for traceability purposes. Acquaintance with the advantages and the risk of the RFID system. The gumshoe of this technology has made a gigantic impact on our daily lives.

Innovative Automobile Intelligence Security Framework based on NAB Architecture †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Identity Management is a combination of procedures and innovations to oversee and secure access to an Information Technology infrastructure. A user authentication in an automobile is a critical security issue due to their unattended and improper deployment as most automobiles are outfitted with limited computing power and accordingly verifying users has now been a fundamental security concern. The methodology employed in this paper is Method for Architecting Secure Solutions (MASS) minutiae-based matching module for finger print identification. The most ordinarily utilized identity management tool is the secret key and username approach which ends up plainly weakened when the more prominent verification of the user identity is required. In this paper, a multi-factor client user identity management paradigm is proposed named Name, Age and Biometric (NAB) which is a mobile application embedded on a microcontroller. This framework has the capability of confirming the Name, Age and Biometric (fingerprint) of the user. The point is to give a layered barrier and make it more difficult for unauthorized user to gain access to automobile, control age eligibility to access the automobile and control theft cases.

New Principles for SAW Acoustofluidics †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Acoustofluidics is a combination of acoustics and microfluidics. Microfluidic chips employing surface acoustic waves (SAWs) use acoustic radiation force and acoustic streaming for non-contact manipulation of micro- and nano-scale particles, which have important applications for separation, enrichment and sorting of biological particles, etc. Exploring the novel physical mechanisms involved can provide an important basis for the development of such devices. This report presents some of our recent theoretical and technical explorations in this area, including the establishment of a theoretical framework for particle acoustophoresis in counter-propagating SAW systems especially those designed for particle separation purposes, the characterization of in-channel physical fields based on kinetic and kinematic methods, Lamb-wave coupled resonance in SAW acoustofluidic chips which significantly increases the energy efficiencies of SAW chips and enables real lab-on-a-chip applications, and the establishment of Fourier acoustic tweezers who have achieved the theoretical limit of selective manipulation for the first time. These results here lay an important physical foundation for the establishment of a predictable, measurable, energy-efficient and high-precision acoustic tweezer platform, and provide new ideas for the development of tools for cell biology and laboratory medicine.

A Stretchable Highoutput Triboelectric Nanogenerator Improved by MXene Liquid Electrode with High Electronegativity †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Growing demand in intelligent wearable electronics raises an urgent requirement to deformable and durable power sources with high electrical performance. Here, we propose a stretchable and shape-adaptive triboelectric nanogenerator (TENG) based on MXene liquid electrode. The open-circuit voltage of an MXene-based TENG reaches up to 300 V. The excellent fluidity and highly electronegativity of MXene liquid electrode, rendering the TENG with long-term reliability and stable electrical output regardless of diverse extreme deformations. With harvesting mechanical energy from hand tapping motion, the TENG in a self-charging system can charge up capacitors to drive wearable electronics. Moreover, the TENG can be attached to both human skin and clothes as a human motion monitoring sensor, which can inspect the frequency and amplitude of various physiological movements. This work provides a new methodology for the construction of stretchable power sources and self-powered sensors, which have potential applications in diverse fields such as robotics, kinesiology, and biomechanics.

基于可穿戴多传感器融合的同步定位建图研究 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 在消防救援中，受到烟雾和明火的影响，传统基于视觉与无线通讯的消防员单兵室内定位建图方法无法正常工作。为弥补这一技术空白，现提出基于惯性导航与超声感知的可穿戴式同步定位建图系统。片状可穿戴设备固定在消防靴外侧。算法以惯性、超声、气压、地磁传感器为主要数据源，提出基于模式识别的行人航迹推测计算定位轨迹，利用栅格建图方法融合超声与气压数据，并采用基于磁指纹匹配和拓扑约束的粒子滤波建图优化，同步生成定位轨迹与建筑结构图。消防模拟烟雾场景下的实验结果表明，可穿戴原型性能与穿戴体验良好，定位平均精度达 1.7 米。

关键词 : 可穿戴传感器；多传感器融合；同步定位建图；行人航迹推算；粒子滤波

3D-Conformal Graphene Film for Flexible Tactile Sensor †

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Abstract: Graphene is considered as an ideal material for next generation flexible and wearable electronics, such as OLED, Skin patches, E-skin and solar cells, and so on, due to its extremely high physical flexibility and perfect biocompatibility. However, graphene electrode is limited in a confining tensile strain for less than 10% and is easy to be torn under large stretching. Herein, we we developed a conformal growth and transfer technique to produce the large-scale uniform graphene on 3D micro-structured flexible PDMS substrate, which show prominent mechanical capabilities: prominent tensile ability of monolayer graphene with the tensile strength of ~28%, and tensile ability of few-layer CGrs with the tensile strength of ~77.8%. And then, we fabricate the tactile sensors with high sensitivity, and the limit of detection is lower than 1 milligram. Furthermore, we fabricate the array of tactile sensors, could collect the pressure image. the E-skin device have 1024 pixels, area of about 1 square foot, and scan rate of 100 Hz. The tactile sensors exhibit the potential for applications in slip feeling, force feedback, safe e-skin of robots.

Accurate 3D Human Pose Estimation based on an RGB-D Camera Array and the Skeleton-Prior Constrained Believe Propagation †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: During the past decade, the computer vision society has witnessed the fast development of the deep learning algorithm and the advanced sensors such the RealSense RGB-D cameras from Intel and the Kinect series from Microsoft. One now can obtain a relatively accurate human pose, i.e., the 3D locations of the skeleton joints of a human, by using a consumer-grade RGB-D camera. However, the accuracy can still not meet the requirement of many real-life tasks such as avatar driving, sport gesture correcting. In this work, we build an RGB-D array containing 3 to 4 synchronized RGB-D cameras for capturing the human pose from different angles. Furthermore, a sophisticated inference algorithm which constrains the conventional belief propagation with human skeleton prior is also proposed. In the experiment, we found the RGB-D array facilitated with the new inference algorithm achieves much higher accuracy compared with single RGB-D cameras.

Directional Sweat Transport and Breathable Sandwiched Electrodes for Electrocardiogram Monitoring System †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Device-body interface is significant for acquiring high quality bio-signals, preventing skin-irritation and minimizing the motion artifacts. However, low breathability of the typical substrate used in a flexible electronic device usually deteriorates the stability of device-body interface, which is imperative for long-term application but commonly disregarded. Here we report a directional sweat transport and breathable electrode using three-layer sandwiched structure. The top two layers are typical Janus hydrolyzed-polyacrylonitrile/thermoplastic-polyurethane (HPAN/TPU), which fascinate directional sweat transport from the hydrophobic HPAN layer to the hydrophilic TPU layer; and the third layer is an electrode layer of Ag nanowires. This dedicatedly designed electrode can transport sweat from skin to the top HPAN layer, while keeping low noise electrocardiogram (ECG) signal detection. In the trial of ECG monitoring, the results show that the electrode can achieve reliable recording with high signal noise rate (SNR) both in calm state (10.5dB) and sweaty state (10.1dB) with sweat tolerance. No allergies or obvious SNR degeneration are observed after utilizing the electrode owing to the effective sweat transport away from the device-body interface rather accumulation. Moreover, skin-friendliness and long-term wearability are confirmed by three-day continuous wearing. Finally, we have demonstrated the anti-sweat accumulating electrode for wearable application.

Integrated Wearable Sensors for Sensing Physiological Pressure Signals and β-hydroxybutyrate in Physiological Fluids †

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Abstract: Flexible and wearable sensors have attracted much attention for their applications in health monitoring and human-machine interaction. The most studied wearable sensors have been demonstrated for sensing a limited range of metabolites such as ions, glucose, uric acid, lactate, etc. Both sweat and urine contain numerous other physiologically relevant metabolites indicative of health and wellness. This work demonstrates the use of the wearable sensor for the detection of β-hydroxybutyrate (HB) in sweat. HB is an important biomarker of diabetic ketoacidosis caused by the accumulation of ketone bodies in the body that often occurs for patients with hyperglycemia or metabolic acidosis. Herein, we fabricated an integrated sensing system coupling an HB detection chamber with a serpentine electrode physiological pressure sensing for pulse beat, vocal cord vibration, etc. The real-time HB detection was based on β-hydroxybutyrate dehydrogenase enzymatic reaction. The stability of the enzyme and cofactor couple were achieved by crosslinking networks and a redox mediator, thereby achieving high selectivity and detection limits to HB in urine and sweat. The dual-functional sensor was integrated with a signal processing circuitry for signal transduction, conditioning, processing, wireless transmission, and real-time convenient health monitoring display to a smartphone via a home-developed software.

Rational Design of Wearable Sensors for Synergistic Optimization of Linearity and Sensitivity †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: The globalization of networks and development of IoT indicate that human beings are playing a central role to dynamically interact and exchange information with the surroundings. Sensors that can real-time record and transmit multiple physiological signals of human beings facilitate the interaction with the complex environment and promote the healthy development of our society. Wearable sensors have been indicated as one key technology with promising applications including human-machine interface and real-time health monitoring, etc. for the future. Even continuous endeavor was paved on the development of flexible sensors, bottleneck still exists in terms of the capability such as sensitivity/linearity balancing for reliable and precise readout and the possibility of facile production. Herein, we will introduce our recent studies and achievements on the rational design of flexible sensors, from materials to structures, towards the multiple applications with the capabilities of broad pressure range covering, simultaneous optimization of sensitivity and linearity, etc. The design principle to optimize the widely-used resistive, capacitive and triboelectric sensors, including contact area, dielectric constant, and elastic modulus will be systematically discussed with solid experimental supports. We will also deliver out recent demonstration of the wearable sensor towards the health monitoring and human-machine interaction, based on the successful performance optimization with a broad working range. Finally, the perspective of wearable devices as a multi-functional platform towards various application scenarios will also be elaborated.

Wearable Flexible Microwave Antenna Sensor for Monitoring Glucose Concentration based on Dielectric Properties †

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Abstract: With the increasing number of diabetic patients in the world, timely control of blood glucose concentration has become the key to treatment. However, most monitoring methods are invasive at present, which will increase the harm to patients. Therefore, it is necessary to develop a sensor that can monitor glucose concentration non-invasively. In this paper, a flexible microwave antenna sensor with a resonance frequency of 2.4 GHz is designed for non-invasive glucose concentration monitoring. Based on the change of glucose concentration in blood, the sensor will affect the dielectric properties, and further affect the reflection parameters of the sensor, and finally realize the monitoring of glucose concentration. By constructing in vitro and multi-layer human tissue models in the high-frequency structural simulation software HFSS for sensing testing, the effects of human tissue on reflection parameters were analyzed, and the sensor structural parameters were optimized. The experimental results show that the resonant frequency shift and reflection coefficient of the sensor have a linear relationship with the change of glucose concentration. The sensor has a cheap and simple fabrication process and has great potential for non-invasive glucose monitoring.

基于高度可拉伸 Ni-Co MOF/CNT/PVA/PU 薄膜的柔性可穿戴电化学装置用于汗液中皮质醇监测 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 当前，开发高性能的柔性可穿戴传感器对于监测人体健康有着重大意义。在此，我们开发了一种基于镍 - 钴金属 - 有机骨架复合材料（Ni-Co MOF）涂覆在 CNT/PVA/PU(CPP) 导电薄膜上的高度可拉伸柔性电化学传感器，用于检测汗液中的皮质醇。含有氨基官能团的 Ni-Co MOF 材料通过戊二醛与链霉亲和素 (SA) 实现共价偶联。形成 MOF SA 复合材料后将其固定在电极表面通过 SA 作用与 biotion-aptamer 相连构建了皮质醇适配体传感器，通过捕获皮质醇形成的复合物阻碍了 MOF 的催化性能，从而大大降低了 MOF/CPP 电极催化 HQ-H2O2 的电化学信号。通过差分脉冲伏安法 (DPV) 进一步监测传感器对不同浓度皮质醇产生的电流大小。该适配体传感器具有高度可拉伸、高灵敏度、低检测限、对干扰物的高选择性和环境储存稳定性。将其与集汗布以及 PDMS 基底组装成可穿戴装置，实现汗液中皮质醇监测。具有成本低、稳定性高、易于制备等特点，在今后的个性化诊断中具有巨大的潜力。

柔性可穿戴器件 - 结构设计及应用 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 面向柔性可穿戴器件研究及应用，利用碳材料、金属纳米材料及凝胶材料的化学惰性、高导电性、良好力学特性、容易构造成膜等特点，针对柔性储能、触摸感应、离子传感等应用，研制开发了多种柔性传感器件，并尝试将其应用于生命体征等多种监测体系中。

Keywords: tactile sensing; pressure sensing; ion sensing

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鱼鳞生物质碳修饰电极对多巴胺的便携式传感检测 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 多巴胺（DA）是一种重要的神经递质，DA 水平异常可能引起帕金森、精神异常、老年痴呆、情感障碍等疾病。本文选用生物废弃物鱼鳞作为原材料，通过酶解、活化和两步热解碳化法制备了一种高导电性的鱼鳞生物质碳材料，并将其修饰在丝网印刷电极表面，构建了一种便携式电化学传感平台并用于 DA 的检测。通过 U 盘式电化学工作站和智能手机进行信号传输，该传感器可以对注射液中的 DA 含量进行实时快速检测。鱼鳞生物质碳具有三维多孔结构和良好的导电性，为 DA 分子的吸附和氧化提供了大的比表面积和活性位点。传感器表现出较好的灵敏度和选择性，检测范围为 1.0–1000 μM，检测限为 0.25 μM（3σ），具有良好的实际应用潜力。

基于姿态特征提取的消防员可穿戴跌倒检测系统 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 据《中国消防年鉴》数据显示，2008–2018 年，我国消防人员致命或非致命伤害事件 625 起中超过一半与跌倒有关。本研究提出一种基于嵌入 9 个惯性测量单元（IMU）的可穿戴消防防护服的跌倒检测系统（FDS）。与传统利用原始加速度和陀螺仪数据进行跌倒识别不同，本研究通过结合多运动传感、姿态和航向参考系统、运动学特征分析、三维重建、机器学习等技术，使火场外指挥官能通过便携终端设备监控每个消防队员的运动状态，并获知任何与跌倒或不活动相关的安全警报。根据浙江省宁波市 14 名消防员的数据采集结果，我们提出的 FDS 准确率达 98.54%，并显著提升响应速度。

基于晶格质子插层 WO_3 的柔性可穿戴 pH 传感汗液分析 †

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Abstract: 在可穿戴生物传感领域，汗液 pH 值监测是一项重要的常规指标。目前可穿戴 pH 传感器主要依赖于有机敏感材料（如聚苯胺和氢离子载体），但其生物毒性是一个挑战。WO_3 是一种典型的无机 pH 敏感材料，具有化学稳定性，生物相容性和低成本的优势。然而，WO_3 扭曲的晶体结构导致其灵敏度和响应时间较差。基于此，我们提出了晶格质子插层法来提高 WO_3 的 pH 传感灵敏度和选择性。通过插层，促使 WO_3 从单斜相向立方相转变，增强了 WO_3 与 H+ 的离子交换能力。插层后的 WO_3 电阻降低了两个数量级以上，提升了离子 - 电子转移效率。另一方面，H+ 占据 WO_3 晶格使其只能与 H+ 发生离子交换，从而提高了 H+ 的选择性。我们进一步将 H_xWO_3 与固体参比电极集成，构建了柔性可穿戴的 pH 传感器件，在弯曲情况下仍显示良好的电位响应。与体外 pH 测量对比，汗液的 pH 在线监测显示出较高的准确性。这项工作强调了晶格质子插层的概念用于调节 WO_3 基 pH 传感器的性能。

Smart IoT-Based Wearable with Sensing for Functional Rehabilitation †

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Abstract: High-dosage lower-limb motor practice has been proven in many existing studies that could effectively help with patients' functional recovery. Yet, evaluation of to which extent the patient adheres to the practice and the performances are not considerably satisfied and many challenges yet to be solved before adopted to clinical practice. Up to date, research that aims at utilizing assistive technology for functional rehabilitation monitoring, such as using 3D motion capture system and depth camera, focused on the performance evaluation using pre-recorded activities data. Few studies have researched on classifying the rehabilitation exercises and their effectiveness in real time in the clinical setting (such as the hospital). This work proposes a low-cost unobstructive IoT-based wearable solution that could perform tracking, classification and quality assessment of patients' rehabilitation performances more effectively where the rehabilitation tasks are based on the American Academy of Orthopedic Surgeons (AAOS). The study utilizes four thumb-size micro-controllers with an integrated six degree-of-freedom (DoF) motion sensor placed on the dorsum of foot and lower shin to capture the motion of patients while performing rehabilitation tasks. Then, a fine-tuned machine learning model is trained to provide the assessment of a patient's rehabilitation tasks based on the real-time motion data. The quality assessment of the rehabilitation is visualized in a graphical form to assist clinicians to evaluate the training outcome and further update the training plans to fit the patient's needs.

Advances in Fiber/Fabric-Based Triboelectric Nanogenerators as Human-oriented Self-powered Sensors †

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Abstract: Fiber/fabric-based triboelectric nanogenerator (TENG) can be directly weaved or knitted into breathable, flexible, lightweight clothes and can efficiently convert the low-frequency, irregular and varied body motion into electricity, such as footsteps, breathing, heartbeat, finger tapping, knees bend, etc., which shows great potential to be used as self-powered sensors for healthcare monitoring, action identifying, motion tracking, electronic skin, pressure detecting, tactile sensing and human–machine interacting. Ideal next-generation wearable human-oriented self-powered sensors are expected to be lightweight, long-lasting, breathable, deformable, and washable, however there remains large gap between currently reported sensing textiles and practical applications. To this end, a critical review is presented on the advances in fiber/fabric-based TENGs as self-powered sensors from the aspects of basic classifications, structural designs, material selections, fabrication techniques, working principles, sensing signal processing and transmission, as well as potential applications. Furthermore, core difficulties, bottlenecks and possible solutions are summarized and discussed, which is crucial for future development of sensing textiles.

A Stretchable, Breathable, Washable, Wearable, All-Textile Smart Keyboard †

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Abstract: The development of stretchable, breathable and washable wearable devices is an emerging technological goal in human-computer interaction. Conductive textiles attract a great deal of interest as versatile materials for wearable devices. Some high-performance wearable devices made of conductive textiles and elastic polymers have been reported. However, it is still an important challenge for the development of textile-based wearable devices to be stretchable, breathable and washable. In this study, a novel wearable smart keyboard is developed. Benefit from the ingenious structural design of double-faced effect functional textiles and 3D spacer textiles, the smart keyboard is all-textile, stretchable, breathable and washable. In addition to the functions of traditional keyboards, smart keyboards also have the ability to detect touch pressure, which lays the foundation for future intelligent applications, such as tracking the touch pressure of typewriting to enhance security. The application examples of integrating the smart textile keyboard into lab-coat for typewriting are demonstrated. This study shows that the novel smart keyboard has great potential in the fields of wearable devices and human–computer interface.

A Dual-Function Wearable Electrochemical Sensor for Uric Acid and Glucose Sensing in Swea †

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Abstract: Simultaneous detection of uric acid and glucose using a non-invasive approach can be a promising strategy for related diseases, e.g., diabetes, gout, kidney disease, and cardiovascular disease. In this study, we have proposed a dual-function wearable electrochemical sensor for uric acid and glucose detection in sweat. The sensor with a four-electrode system was prepared by printing the ink on a common rubber glove. CV and chronoamperometry were used to characterize the prepared sensor's electrochemical sensing performance. The sensors exhibited the linear range from 0 to 1.6 mM and 0 to 3.7 mM towards uric acid and glucose electrochemical sensing in phosphate buffer solution, with the corresponding limit of detection of 3.58 µM and 9.10 µM obtained, respectively. Moreover, the sensors had shown their feasibility of real sample sensing in sweat. The linear detection range for uric acid (0 to 40 µM) and glucose (0 to 1.6 mM) in the sweat can well cover their concentration range in physiological conditions. The prepared dual-function wearable electrochemical sensor features easy preparation, fast detection, high sensitivity, high selectivity, and the practical application potential in uric acid and glucose sensing.

DNA-Specific Ultra-sensitive Fluorescent Probe Monitors Clustered DNA Lesions †

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Abstract: The complexity of DNA damage determines the severity of its biological consequences. Clustered DNA lesions can produce one or more different types of DNA damage in 1-2 rings of DNA helix, which can cause serious diseases such as Alzheimer and Parkinson. Therefore, it is of great significance to use fluorescence sensors to achieve high-selective and high-sensitivity visual analysis to monitor the level of clustered DNA lesions. How to use the structural adjustment and specific chemical reactivity of fluorescent molecular probes to achieve a variety of fluorescence signal changes is the key point for its high sensitivity to synchronously identify multiple DNA damage. Using propylene nitrile derivatives as the matrix, the molecular probe was constructed that can produce a series of multi-color fluorescence signals. The conjugate double-bond skeleton of the molecular probe can rotate and regulate its conformation torsion in a free state within a hydrophobic structure. At the same time, it uses the hydrolysis of acrylonitrile groups in the DNA hydrophobic environment. Molecules emit a series of fluorescent signal changes, which are used to real-time monitor different types of DNA damage, such as DNA base accumulation damage and DNA double strand fracture to achieve ultra-sensitivity detection of clustered DNA lesions. This study can be used to monitor the levels of cluster DNA injury lesions in many diseases.

DNAzyme Controlled Cell-Cell Interactions †

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Abstract: Cell membranes provide a highly complex biological boundary that carries a variety of essential surface receptors for cells to recognize or communicate with each other. Regulating cell-cell interactions and cell behaviors via cell surface engineering are of significance for biological research, such as cell fate control and cell therapy. Recently, Dr. Ruo-Can Qian's group has achieved remarkable progress in the field of cell surface engineering and regulation based on DNAzymes, by working together with Prof. Yi Lu from University of Illinois at Urbana-Champaign. To realize elaborate controls of cell dynamic behavior, the enzyme and substrate strands of Zn^{2+}- and Mg^{2+}-specific DNAzymes are combined to build DNA double-chain molecular switches enabling 2-factor disassembly control including AND and OR operation. Via double-chain hybridization, separate cells link with each other to form large cell assemblies. Different disassembly outputs can be controlled by the embedded control switch and its two input signals of Zn^{2+} and Mg^{2+}. The established method has been applied to control the assembly and disassembly between two cell spheroids. The migration of the T-cell spheroid from one tumor cell spheroid to another can be achieved with our strategy, which shows potential insights as a new tool for therapeutic application in cancer treatment.

Enhancing Bio-Image Resolution Limit by Advanced X-ray Imaging System †

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Abstract: Great impact may be anticipated when the resolution of the bio-image is enhanced, which is yet to be realized despite the many attempts. Such possibility has now been achieved by the X-ray imaging method here. The CMOS sensor was adopted to replace the traditional CCD sensor, which enhanced the pixel resolution by around 100 times. The traditional X-ray imaging light path was also redesigned by replacing the circular aperture with a square one, which enabled us to apply advanced mathematical algorithm to resolve the point spread function (PSF), removing eventually the blur from PSF. A much clearer sample picture was obtained using the D8 Advance X-ray machine, based on these discoveries, which showed a resolution limit at several microns, allowing us to observe the body tissue at a smaller scale. Hopefully, these discoveries will not only provide better healthcare for the patient, but also deliver innovative scientific insights to the wide research community.

Improving Image Quality and Temporal Resolution of Laser Speckle Contrast Imaging by Combining Filtering Techniques †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Blood vessel morphology and flow velocity are critical for the diagnosis and treatment of vascular diseases, such as the laser treatment of port-wine stains. Based on the dynamic light scattering theory, the laser speckle contrast imaging (LSCI) allows for the non-invasive acquisition of blood vessel morphology and flow velocity. The main principle is to calculate the contrast value through statistical analysis, and use the inverse relationship between the speed and the contrast to obtain the blood flow rate. However, it is difficult to obtain an acceptable level of signal-to-noise ratio (SNR) with a few raw speckle images due to statistic errors and motion artifacts. Many filtering techniques had been proposed to improve the SNR of contrast images. However, combining the advantages of various filtering techniques to achieve higher SNR and temporal resolution with fewer raw speckle images has not been reported. In this work, we firstly compare the SNR improvement of anisotropic LSCI (aLSCI), spatial filter and guided filter with the traditional temporal contrast algorithm. Secondly, the filter operation order was optimized. Finally, the improvement of temporal resolution due to the SNR improvement was studied. The results showed that guided filtering has the best SNR improvement effect, followed by spatial filtering, and finally anisotropic filtering. By implementing anisotropic filtering, spatial filtering, and guided filtering in sequence, the SNR can be increased by 9.6 times. The temporal resolution is improved by 10 times by the anisotropic filtering.

Less Counts More: Few Elongated Cells Drastically Alter Super-Diffusion in Bacteria Swarming Under Antibiotics †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Microorganism inevitably encounter the environmental variation, thus develop necessarily strategies to adjust the colonies for survival. Here, cooperating Serratia Marcescens bacteria are used to reveal how the population adapt to the gradually deteriorated habitat. Subjected to dose increase of the antibiotic, the swarming bacteria exploit evolving turbulences for transferring, exhibiting a global transition from homogeneous turbulence to defect-mediated vortex-jets with large coherent length. Towards challenging of the detailed transport in such a microscale living turbulence, single nanoparticle tracking is developed to elucidate the complete view of transport process up to the limit of ballistic diffusion to resist stronger drug. We uncovered an adaptive strategy to hazard tolerance by means of lengthening with negligible fractional number from the whole community, but being able to significantly coordinate swarming migration into strengthening turbulence, which implies a possible swarming strategy against the harmful environmental variation.

Living-System-Induced Evolution of Peptide Probes and Their Application in Bioimaging †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: The primary principle for new molecular evolution is from nature, mimicking nature and beyond nature since it is of extremely important for the artificial molecules to keep their structure and function in natural system. This is especially true for the self-assembled nano-construction in situ in the complicated living bodies. Herein, we put forward a directed evolution strategy consisted of high-content screening from living system and artificial modification in order to find 'totipotential peptides' in a precise way based on the microchip platform. Progressively dimension reduction of the capability and precise anchoring the target was realized. We obtain a series of nano peptide probes which could realize high resolution molecular imaging and therapy simultaneously. We envision that the strategy and its applications provide a new method for molecular discovery and improve the performance of peptide nano self-assemblies for diagnostics and therapy.

mtDNA-Specific Ultra-Sensitive Near-Infrared Fluorescent Probe and the Biometric Application †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Mitochondrial DNA (mtDNA), as a class of important genetic material, is vulnerable to damage, resulting in a series of metabolic diseases, hereditary disease etc.1 And mtDNA damage can occur in a very short time (ca. 5.0 min) under physiological conditions,2 i.e. mtDNA can be used as a sensitive indicator of cell health. Thus, the development of rapid, ultra-sensitive and specific tools for monitoring mtDNA in cells is of great significance for assessing cell health. Herein, a near-infrared fluorescent probe (YON) using dicyanoisophorone as a fluorophore was constructed for ultra-sensitive monitoring of mtDNA in living cells. A series of performance tests showed that, based on the A-π-D-π-A molecular structure designed, YON could efficiently and specifically bind to mtDNA through minor grooves (binding energy = −76.77 kcal/mol) in a very short time (1.3 min) and induced an intramolecular torsional conformational change, resulting in a significant enhancement of the fluorescence signal at 640 nm, enabling rapid, ultra-sensitive and specific monitoring of mtDNA in living cells. In addition, YON could be used to evaluate the health of cells by monitoring microchanges of mtDNA enabling the ultra-sensitive evaluation of apoptosis.

Non-invasive Detection of Skin Structure Based on Inverse Monte Carlo Radiation Method †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: The non-invasive detection of skin's structure lays the foundation for the personalized laser surgery of vascular skin diseases such as port-wine stains (PWS), which can be achieved by diffuse reflectance spectroscopy (DRS). This study aims to propose an inverse Monte Carlo radiation method based on two source-detective separations to quantify the skin structure. The variables of the skin model were divided into two groups, including chromophore concentration (melanin and hemoglobin), epidermal thickness and average vessel diameter in the normal group, as well as diameter and thickness of PWS vascular layer in the diseased group. To do this, a multi-layered skin models were constructed including an epidermis layer, two dermis layers and a PWS vascular layer. The epidermis layer considers melanin absorption and skin matrix absorption, while the dermis layer considers blood absorption and skin matrix absorption. The scattering properties of these two layers are set to be the same. The PWS vascular layer only considers the absorption and scattering properties of blood. The nonlinear global optimization method was used to analyze the DRS signals in order to solve the variables of the skin models based on geometrical, absorbing and scattering properties. The results showed that the new objective function improved the inversion accuracy of the skin structure variables. The error of variables in normal group except epidermal thickness is reduced by more than 40%, and that in diseased group is reduced by more than 16%.

Non-Invasive Measurement of Subcutaneous Blood Vessels by Photothermal Radiometry based On One-Dimensional Deep Learning Networks †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: After selectively absorbing the laser energy with a certain wavelength during the laser therapy of vascular dermatosis, a dramatically rising temperature causes blood coagulation. The vascular architecture and temperature peak are critical in revealing the bioheat transfer process and determining the best laser parameters for achieving target therapy while avoiding damage to the surrounding normal tissue. In this work, a photothermal radiometry approach based on a one-dimensional convolutional neural network (1D CNN) deep learning architecture is suggested to non-invasively estimate the depth, radius, and temperature of blood vessels after monitoring the mid-infrared (IR) emission from the sample surface following exposure to short laser pulses. The higher performance of 1D CNN on vascular information evaluation has been proven using simulated data as compared to standard inversion approaches. To further confirm its validity, we also employed the 1D CNN to measure the surface dynamic temperature after the 1064 nm millisecond pulsed laser irradiation of the model containing artificial blood vessels. In extremely short processing time, the accuracy of predicted depth, radius, and temperature can reach 95%, 88%, and 93%, respectively.

核酸适体的分子设计与膨胀显微成像 †

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Abstract: 核酸适体是一类特异性识别靶标分子的单链 DNA 或 RNA 序列，它可以通过插入一些调控序列而实现对靶标分子的智能响应。然而，这些核酸序列的进入可能会导致亲和力的变化。我们通过对原始核酸适体的裁剪，获得了一种稳定的核酸适体 ZAJ-2c 和一种环境敏感的核酸适体 ZAJ-2d，通过质谱鉴定它们的靶标为细胞膜上的 CD49c 分子。ZAJ2c 的特点是在 4–37 °C 的温度范围内具有不依赖二价阳离子的结合能力，可用于测量肿瘤细胞 CD49c 的表达。ZAJ-2d 在 4 °C 的结合缓冲液中具有纳摩尔级的结合亲和力，但在 37 °C含 5 mM EDTA 的 PBS 缓冲液中完全失去结合能力。通过简单地调节温度和二价阳离子，可实现 CD49c 阳性细胞的选择性捕获和释放。另外，将细胞核靶向的核酸适体 Ch4-1 两端分别标记荧光分子和丙烯酰胺基团，成功实现了细胞核的高分辨膨胀显微成像，可省去多步标记、染色等过程。因此，核酸适体是一类可设计、可修饰的特异性识别分子，在生物传感和生物成像中发挥着重要的作用。

活体成像与测量 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 在活体层面对疾病特征分子的实时动态变化信息进行成像及测量，这对于研究疾病发生分子机制具有重要意义。然而，目前利用活体成像对疾病相关活体内分子信息进行定量化的获取仍然面临着挑战，也是当前化学测量学领域最具挑战性的问题之一。每种活体成像技术都各具独特的优势和固有的局限性，近红外二区（NIR-II，950–2000 nm）的荧光成像的灵敏度十分优异，但组织穿透力和在浑浊介质中的空间分辨率较低；NIR-II 区的光声成像的空间分辨率较好、穿透深度深，但是灵敏度很有限 [1,2]。因此，如何设计分子探针，集成这两种二区成像，实现优势互补的双模式增强，是肿瘤微环境分子影像的材料科学问题，但相关材料仍然缺乏发展与报导 [3]。目前 NIR-II 区荧光与光声成像主要集中在直接对疾病病变或者器官生物成像。目前利用活体成像对疾病相关活体内分子信息进行定量化的获取仍然面临着挑战，也是当前化学测量学领域最具挑战性的问题之一 [4]。为进一步提高活体成像精准度及实现可定量分析，我们课题组发展了一系列具有响应性的 NIR-II 区荧光与光声双模式成像比率型分子探针，用于靶向成像具有免疫检查点通路的肿瘤细胞以及免疫相关细胞的特征生物标记物 [5,6]。同时建立了基于 NIR-II 区比率型成像的活体测量新的方法，提高了对生理分子信息原位、定量获取的精准度。进一步揭示了活体分子比率成像信号与疾病发生发展之间的关联机制，提出了实时、无创疾病活体分子诊断新策略 [7–10]。

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生物膜仿生纳米酶在肿瘤细胞成像及诊疗中的研究 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 区别于传统纳米材料，由于生物分子的修饰，生物膜仿生纳米酶被赋予更多优势，例如更好的生物相容性、更精准的靶向性、延长药物循环等，使其体现出更好的生物安全性和治疗效果。我们以肿瘤细胞膜、大肠杆菌膜为模型，构建了 Fe_3O_4/MnO_2 仿生纳米酶用于细胞成像和诊疗。一方面，乳腺癌细胞膜可以增强同源靶向性，使药物在肿瘤区域大量蓄积；另一方面，大肠杆菌膜中高表达的呼吸链酶 II 和超氧化物歧化酶可以催化肿瘤局部产生 H_2O_2，从而增强类 Fenton 反应。成像结果表明，多功能仿生纳米平台增强了化学动力学 / 光热 / 化学联合治疗效果。

荧光探针性能调控与活体精准成像应用 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 传统荧光探针难以实现细胞和活体原位成像、高选择性成像和清醒动物成像，针对上述问题，张晓兵团队开展了系统深入的研究工作：揭示氢键驱动小分子探针有序组装机制，首次提出疏水疏脂染料概念，提出小分子探针荧光原位成像新思路；探索荧光成像探针分子识别构效关系，提出基于分子结构调控的小分子探针构建策略，发展高选择性生物成像分析方法；发现富电子蒽衍生分子的长余辉发光特性和机制，发展有机长余辉发光共振能量转移精准成像分析方法，实现清醒动物的长余辉成像。

多光谱窄带宽表面晶格共振传感器 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 提出了 Si/SiO_2 纳米颗粒二聚体阵列的多光谱窄带宽表面晶格共振 (SLR) 传感器以获得两个高品质因数 (FOM)。我们证明，由于高灵敏度和窄带宽，FOM 可以达到 173 的值。Si 纳米粒子的形状和直径、阵列的周期、二聚体之间的间隙对 SLR 和 FOM 有重要影响。该工作对多光谱单反传感器的设计具有重要意义。

A High Sensitive Accelerometer Based on Fiber Optic High-Finesse Fabry-Pérot Interferometer †

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Abstract: A fiber optic accelerometer with high sensitivity, high resolution and compact size is proposed for low-frequency acceleration sensing. The sensor is composed of a rigid outer frame and miniature spring-mass structure as the inertial sensing element. A self-focusing lens is introduced to reduce light scattering loss so that the high finesse Fabry-Pérot interferometer (FPI) can be formed between lens facet and the cubic mass surface to measure the FPI cavity length change caused by acceleration. The corresponding change of light phase is magnified due to the multi reflection of light within the interferometric cavity and the dynamic acceleration sensing of the designed accelerometer is performed by using white light phase demodulation system, which shows a high acceleration sensitivity of 51.8 dB re rad/g with a 3 dB bandwidth of 50 Hz. A minimum detectable acceleration (MDA) of 121.7 μg/Hz1/2 can be obtained at signal frequency of 50 Hz and the resolution of the sensor reaches 2.3 μg. The sensor features simple assembling and good repeatability. Its transverse sensitivity is measured to be less than 7.9% (−22 dB) compared to the sensitive axis. The experimental result indicates that the proposed accelerometer has application potential in areas such as seismic detection and structural health monitor.

Bidimensional Displacement Optical Sensor †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Diplacement measurement plays a primary role in several industrial and research areas. The extension to more than one dimension can affect the accuracy due to coupling of the dimensions. Here we developed a high performance fully optical sensor for bidimensional displacement measurement in the transverse plane with good performance in term of resolution.

Buried Fiber Bragg Grating Temperature Sensor †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Fiber Bragg grating sensors have the outstanding advantages of small size, light weight, corrosion resistance and high sensitivity. Using these advantages, fiber Bragg grating sensors can be implanted into the interior or surface of objects by inlaying or casting without affecting the beauty and reliability of the object, and the relevant physical parameters are measured with higher accuracy. We have insulated and encapsulated the fiber grating temperature sensor and poured it on the surface of the metal coating sample to achieve accurate measurement of the surface temperature of the coated sample. In addition, we have monitored the temperature changes of the coated samples exposed to the natural environment for one day, and compared the differences in the endothermic effect of the coated samples of different colors.

Detecting Inorganic Phosphorus in Water Environment by Biosensor Based on Bioluminescence Resonance Energy Transfer †

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Abstract: Inorganic phosphate (Pi) is a significant indicator for the eutrophication of environmental water, while traditional ammonium molybdate spectrophotometry causes chemical reagent pollution and costs long reaction time. Therefore, highly sensitive and rapid detection methods for Pi are urgently needed. Here, we developed a bioluminescence resonance energy transfer (BRET)-based biosensor, which can detect Pi in water (nM-μM) quickly, sensitively, and high-throughput. A small volume of NanoLuc and the Venus fluorescent protein was selected as the fluorescent donor and receptor, respectively. Based on the preliminary expression and purification, a good response of Nluc-PiBP-Venus BRET biosensor to inorganic phosphorus was obtained. The detection range and detection limit were optimized using the point mutagenesis of flexible joint and binding pocket. The immobilization strategy based on biomimetic mineralization of metal-organic frameworks as protective coatings for protein was adopted to improve the anti-interference ability and applicability of the biosensor for complex water environments. The biosensor has a good application prospect in miniaturized portable equipment development and high-throughput detection of water quality.

Development of Bolometer based Uncooled Infrared Image Sensor with CMOS-MEMS Single Chip Integration Scheme †

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Abstract: MEMs based infrared (IR) image sensor can find wide applications in night vision systems, automotive and consumer electronics. In this paper, CMOS-MEMS single chip integration scheme was used to develop MEMS bolometer based IR image sensor, which had advantages of low cost and high performance because of shared substrate area between readout ASIC and MEMS structure. Readout circuit was firstly designed and fabricated by standard CMOS technology. Then the CMOS-MEMS interface module was developed to realize PAD, reflection layer and related structure. After that, MEMS micro-bridge structure based Micro-Bolometer device was built on the interface module. With CMOS compatible process consideration, CVD based low temperature silicon film was used as sensing material and sacrificial material. Anchor and contact module were developed by trench first approach. Ti\TiN thin metal electrode layer was used to define the resistor device and realize electrical connection between MEMS and readout circuit. Global and local stress engineering were done to improve the wafer warpage and obtain flat micro-bridge surface. After full fabrication process, within wafer resistance uniformity was checked, and device level TCR was measured at room temperature. After process optimization, the sensor chip was released and the micro-bridge surface flatness was checked by optical method and SEM. Final the function and performance of the image sensor was evaluated.

Foreign Material Detection Based on Visual Features Fusion †

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Abstract: Foreign material detection is an important technology for intelligent industry, especially in tobacco sorter system. Most algorithms are focusing on finding the threshold of color feature, however, it's hard to detect the foreign material with similar color, so this paper proposals a novel method for foreign material detection based on visual features fusion and machine learning. Firstly, the texture feature with Laws filter is developed, secondly, we compares the effect with features fusion based on SVM and YOLO v5 model, thirdly, a special hardware system is developed for testing foreign material detection in tobacco sorter process. The tests show this method is better than the exiting ones, and the hardware can improve the calculation speed.

High Sensitivity Fiber Optic Hydrophone Based on Fabry-Perot Interferometer for Multiplexing †

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Abstract: A high sensitivity fiber optic hydrophone based on Fabry-Perot interferometer (FPI) for low-frequency underwater acoustic signal sensing is proposed. The two reflectors of the FPI are metal composite diaphragm with a diameter of 3.5 mm and fiber end face. The phase sensitivity and the minimum detectable sound pressure are -134.15 dB re 1 rad/μPa and 0.96 mPa/Hz1/2 at 40 Hz, respectively. A flat response range between 5 to 250 Hz is realized with the sensitivity fluctuation 3 dB. To improve the practicability of the fiber optic hydrophone, by using high-speed optical switches and fiber couplers, a multi-domain multiplexing method based on white light phase demodulation system is proposed. The experimental result indicates that the proposed multiplexing method can realize the application of four-element optical fiber hydrophone. Combined with the proposed hydrophone, this multiplexing method can achieve simultaneous detection of acoustic signals below 250 Hz, which gives the fiber optic hydrophone based on FPI great potential for low-frequency underwater acoustic source localization.

Highly Sensitive Nitrogen Dioxide Detection Based On Photoacoustic Spectroscopy †

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Abstract: Nitrogen dioxide (NO_2) is one of the primary atmospheric pollutants, which can cause the formation of acid rain and photochemical smog. We developed a highly sensitive NO_2 sensor based on photoacoustic spectroscopy by using a low-cost high-power laser diode (LD) emitting at 450 nm. The designed photoacoustic detection module can reduce the sensor size and suppress the noise. A LabVIEW-based control system was employed in the sensor. The parameters of the sensor were studied in detail in terms of laser power and operating pressure. The linearity of the sensor response to the laser power and NO_2 concentration confirms that saturation effect does not occur. A 1σ detection limit of 82 ppt (part per trillion by volume) was achieved with a 1-s averaging time, corresponding to a normalized noise equivalent absorption (NNEA) coefficient of 1.058×10^{-9} W cm-1 $Hz^{-1/2}$. A 72 h outdoor continuous on-line monitoring of environmental NO_2 was implemented to demonstrate the reliability and validity of the developed NO_2 sensor.

Highly Sensitive SO2 Sensor Based on All-Optical Photoacoustic Spectroscopy by Using a 7.41 µm EC-QCL †

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Abstract: A high-sensitive photoacoustic sensor system of Sulfur dioxide (SO2) detection based on a pulse wave room-temperature, high-power external cavity quantum cascade laser (EC-QCL) is reported. The excitation wavelength of the laser is set to 7.41 µm for alignment strongest absorption line of SO2. A differential photoacoustic cell is used to reduce environmental noise and enhance the signal. The photoacoustic signals are detected by fiber-optic acoustic sensor based on composite Au-Cr diaphragm with intensity-based quadrature point (Q-point) demodulation. The use of composite diaphragm greatly improves the success rate of diaphragm transfer and the diaphragm is made very thin. Two same Cr-Au diaphragms of 330 nm thickness and 6.35 mm radius is respectively used in photoacoustic cell of two channels as acoustic detection. Wavelet denoising and Empirical mode decomposition (EMD) analysis is applied signal process for promote signal-noise-ratio. Finally, a minimum detection limit (1σ) 71.96 ppb at 1s of integration time is achieved, and this sensor is applied to actual environmental monitoring to verify its practicability.

Radial-Cavity Quartz-Enhanced Photoacoustic Spectroscopy †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Photoacoustic spectroscopy (PAS) is a kind of zero-background optical gas sensing technology with the advantages of high sensitivity, high selectivity, and wide dynamic range. As a variant of PAS, quartz enhanced photoacoustic spectroscopy (QEPAS) is boomingly developed in the past decades since its invention in 2002. In QEPAS, a sharply resonant quartz tuning fork (QTF) is used as the transducer converting acoustic signal to electrical signal by its piezoelectric property. In order to improve the QEPAS sensor performance, acoustic-micro-resonators (AmRs) are used to create acoustic resonance to enhance the acoustic signal. Up to now, all QEPAS configurations are based on resonators with longitude resonance which requires the resonator length far larger than the its diameter. In this case, the optical alignment will be more difficult, especially when long wavelength sources were used, such as quantum cascade lasers and THz sources. We firstly demonstrated radial-cavity quartz enhanced photoacoustic spectroscopy (RC-QEPAS) that creating radial resonance mode to enhance the QEPAS signal. The RC-QEPAS having three advantages; 1) radial resonance eliminates the requirement on resonator length, greatly facilitating the optical alignment; 2) strong radial resonance mode leads to a substantial signal enhancement. With an optimized radial cavity, the detection sensitivity of QEPAS was enhanced by > one order of magnitude. The RC-QEPAS makes the acoustic detection module more compact and optical alignment comparable with a bare QTF; 3) the radial-cavity acts as resonator and gas cell simultaneously, simplifying the sensor structure and reduce the gas sampling volume.

Rapid Identification and Detection Of P450 1A by the Spectral Changes by Regulating Molecular Structure †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Cytochrome P450 1A (CYP1A) is one of the most important phase I drug metabolizing enzymes and plays a crucial role in the metabolic activation of carcinogens to final carcinogens, leading to tumor formation and increased incidence of cancer diseases. Thus, there is an urgent need to develop a practical method for rapid and sensitive detection and real-time monitoring of CYP 1A enzyme activity in biological systems, which will be very helpful to timely identify the potential abnormal expression behavior of this cancer-related enzyme in human body, and further guide the understanding and prediction of drug metabolic pathways and side effects. In this work, naphthalimide dyes with high quantum yield, easy modification, large Stokes shift and good photothermal stability were selected as fluorescent parent. Meanwhile, considering the substrate preference of CYP1A and its high O-dealkylation ability, a series of naphthalimide derivatives were synthesized by introducing methoxyl group in the parent nucleus and changing the substituent group in the head. A variety of CYP isoforms were used for selective screening to explore the potential relationship of structure-spectral-selectivity. After screening and optimization, when the substituent is N, N-dimethylethylenediamine, the probe showed high selectivity and sensitivity in the O-demethylation catalyzed by CYP1A. In addition, the probe can be used to monitor the activity of CYP1A in complex biological systems in real time, which provides a broad prospect for bioimaging of endogenous CYP1A in living cells and further study of CYP1A-related biological functions.

Simplified Highly-Sensitive Temperature Sensor Based on Harmonic Vernier Effect †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: A highly-sensitive temperature sensor with cascaded polarization maintaining fiber-Sagnac interferometers (PMF-SIs) based on harmonic Vernier effect has been proposed and experimentally demonstrated. Both simulation and experiment results indicate that the fundamental Vernier effect can be achieved through cascading two PMF-SIs with similar free spectral ranges (FSRs) and the first-order harmonic Vernier effect can be further realized by two PMF-SIs possessing FSRs with an approximate multiple relationship. The maximum sensitivity of the cascaded PMF-SIs based on harmonic Vernier effect has be enhanced about 35.46 times compared with that of single PMF-SI, exhibiting a high temperature sensitivity of −53.30 nm/°C in the temperature measurement range from 30 °C to 37 °C. The temperature sensor with simple structure and high sensitivity has a great application prospect.

Single-Wavelength Passive Homodyne Phase Demodulation Technique for Michelson Interferometric Sensors †

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Abstract: A single-wavelength passive homodyne phase demodulation technique is proposed for Michelson interferometric sensors. By utilizing characteristic that initial phase difference of interferometric signals from two outputs of a 2×2 optical coupler is π, a linear fitting-trigonometric identity transformation-differential cross multiply (LF-TIT-DCM) algorithm is applied to those two interferometric signals to interrogate phase signal of the Michelson interferometer. Thorough theoretical deduction is made to demonstrate effectiveness of the LF-TIT-DCM algorithm. A diaphragm based Michelson interferometric fiber optic acoustic sensor is fabricated and a phase demodulation system is built to prove the aforementioned technique. Dynamic range of the proposed algorithm is tested by applying acoustic signal of different amplitude to the acoustic sensor and good linearity is observed from 0.2 rad to 3.1 rad. Several experiments are performed to prove that the proposed technique is robust and stable. Experimental results show that initial phase differences of optical couplers with different ratio are tested to be π and demodulated phase amplitude is hardly influenced by optical power and laser wavelength. Moreover, excellent repeatability is observed during thirty minutes.

Strain Distribution Monitored by FBG Sensor for Helicopter Windshield Application †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Great impact can be made to the helicopter windshield after in service for some time, due possibly to the combined effects of external mechanical stress, internal assembly stress, low temperature in winter, and temperature difference between day and night. Despite the advantages of light weight, ease of manufacturing, excellent weather resistance and good light transmission and mechanical properties, the windshield material PMMA YB-2 aviation plexiglass experienced silver streaks, cracks, and scratches, attributing to the various loads during service, such as cabin pressure, cyclic aerodynamic load, temperature load and installation stress. This not only causes the deterioration of optical transparency, but also reduces the mechanical properties of the material, leading to sudden burst or other vicious accidents. Thus, this research aims to resolve this challenge using FBG strain sensing method to obtain the actual measured data of the windshield strain state under various engine power conditions, creating a strain distribution map of the measured parts. Hopefully, this will assist the wide research community to monitor the real time strain distribution, providing a final solution to the huge challenge.

Two-Dimensional Field-Effect Transistor Sensors †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Two-dimensional field-effect transistor (2D-FET) sensors are one of the frontier research fields of advanced sensing technologies. These materials have large surface area and ultra-thin thickness approaching the physical limit, which give rise to remarkably enhanced sensitivities. On the other hand, all of the electron processes take place at the material surface or interfaces. The interfaces will largely influence the performances. Thus, the interfacial modulation is an important scientific question. This research is focused on the interfacial modulation of the 2D-FET sensors. Main results include: new methods are developed to controllably produce high quality 2D sensing materials and the interfaces of the 2D-FET sensors; a new approach is demonstrated to improve the interface between the semiconductor and the dielectric substrate by using conformal h-BN; new mechanisms such as giant photoelectrical-gating effect, photoelectrical enhancement effect of molecular crystals at 2D limit, controllable charge doping at the sensing interface, etc. are developed to modulate the electron processes at the sensing interface, which improves photoelectrical or chemical sensing performances of 2D-FET sensors.

Typical Fluorescent Sensors Exploiting Molecularly Imprinted Hydrogels for Environmentally and Medicinally Important Analytes Detection †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: In this work, two typical fluorescent sensors were generated by exploiting molecularly imprinted polymeric hydrogels (MIPGs) for zearalenone (ZON) and glucuronic acid (GA) detection, via analyte's self-fluorescence property and receptor's fluorescence effect, respectively. Though significant advances have been achieved on MIPG-fluorescent sensors endowed with superior stability over natural receptor-sensors, there is an increasing demand for developing sensing devices with cost-effective, easy-to-use, portable advantages in terms of commercialization. Zooming in on the commercial potential of MIPG-fluorescent sensors, the MIPG_ZON is synthesized by using zearalanone (an analogue of ZON) as template, which exhibits good detection performance even in corn samples with a limit of detection of 1.6 mM. In parallel, fluorescein-incorporated MIPG_GA is obtained and directly used for cancer cell imaging, with significant specificity and selectivity. Last but not least, our consolidated application results unfold new opportunities for MIPG-fluorescent sensors for environmentally and medicinally important analytes detection.

Ultra-Highly Sensitive Methane Detection Based on Cantilever-enhanced Non-resonant Photoacoustic Spectroscopy †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: A highly sensitive methane (CH4) trace gas sensor based on cantilever-enhanced non-resonant photoacoustic spectroscopy (PAS) is demonstrated. A distributed feedback (DFB) laser with central wavelength of 1.65 μm is used as the excitation source in the spectroscopy detection. The pressure variations due to the photoacoustic signal are detected with a miniature silicon cantilever, whose displacement is measured with a Fabry–Pérot (FP) interferometer. The signal is effectively improved by two same cantilevers of 4 μm thickness, which are placed against in the middle of the photoacoustic cell to suppress the external vibration noise by 21 dB. The cantilever microphone has high sensitivity, which is over 7 μm/Pa within 2.5 dB fluctuation in the range of 5 Hz to 250 Hz. Wavelength demodulation and second harmonic demodulation technology is applied to suppress the noise caused by window and wall absorption of cell. A miniaturized non-resonant cylindrical photoacoustic cell of 1.2 mL is used for trace methane gas detection, which is 4 mm diameter and 96 mm length. A minimum detection limit of 111ppb is achieved for methane gas at 1s of integration time.

Whole-Device Scalable Fabrication of Flexible Perovskite Photodetectors †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Perovskites have attracted enormous attention in optoelectronics, owing to their excellent optoelectronic properties, low-cost constituents, and simple solution fabrication approaches. Despite significant advances in large-scale production of perovskite films, electrode layers—indispensable components of an optoelectronic device— are deposited onto perovskite films using complicated methods, such as thermal evaporation and chemical vapor deposition, which hinders the large-scale production of the whole device. Herein, a whole-device scalable fabrication is developed by laser synthesizing porous graphene as electrodes. Specifically, a CO2 laser beam transformed the top layer of polyimide (PI) film, a commonly-used flexible substrate, to laser-induced graphene (LIG) with an interdigitated pattern. Then, a methylamine-free perovskite precursor solution was spin-coated or printed onto the PI film, followed by an annealing process to form a high-quality stable perovskite film. The perovskite, LIG, and PI compose a flexible photodetector, acting as sensitive element, electrode, and substrate, respectively. The fabricated device exhibited large photo-dark current ratios (the largest ratio of 110) and high response speeds (the shortest rise time of 0.5 s and the shortest decay time of 0.4 s) in a broad wavelength range (365 nm to 940 nm). Moreover, the device maintained the high optoelectronic performance during a cycling bending test, demonstrating its high flexibility. The developed whole-device scalable fabrication sheds light on the commercialization of perovskite based optoelectronic devices.

基于氧化还原反应的次氯酸探针用于细胞凋亡监测 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 细胞程序死亡 (programmed cell death，PCD) 也常常被称为细胞凋亡，是生物体发育过程中普遍存在的，是一个由基因决定的细胞主动的有序的死亡方式，是维持生物体功能和组织稳态的重要过程。生物体中细胞凋亡的异常发生将导致生物体功能紊乱，如，次氯酸含量异常变化引起氧化应激，导致组织损伤和疾病的发生。因此，构建一种可应用于次氯酸快速检测的方法在生命科学及医学临床研究中具有重要意义。文献报道，肟在温和条件下可以选择性的被次氯酸氧化形成醛或者酸。基团肟中的碳氮键为次氯酸的反应位点，通过次氯酸的氧化断键作用能够引起探针颜色和荧光的变化。基于此，本工作设计开发了一例基于氧化还原反应的次氯酸荧光探针用于细胞凋亡的监测。体外实验表明探针对次氯酸具有良好的响应能力，细胞实验表明，随着次氯酸含量的变化，探针呈现不同的荧光信号，实现对细胞凋亡过程的实时监测和成像。该探针为细胞凋亡过程研究提供了一种潜在的研究工具。

基于自适应中心聚焦机制的图像质量评价算法 †

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Abstract: 用于光学传感器成像质量评估的图像质量评价（IQA）建模过度依赖于人眼视觉系统（HVS）研究的固定阈值先验，算法无法适应复杂动态的光学成像环境，评价精度不足。为提升 IQA 算法精度与鲁棒性，本文结合 Laplace 算子，创新性提出自适应全参考图像质量评价模型。本方法结合图像色彩、边缘梯度及相位一致性特征，制定多元决策模型。同时通过统计 Laplace 算子滤波图像的信息熵，提出自适应视觉中心聚焦范围阈值和动态权重预测算法。TID2013 和 LIVE 数据库中的预实验结果表明，本方法有效克服固定阈值带来的影响，评价结果的一致性精度误差较现有主流方法提升约 10%。

比率型荧光探针用于黑素瘤细胞中酪氨酸酶活性的定量检测 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 酪氨酸酶 (Tyrosinase，TYR) 是一种重要的酚羟基氧化酶，是黑色素代谢过程中的关键酶之一，其活性直接影响黑色素的产生。1 TYR 在黑色素瘤细胞中的过量表达与皮肤病的产生息息相关，例如，白癜风和黑色素瘤。2 因此，构建一种可应用于活体酪氨酸酶快速检测的方法对相关疾病的诊断和治疗监测具有重要意义。本工作利用酪氨酸酶识别基团（3- 羟基苄基）设计合成了一例检测酪氨酸酶活性的比率型荧光探针。当使用酪氨酸酶处理探针时，识别基团被切断，探针呈现比例荧光信号。此外，探针具有较大的斯托克斯位移，对酪氨酸酶有很高的灵敏度，并且不受其他相关活性物种的干扰。因此， 该探针有望成为监测复杂生物系统中酪氨酸酶活性的良好工具。

用于表面增强拉曼光谱 (SERS) 的 TiO_2@Ag 纳米管阵列基底的电化学快速制备方法 †

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Abstract: 目的：开发一种快速简便的制备有序 TiO_2@Ag 复合纳米阵列的方法，构建高性能 SERS 生物传感基底。方法：电化学阳极氧化法制备 TiO_2 纳米管，阴极还原法在 TiO_2 纳米管顶端沉积纳米银环状结构。结果：FDTD 计算表明 80 nm 直径的 TiO_2 顶部沉积 15 nm 厚度 Ag 形成的结构具有较强的 LSPR 效应，对制备的 TiO2@Ag 复合纳米阵列进行 SEM、TEM、XRD 和 BET 测试证明，该结构形貌规则有序，TiO_2 纳米管顶端有环状均匀沉积的纳米银结构形成，吸附性能良好。利用罗丹明 6G 计算 SERS 增强因子高达 1.5×109，与 FDTD 计算的结果相符。结论：该制备方法快速简便，基底 SERS 增强性能优越，有望用于高性能 SERS 生物传感应用。

A Compact Three-Dimensional Optical Fiber Accelerometer Based on High-Finesse Fabry-Pérot Interferometers for Low Frequency Vibration Sensing †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: A tri-axis accelerometer based on a three-dimensional spring-mass oscillator and high-finesse FP interferometers is theoretically researched and experimentally characterized. The mechanical property of the sensing structure is analyzed to predict the accelerometer's frequency response, and the light setup of the high-finesse FP interferometers is introduced to enhance the sensitivity. During the experiment, the proposed sensor shows high sensitivity of over 50.9 dB re rad/g in the frequency range of 5–80 Hz, and its minimum detectable acceleration is as low as 186.3 ng/Hz1/2. The demonstrated optical accelerometer features high sensitivity, low noise and compact size, which has great potential in applications such as seismic detection, structural health monitoring, and so on.

A Photoacoustic Detection System Based on Cantilever Microphone †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: An extremely sensitive method has been applied to detect multi-gas dissolved in the oil of transformer. The multi-gas is closed in a sample cell, which is penetrated by different bands light in fixed-frequency. The absorption of the light radiation stimulates multi-gas to form a sound wave, which could be measured by an extremely sensitive cantilever microphone. The concentration of some gas absorbing the light radiation is directly proportional to the intensity of the sound wave. The detection limit can reach sub-ppb, satisfied analysis of dissolved gas in the oil of transformers.

Compensation of Temperature Drift for a High–Precision Small Angle Measurement System †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: This paper proposes a temperature compensation method for a high-precision small angle measurement system based on the four-quadrant photoelectric detector autocollimator. The proposed method is based on the linear dependency on the temperature. The experimental results show that after performing the temperature compensation proposed, the angle outputs are almost stable over a wider temperature range and will not change with the temperature. The fluctuations are only 1.2 arc seconds, which can obtain long-term real-time stable angle outputs. The proposed compensation method will lay a strong foundation for the applications of the high-precision small angle measurement system.

可变分辨率的压缩感知高光谱计算成像方法 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: 压缩感知高光谱计算成像系统能够打破传统高光谱成像的技术瓶颈，获取超越图像传感器分辨率的高光谱图像，广泛应用于遥感监测、医疗诊断等领域。作者团队基于一种典型的高光谱计算成像系统型式，提出了可变分辨率的压缩感知高光谱计算成像方法。在不改变系统结构的前提下，利用数字微镜阵列 (DMD) 分区同值调制，实现对空间分辨率的灵活调节，满足不同应用场合需要；其后，如若对图像空间分辨率产生了更高的需求，通过超分辨重建算法，以更快的速度获取与原始 DMD 相同分辨率的更高重构质量的图像。仿真和实验结果验证了提出方法的有效性和可行性。

Acoustic Streaming: Actuator for Fluid and Particle Manipulation †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Acoustic streaming is a nonlinear effect generated by the absorption of sound energy/intensity in a fluid, which results in a nonzero time-averaged Reynolds stress force in the thin viscous boundary layer or in the bulk of a fluid. In the past several decades, acoustic streaming, as an acoustic actuator, has been frequently used for particle and fluid actuations for e.g. biomedical and biochemical applications in the microfluidics field. In this work, we will give a general description of the fundamental theory of acoustic streaming, with special emphasis on the mechanisms of acoustic streaming patterns that are generated in microfluidic channels, followed by their applications in fluid and particle manipulation, including fluid pumping and mixing, particle rotation, trapping, concentration and transportation, cell sonoporation and lysis, etc. While introducing the fancy results that have been obtained by several research groups, we will give a brief description of the recent theoretical and experimental work related to acoustofluidics performed in our own research group.

Analysis on Fallback Values of Digital Control System in Nuclear Power Plants †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Digital Control System (DCS) based on Mitsubishi MELTAC + HOLLIAS platform has been developed in ACPR1000 nuclear power plants. To fully utilize the superiority of digitalized technology, the analysis on fallback values setting in DCS is conducted. Fallback values, as the substitution of invalid signals when they are detected in DCS, are considered in a dominant position to determine the system behavior and consequences of plant operation as they will participate in the control logic in place of the invalid signals. On the basis of briefly introducing the architecture of ACPR1000 DCS and the invalidity management mechanism of signals, the failure mode of signals from sensors to DCS cabinets, the analysis range for fallback values, analysis principles and method, implementing modes for various signals and engineering application are summarized in this paper. The study is significant to enhance the reliability of the instrument and control system itself and guarantee the safety level of nuclear power plants.

A Green Fabrication Process of Flexible Strain Sensor Based on Liquid Power-Ultrasound at Room Temperature and Normal Pressure †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Flexible strain sensors with broad sensing range, high sensitivity and good stability are highly desirable because of their potential applications in interactive electronics, implantable medical devices and robotic systems with human-sensing capabilities. In this work, a flexible strain sensor fabrication method based on liquid power-ultrasound at room temperature (25℃) and normal pressure (1 atm) is reported. This method utilizing the acoustic cavitation and acoustic streaming induced by power ultrasound of 19.9 kHz in multi-walled carbon nanotube (MWCNT) water solution to deposit MWCNT nanomaterials onto the surface of a PDMS substrate. The prepared strain sensor has a large stretchability (≥420% strain), high sensitivity (gauge factor, GF=8.4~68.3) and good stability (>10000 cycles at 50% strain). Also, the remained MWCNTs solution in the fabrication process can be recycled, and the fabrication method has little selectivity for nanomaterial species, which can achieve effective and reliable deposition of various nanomaterials such as carbon nanotubes, graphene and silver nanowires onto the surface of a flexible substrate. Therefore, the proposed technique provides a promising and environment-friendly method for the fabrication of high-performance flexible strain sensors with a nanomaterials/polymer substrate.

Fabrication and Study of a Capacitive Tactile Sensor Based on Carbon Black-PDMS Composite Material with CNT Coating Layers †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: With the rapid development of robot intelligence, various kinds of force sensors and tactile sensors have been developed to strengthen the sensing technology. In this work, a new type of capacitive tactile sensor was proposed for pressure sensing, which is based on carbon black / PDMS composite dielectric layer and upper and lower electrodes of CNTs / PDMS composite layer. A model was established for the output characteristic of loading pressure on the sensor, which can be used to predict the value of the applied force. Then the prototype with carbon black / PDMS composite dielectric layer was fabricated and characterized. It was concluded that the dielectric constant of carbon sensor can reach 0.1 N in normal direction and 0.2 N in tangential direction with good stability. Finally, the multi-directional force results were obtained. Compared with the individual axis-directional force results, the output capacitance value of multi-directional force was lower, which indicated the amplitude decrease of capacity change in the normal and tangential direction. This might be caused by the deformation distribution in the normal and tangential direction under multi-directional force. The proposed fabrication method is a trial to design a pressure sensor with lower cost and multi-directional responses.

Geometric Structure Analysis and High Temperature Characteristics of AlGaN/GaN Heterostructure Hall Effect Sensors †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Hall sensor is the most commonly used sensor type in magnetic sensing which has many applications in industrial production, automotive electronics, aerospace, biomedicine and many other fields. Traditional Hall devices with Si, GaAs and many other materials cannot work at high temperature and have high offset voltage. In this paper, the Hall device fabricated by AlGaN/GaN heterojunction two-dimensional electron-gas structure can work in high temperature environment. The temperature drift coefficient is only 98.3 ppm/K in the temperature range from room temperature to 400 °C, and the offset voltage is only 52 μV when the input current is 1 mA. In addition, the angle and noise characteristics of the device were also measured. In order to study the influence of the input-output aspect ratio of the cross structure with non-quadruplex rotational symmetry structure on the device performance, five Hall devices with different structures are designed for verification, and the results are consistent with the simulation results. The devices that expected to work in harsh environments are obtained and the effects of different input-output aspect ratios of the devices are confirmed.

In Situ and Rapid Alignment of Pump Beam and Magnetic Field for Nuclear Magnetic Resonance Gyroscope †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Nuclear magnetic resonance (NMR) gyroscope is one of the new type gyroscopes developed rapidly in recent years, which is based on the spin-exchange optical pump technique and owns advantages of small size, high precision, and low cost. Under ideal condition, the pump beam, which propagates along the z axis, has the identical direction with the magnetic field. While, the reality is that these two directions are inconsonant (e. i. there is a small angle between the pump beam and magnetic field), it will affect the performance of NMR gyroscope. An in-situ and rapid alignment of pump beam and magnetic field for NMR gyroscope is demonstrated here. The magnetic field direction is considered as a benchmark, the alignment can be achieved via adjusting the direction of pump beam. When the projection fields in the x and y axes are zero and the output amplitude of NMR gyroscope reaches its maximum, the alignment between the pump beam and the magnetic field can be realized successfully. This method has a good general applicability and can also be used for the magneto-optic alignment of atomic magnetometer.

Measurement Method for Magnetic Field Based on Harmonic Resonance of Amplitude Modulation Signal †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: The optical amplitude modulated Bell-Bloom magnetometer has the advantage of high sensitivity and no RF signal interference. It is a proper candidate for weak magnetic field detection. Magnetic field measurement is performed by modulating the pump light amplitude to obtain the spin-precession phase information of the atomic magnetic moment. For the Bell-Bloom magnetometer of this configuration, a higher frequency of modulation signal is required when measuring magnetic fields of greater intensity. Due to the limitations imposed by accuracy of modulation signal source and signal processing system, the measurement sensitivity decreases accordingly as the magnetic field intensity increases. We propose a magnetic field measurement scheme which uses the standard square wave as the modulation signal of the pump laser, and the magnetic resonance signals caused by the high-order harmonic in the square wave are employed to calculate the magnetic field intensity, so as to expand the magnetic field measurement range at a lower modulation frequency. The theoretical analysis is consistent with the experimental result and suggests a distinguishable range of harmonic resonance signal. The maximum measurement range of magnetometer under specific sensitivity condition is determined according to the characteristics of resonance signal.

$MoSe_2$/ZNRs Hybrid Material for Hydrogen Gas Sensor at Room Temperature †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: Molybdenum diselenide ($MoSe_2$) is a promising gas sensing material due to its large surface-to-volume ratio, narrow band gap, and excellent absorptions. However, $MoSe_2$-based gas sensors possess inferior gas response and recovery at room temperature. In this context, assembly of hybrid structures can be an effective technique to stimulate the intrinsic structural and electronic properties of $MoSe_2$ nanosheets (NSs). Herein, we report interfacial science and engineering to design a unique p–n hetero nanostructure for the first time using $MoSe_2$NSs doped with ZnO nanorods (ZNRs) through facile methods. The systematic material analyses revealed that $MoSe_2$ is consistently coated on the surface of ZNRs in this present hybrid combination. The $MoSe_2$-ZNRs hybrid structure exhibits an excellent sensitivity (~60%), which is better than those of pristine $MoSe_2$ NSs (20%) and ZNRs (10%) toward H_2 gas. It was revealed that the finest doping of $MoSe_2$ on the surface of ZNRs improves the H_2 gas sensing properties when compared to that of pristine ZNRs. This can be ascribed to the structure–property correlation, synergistic interfacial effects, and p–n hybrid hetero junctions between exfoliated $MoSe_2$ and ZNRs. The successful hybridization of the $MoSe_2$-ZNRs hetero nanostructure paves the way to future opportunities on the hybridization and fabrication of MOS with TMDs gas sensors.

1/f Noise Characterization of CVD Based Amorphous Silicon Resistor †

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Abstract: Amorphous Silicon is widely used in advanced CMOS technology and MEMs/Sensor products because of its remarkable properties. In this paper, amorphous silicon resistor device was designed and fabricated, in which amorphous silicon deposition process was developed on CVD tool. PVD Ti\TiN was used as electrode layer, and its pattern was used to define two terminal of the resistor device. FTIR and SIMS were used to characterize element concentration and bonding information of the amorphous silicon film. I-V curve of the device was measured by Keysight B1500 to check the ohmic contact performance. After selecting appropriate load for resistance matching, the noise spectra was measured by Keysight E4727B. Due to the amorphous state of material of the resistor device, the noise is mainly determined by carrier number fluctuation induced by traps and the dangling bonds at the grain boundary. These traps and dangling bonds can emit and capture charged carriers randomly, which was depending on the relative position of their energy level and Fermi energy level. And it was the carrier number fluctuation induced by these events that had introduced the current noise. Based on the analysis and random fluctuation properties of resistance noise, noise model of the resistor device was built and model parameters were extracted according to the measured data.

微结构光子晶体光纤生物传感器结合高效荧光采集系统超灵敏检测 N- 乙酰氨基葡萄糖转移酶 †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: N- 乙酰氨基葡萄糖转移酶（OGT）与 β-N- 乙酰葡萄糖胺糖基化密切相关，被认为是一种新的有前景的诊疗靶点。目前，OGT 的研究和检测受到其超低细胞丰度和酶活性的低稳定性的阻碍。我们提出了一种基于微结构光子晶体光纤（MSOF）的新型生物传感器，用于 OGT 的超灵敏分析。利用 MSOF 作为载体固定荧光标记肽和非放射性 UDP-GlcNAc 作为糖供体进行 O-GlcNAc 糖基化修饰。构建的结合凹面镜和显微镜物镜的荧光收集系统进一步提高了激光诱导荧光（LIF）检测灵敏度，检测灵敏度低至 3.40 × 10^{-2} pM，并成功应用于乳腺癌患者血液样本的 OGT 活性分析，为 OGT 分析研究提供了一个有前景的分析平台。

Performance Characterization of Hall Magnetic Field Detector Based on AlGaN/GaN Heterostructure with Back-End Interface Circuit †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: A Hall element based on AlGaN/GaN heterostructure fabricated on a 6-inch silicon wafer and applied in high temperature environment is proposed. On this basis, a Hall magnetic detector with high sensitivity, high linearity and low noise is prepared, and the instrument performance is characterized. In order to make the instrument have small offset voltage and intrinsic noise, the cross horizontal Hall element with quadruple rotational symmetry is adopted. In addition, a back-end interface circuit is proposed to improve the sensitivity of the instrument by cancelling offset voltage, filtering and amplifying the output voltage of the Hall element. The instrument can be excited in two optional operating modes: current mode or voltage mode, which can realize the measurement of static magnetic field and dynamic magnetic field at low frequency.

Disturbance of Neutron Flux Measurement under Post-accident Conditions in Nuclear Power Plant †

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Abstract: Sub-criticality monitoring under post-accident conditions is of great significance for emergency operation in nuclear power plants, as many post-accident physical phenomena may disturb the measurement process of neutron flux outside reactor, how to quantitatively evaluate the disturbances is therefore becoming a key issue for core reactivity monitoring in post-accident conditions. In this paper, Monte Carlo model is established based on actual neutron diffusion process to quantitatively evaluate the disturbance to neutron flux measurement outside reactor considering the following post-accident physical phenomena: control rod assembly block after reactor trip, reactor cavity flooding, core draining. The amplification and attenuation factors due to these physical phenomena are obtained, based on which proposals are suggested to realize accurate diagnosis of core sub-criticality state and to prioritize the nuclear power control in post-accident conditions, this is essential for operating strategy orientation and fuel clad barrier integrity control in emergency operation of nuclear power plants.

Fault Identification of Meta Action Unit Based on Multi-Source Information Fusion and D-S Evidence Theory †

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† Presented at the 8th International Symposium on Sensor Science–China, Nanjing, China, 27–29 March 2023.

Abstract: This paper focus on the fault information of a single sensor is limited by the process of fault identification of the transmission device of NC machine tools, and the traditional D-S evidence exits many evidence conflicts when dealing with multi-source high-dimensional data, a meta action unit fault identification method based on multi-source information fusion and improved D-S evidence theory is proposed .Firstly, a mechanical element action signal acquisition test-bed is established to analyze the correlation degree of multi-source information of the element action unit. The data layer fusion of multi-source similar information of the element action unit is realized, and the multi-source in-formation fusion framework is established by the covariance crossover method; Then, t-sne is used to reduce the feature dimension and extract the evidence body, the decision fusion of heterogeneous information is completed by using the improved D-S evidence theory, and the fault identification model of meta action unit is established. Finally, this method is applied to the fault identification of ball screw, and compared with traditional information fusion methods, single vibration signal and similar information fusion methods. The experimental results show that the proposed method is superior to other methods in recognition accuracy and robustness.

Analysis of the Coordinate Time Series of Shanxi CORS Considering the Common Mode Error

Xiaotong Li, Wei Li, Zhemin Sui, Yutong Huang and Xukang Xie

Lanzhou Jiaotong University

Abstract: Crustal Movement Observation Network of China (CMONOC) is composed of 260 Continuously Operating Reference Stations (CORS) and 2000 unscheduled observation stations, which is a high precision and high temporal and spatial resolution observation network covering China, and provides strong data support for the research of GPS coordinate time series and earthquake prediction. In order to explore the impact of common-mode error on noise analysis of time series, this paper selects the data of 10 continuous observation reference stations in Shanxi from 2011 to 2021, adopts four common methods for removing outliers from coordinate time series for comparative analysis, and adopts better elimination methods to preprocess. The common-mode errors of time series were extracted and eliminated by principal component analysis (PCA). Bayesian analysis and maximum likelihood estimation were used to analyze the noise of time series before and after PCA and determine the optimal noise model. The results show that using interquartile range to eliminate outlier is the best for Shanxi, and not only have white noise but also colored noise in time series. The common mode error can be eliminated effectively by principal component analysis. The optimum noise model for Shanxi is WN+FN before and after the common mode error is eliminated. Eliminating common-mode errors can effectively reduce the noise magnitude of each direction. In the N direction, the noise magnitude of white noise and flicker noise are reduced by 27.8% and 35.22% on average, 36.52% and 33.83% In the E, and 28.5% and 35.02% in the U direction.

Baseline Estimation Method Based on Time Domain Random Sub Aperture and Interferogram of Airborne Array Tomography SAR

Ling Yang

Chinese Academy of Sciences

Abstract: In the airborne array Tomographic SAR three-dimensional imaging technology, the baseline length is the main factor that restricts the resolution. Flexible baseline can increase the length of the baseline, but the inaccurate estimation of the baseline length often leads to the imaging quality not meeting the requirements. In this study, a baseline estimation method combining airborne array tomographic SAR time domain random sub aperture and interferogram is proposed. Firstly, the time domain random subaperture division model of airborne array tomographic SAR is established. Then, the baseline estimation is carried out according to the division model and the interferogram to obtain the accurate baseline length. In addition, the actual baseline and the estimated baseline are estimated by Kalman filter. Finally, the estimated results are used to re image the image. The experimental results show that compared with the traditional baseline estimation method, this method improves the time and efficiency, and improves the baseline interference performance of the rigid flexible combination.

DEM-Based Peak Point Extraction and Identification, Vegetation Classification and Biomass Inversion Model in Chongli District

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Abstract: Chongli district of hebei province is the host region of 2022 winter olympics skiing. As a mountainous area, the top of mountain is one of the important topographic features. Vegetation species and biomass can directly reflect the distribution of local forest resources. In view of the difficulty and low accuracy of the existing image processing technology in extracting the characteristics of mountain top points, this paper proposes a mountain top point recognition technology based on deep learning and digital elevation. 2792 information of mountain top points are extracted through experiments. The results show that this technology reduces the false extraction rate of mountain top points to 4.25 %, the missing extraction rate to 4.15 %, and the recognition accuracy is improved to 92 %. Based on the multispectral data of Sentinel-2B satellite, the vector boundary and normalized vegetation index were used to extract the study area, and then the surface vegetation in Chongli District was classified by K-Means clustering. The classification results can be combined with the biomass inversion model to calculate the total biomass of the investigated area. The inversion equation of biomass in Chongli District was constructed by multispectral remote sensing data and topographic data (shrub forest R^2 = 0.811, broad-leaved forest R^2 = 0.356, coniferous forest R^2 = 0.223). Through multiple linear regression, the biomass model was obtained, and the overall accuracy was 93.58 %, 89.56 % and 97.53 %, respectively, which met the requirements of investigation accuracy.

GPR Diagnosis of Pavement Damages: A Method of Combining Multi-Object Detection and Image Enhancement

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School of Transportation, Southeast University

Abstract: New nondestructive testing technologies such as ground penetrating radar (GPR) and image recognition technology based on artificial intelligence (AI) have been gradually applied in the process of road inspection and maintenance. Aimed at practical requirements for nondestructive testing of road damages, this paper develops an intelligent recognition algorithm and image enhancement method for GPR images.

Firstly, GPR equipments were used to detect the internal road diseases and obtain GPR images. Then, according to the propagation characteristics of radar wave in the pavement medium, the characteristics of GPR spectrum of typical damages were analyzed based on Gprmax simulation and laboratory test. Based on this, the training data set of GPR damage image was constructed.

Secondly, the geometric operations and color operations were conducted to enhance the GPR images. And the Bayesian search method was utilized for improved data augmentation policies. A sub-policy consists of two operations, each operation being an image processing function such as translation, rotation, or shearing, and the probabilities and magnitudes with which the functions were applied. After these operations, the GPR dataset augmentation and enhancement were realized.

Finally, YOLOv3 model and Faster-RCNN model were used to study the classification and location of GPR image damages, and the identification accuracy and detection speed after data enhancement were compared and analyzed. Results showed that an optimized data augmentation policy has improved detection accuracy by improving mAP and F1 score.

Implication of Remotely Sensed Data in Assessing Crop Water Ingestion Using Machine Learning

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Abstract: Pakistan's agriculture fulfills almost 90% food and fiber requirements. Wheat is its major food crop and its sustainable production is on threat due limited and scarce water sources. Therefore, precise estimation of irrigation water requirement is essential to save water. Current study aimed to apply remote sensing data and testify it for quick and efficient ETc estimation. Thus, SEBAL and CROPWAT methods were tested and compared, which used satellite data and climatic data respectively. Both were applied to estimate wheat crop ET for year 2016-17 in Peshawar. The study revealed that CROPWAT required many climatic parameters, which were difficult to collect due to involvement of huge labor and instrumentations. Whereas, remote sensing based estimation using energy balance approach found easy and quick that provided actual on ground estimation of crop ET. The results testified the accuracy, cost effectiveness and ease of application for reliable results. The result revealed that the seasonal ETc by satellite data was 299.7 mm whereas ETc by CROPWAT was found as 322.39 mm, which was 0.07% higher. Moreover, monthly ETc maps provided temporal and spatial variability of crop water use during the growing season. The results revealed that ETc estimated from remotely sensed data are a useful tool to quantify crop water consumption that helps the farmers to apply appropriate amounts of irrigation water corresponding to each growth stage, leading to judicial use of water.

Improving the Interpolation Accuracy of Marine Gravity Field Based on a New Seabed Terrain 3D Optimization Method

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Abstract: The accuracy and spatial resolution reconstruction of global marine gravity anomaly maps are carried out in this paper. Firstly, the seabed terrain was introduced into the ordinary 2D (Two-Dimensional) kriging to construct a new seabed terrain 3D (Three-Dimensional) optimization (NST3DO) method. Secondly, based on the NST3DO method and the ordinary 2D kriging method, respectively, the relatively low spatial marine gravity anomaly maps with resolutions 2′×2′ and 3′×3′ were interpolated into high spatial marine gravity anomaly maps with resolution 1′×1′. The results demonstrated that the accuracy of marine gravity anomaly maps after interpolation based on the NST3DO method were improved by 48.92% and 33.76% respectively compared with the ordinary 2D kriging method, verifying the effectiveness of this method. Finally, after the seabed terrain data with high spatial resolution 0.25′×0.25′ were brought into the NST3DO method, the marine gravity anomaly map with resolution 1′×1′ was interpolated to the marine gravity anomaly with resolution 0.25′×0.25′. Then the marine gravity anomaly was checked against shipborne gravity anomaly, whose root mean square was 4.179 mGal, which further verified the application value of the NST3DO method.

Non-line-Of-Sight Moving Target Detection Method Based on Millimeter-Wave Radar

Yilin Wei, Bing Sun and Yuetong Zhou

Beihang University

Abstract: In modern society, public safety issues have gained more and more attention all over the world. At the present time, most security systems only detect and track targets in line-of-sight (LOS). However, in practice, the locations of targets are often out of the line of sight. This article focuses on the non-line-of-sight (NLOS) moving target detection with low-power transmission signals by reflection. And there are two key problems, the weak target echo signal and the multipath effect. In terms of this issue, this paper constructs the echo signal model of NLOS target. On the basis of echo model, the detection method of NLOS moving target based on millimeter wave radar comes up, which is of great theoretical value and important practical significance for indoor security. This paper innovatively applies polynomial fitting method to suppress static noise and range gating method to suppress noise from other range gates. Then, the location and velocity of the target are estimated by two-dimensional fast Fourier transform (FFT) and multiple signal classification (MUSIC) method. Further, the simulations and experiments of NLOS target detection are carried out, through which the accuracy of the NLOS target echo signal model and feasibility of the target detection method proposed in this paper are verified.

Quality Assessment of CFOSAT SCAT Wind Products Using In Situ Measurements from Buoys and Research Vessels

He Wang

National Ocean Technology Center

Abstract: The CFOSAT (Chinese-French Oceanic SATellite), carrying the first Ku-band scatteromenter (SCAT) with rotating fan beam, was successfully launched in October 2018. The preliminary quality assessment of CFOSAT SCAT wind data is carried out through the comparison for the period from Jan 2019 to Jun 2021 operationally released products with in situ measurements. The reference winds include in situ measurements from offshore (> 50 km) meteorological buoys of the National Data Buoy Center (NDBC) and serval research vessels. All in situ winds were converted to the 10 m equivalent neutral winds using the coupled ocean atmosphere response experiment (COARE) bulk algorithm. The temporal and spatial differences between the CFOSAT SCAT and the in situ observations were limited to less than 30 min and 12.5 km. For CFOSAT SCAT wind speed products, the comparison and analysis using the NDBC buoys yield a bias of 0.34 m/s, a root mean square error (RMSE) of 1.24 m/s. Although less accurate of CFOSAT SCAT wind direction at low winds, the RMSE of 19.76 deg with a bias of 1.13 deg is found for wind speeds higher than 4 m/s. Moreover, CFOSAT SCAT winds were evaluated against anemometers in situ onboard R/Vs , whose cruise were distributed globally. The comparison results against R/V winds are found consistent with those by the widely used NDBC buoys. The encouraging assessment results show that wind products from CFOSAT SCAT satisfy the mission specification and will be useful for scientific community.

Remote Sensing Data Analytics for Gridded Precipitation Products – A Multisite Assessment

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Abstract: In recent years, gridded precipitation datasets have been employed to create rainfall maps, improve flood monitoring systems, and investigate hydrological regimes. Nevertheless, the indirect measurement through remote sensing may result in significant errors, biases, and uncertainties in precipitation estimates. Therefore, this study evaluates NASA TRMM daily precipitation product 3B42 Version 7, and NCEP daily precipitation product CFSR against gauge rainfall recorded over numerous stations located in diverse climatic and topographic areas of China and Pakistan. Two assessment criteria, namely detection efficiency and quantification efficiency, were used to appraise the accuracy of the gridded precipitation products. These indicators are also used to validate precipitation products at different seasonal levels and analyze the differences among varying meteorological and topographic conditions. The evaluation results demonstrate contrasting accuracies for the studied gridded precipitation products over different stations in the study area. Overall, TRMM performed better than CFSR over most stations located in Pakistan, mainly in terms of detection. However, TRMM leaned towards an underestimation in the humid and subhumid stations and an overestimation in the arid and semiarid stations located in the area. For stations located in the Ordos plateau and Huai River region of China, CFSR performed significantly better at detecting precipitation than the TRMM product. In the Ordos plateau, CFSR exhibited an overall better correlation with the ground-based precipitation than TRMM. Conversely, TRMM correlated better with the rain gauge precipitation than CFSR in the subhumid area of the Huai River basin.

Remote Sensing Image Integrity Authentication Model Based on Blockchain and Perceptual Hash

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Abstract: Remote sensing images are vulnerable to various unintentional or intentional tampering attacks in transmission, use and storage, which destroys the integrity and authenticity of remote sensing image data. In addition, if these tampers involve important content such as endangering national security and court evidence, they may have serious consequences. Therefore, the integrity and authenticity of remote sensing images urgently need technical support. For the integrity authentication of remote sensing images, based on the analysis of the perceptual hash characteristics of remote sensing images, this paper designs a perceptual hash algorithm considering the spectral and spatial characteristics of remote sensing images. The algorithm realizes band fusion based on NSCT transform. It extracts the perceptual features of the fusion result by the Canny operator and SVD; the MD5 function normalizes the extracted perceptual features. Finally, the perceptual hash sequence is generated. Experiments show that the perceptual hash algorithm can maintain the robustness to format conversion, data compression and other operations to deal with the conventional processing of remote sensing images. Due to its distributed storage and non-tamperability, blockchain technology can ensure the security of the original hash value. A remote sensing image integrity authentication model is constructed based on blockchain and perceptual hash technology to ensure the authenticity and security of the original perceptual hash value. Finally, based on this model, a safe and reliable perceptual hash anti-counterfeiting and traceability system based on Hyperledger Fabric is established, which effectively solves the problem of remote sensing image data integrity authentication.

The Detection of Terrestrial Gamma-Ray Flashes during Thunderstorms with Remote Radio Measurements of a Distinct Class of Lightning Discharges

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Abstract: Terrestrial gamma-ray flashes (TGFs) are kinds of high-energy emissions produced during thunderstorms and are almost exclusively detected with spacecraft-based gamma-ray detectors. Because of the strong atmospheric gamma-ray attenuation from the low-altitude atmosphere and the geometry-driven short horizontal detection range, the ground detection of TGFs with gamma-ray detectors is challenging. Recently a distinct class of radio emissions, called energetic in-cloud pulses (EIPs), was found to be closely linked to the production of a subset of TGFs. These radio signals can be remotely measured and identified by the radio sensors at thousands of kilometers from the source, which provided a decent and useful way to detect TGFs over a large region. In this study, we present several lines of strong evidence that strengthen the connection between a subpopulation of TGFs and EIPs, which was proposed in previous studies. Importantly, by identifying EIPs from radio signals, we found two new TGFs that were previously unreported from space-based detection. This demonstrates that some TGFs can be detected from the radio measurements alone when the spacecraft-based detectors are unavailable.

A Comparative Study of Spatial Prediction of Landslide Hazard Using ANN and FR-AHP Models: A Case Study from Tehri Region, Uttarakhand, India

ANKIT TYAGI, Reet Kamal Tiwari and Naveen James

IIT Ropar

Abstract: Landslides in India are the most commonly occurring natural hazard in the areas of the Himalayas. The Tehri area is located in the Lesser Himalaya of Garhwal District in Uttarakhand, India. It lies in zone IV of the seismic zoning map of India and receives heavy monsoon rainfall. Because of the large-scale slope instability in the area, it has received the special attention of researchers. In the recent past, many landslide hazards studies were carried out for different regions in the Uttarakhand state. However, limited work is done considering external factors. Hence, in this study, five external factors i.e. seismic ground shaking, soil moisture, soil temperature, evapotranspiration and rainfall and 16 internal factors i.e. slope, aspect, relative relief, curvature, distance to road, distance to streams, distance to reservoir, Stream Power Index (SPI), Topographic wetness index (TWI), Terrain Ruggedness Index (TRI), Sediment Transport Index (STI), landcover, soil type, lithology, geomorphology and geology are used in the preparation of Landslide Susceptibility Map (LSM) using (Artificial Neural Network) ANN model and a hybrid model of Frequency Ratio Method (FRM) and Analytical Hierarchy Approach (AHP) technique. The accuracy of both models is compared using the success rate curve technique. The Area Under Curve (AUC) showed that the hybrid model has 81% accuracy, whereas the ANN model has shown only 89% accuracy.

A Keypoint-Constrained Deep Neural Network with Scene-Adaptive Augmentation for SAR Ship Detection

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Abstract: As an active microwave imaging sensor for the high-resolution earth observation, synthetic aperture radar (SAR) has been extensively applied in military, agriculture, geology, ecology, oceanography, etc., due to its prominent advantages of all-weather and all-time working capacity. Especially, in the marine field, SAR can provide numerous high-quality services for fishery management, traffic control, sea-ice monitoring, marine environmental protection, etc. Ship detection in SAR images has attracted more and more attention on account of the urgent requirements of maritime rescue and military strategy formulation. Nowadays, deep learning (DL) offers advanced synthetic aperture radar (SAR) ship detection performance. However, existing DL-based detection models still underperform in small sample SAR applications. Moreover, the learning-imbalance from the sample scene-imbalance reduces the detection accuracy of inshore ships. Thence, a keypoint-constrained deep neural network with scene-adaptive augmentation (KC-DNN-SAA) is proposed. KC extracts ships' rotation-invariant, scale-invariant, and anti-speckle-noise keypoint features to constrain network learning to alleviate the small sample overfitting. SAA adaptively balances the sample proportion between inshore scenes and offshore ones by a classification network to enhance learning benefits of inshore scenes. Results on the SSDD and HRSID datasets show the excellent performance of KC-DNN-SAA.

Analysis of China's Seven Major Urban Agglomerations Based on Nighttime Light Imagery

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Abstract: Urban agglomeration is an important carrier to promote the integration and development of major national regional strategies, and its spatial organization and economic connection are closely linked. This paper studies the actual development scale of urban agglomerations from the perspective of scale of urban agglomerations by combining regional administrative boundary and economic population index. In view of the development status of urban agglomerations, this paper takes the seven major urban agglomerations in China as the research area to extract Nighttime Light Imagery of the region; Then, based on Head/Tail Breaks and Zipf's law, the distribution of urban hotspots within the administrative boundary of China's seven major urban agglomerations is explored; Finally, the Distribution Characteristics of the major urban agglomerations in China Based on Economic and Population Indicators. The results show that the internal development scale of China 's seven major urban agglomerations and the overall development of urban agglomerations are quite different. In the future practical research on the development of China's urban agglomerations, it is necessary to provide reference for regional development by combining the distribution of urban hotspots.

An Insurance Oriented Satellite Imagery Platform and Its Applications

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Abstract: In recent decades, natural disasters are dramatically increasing in both frequency and severity due to climate change. Insurance sector assumes a key in economic and social stability in respect of risk reduction and transfer. However, insurance companies expose themselves to the significant disaster losses, and excessive payout could undermine their capability to resist risks. Geospatial-temporal technologies builds a knowledge repository to detect potential risk, estimate risk exposures, reduce time to assess the loss and mitigate impact. Therefore, in this paper, we introduce PingAn-Taiyi, an insurance-oriented remote sensing platform, embedded with insurance data model, to store, manage, and process in cloud-based environment, promoting risk management capability of insurance company. The platform is based on micro-service architecture and container engine, supporting distributed data storage and processing, deployed on Ping An Cloud.

This platform can access to both radar and high-resolution optical images, providing services such as flood mapping, surface deformation monitoring and etc. Through high-resolution images of different sensors based on this platform, the insured subject can be continuously monitored to avoid risks, identify the condition of object of insurance, such as construction schedule and stacking of materials. Combined with inundation mapping and surface deformation monitoring services, we provide a disaster monitoring and risk management services for the whole process of claim investigation, loss assessment, and claim settlement, improving the ability of insurance industry to respond to natural disasters and reduce risks.

Atmospheric Correction to Passive Microwave Remote Sensing in Snow Depth Inversion

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Abstract: Variable atmospheric conditions are typically ignored in the retrieval of geophysical parameters of the Earth surface when using spaceborne passive microwave observations. However, high frequencies, e.g. 37 and 92 GHz are sensitive to variable atmospheric absorption, even in winter dry conditions. In this study, the influence of variable atmospheric absorption on Snow Depth (SD) was quantitatively investigated, based on 4-year (2010–2014) the before and after atmosphere corrected brightness temperature of the Special Sensor Microwave Imager Sounder (SSMIS) and in situ snow depth observations from Chinese meteorological stations.

Bathymetry Inversion and Analysis Based on Multi Strategy Data Fusion of Altimetry Gravity Anomalies and Vertical Gravity Gradients

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Abstract: Bathymetry data is important for researching the Earth sciences and guiding military missions. However, the ocean bathymetry is hard to detect in direct ways. In recent years, one of the bathymetry prediction methods is based on ocean gravity data, which can be easily approached by satellite altimetry with high resolution and precision. In this paper, the error propagations from altimetry sea surface height measurements to gravity products and bathymetry are derived. The inversion correlations between gravity anomaly, vertical gravity gradients and bathymetry wavelength are analyzed using the correlation spectrum method in frequency domain. Based on the analysis, three strategies of gravity anomalies and vertical gravity gradients fusion are proposed to predict the bathymetry. Three ocean areas are selected to be the experimental areas and the simulation results show that the vertical gravity gradients perform well in shallow waters and steep terrains. The shipborne sonar data is used to be the control points and check points to estimate the inversion accuracy. The experiments verified the data fusion methods that can improve the water depth inversion accuracy when the ocean topography is complex. And then the nonlinear relationship between gravity data and seabed topography are talked in the experimental areas. Some of the other water depth models are chosen to estimate the inversion accuracy and nonlinear relationship as well. Conclusions can be drawn that the accuracy of using data fusion and cubic nonlinear relationship is higher than that of linear inversion of water depth using only a single gravity data source.

Canada AGB Dynamics in Response to Disturbance

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Abstract: Canadian forests play an important role in the global carbon cycle. However, it has experienced extensive tree mortality and forest loss due to multiple kinds of stand-replacing forest disturbances in recent decades. The response of forest dynamics to these stand-replacing disturbances is still unknown. Here, we estimated the carbon dynamics over the stand-replacing disturbance areas caused by fire, logging and insects for the period 2000–2012 in Canadian forests. A recently developed disturbance product was used here to define three types of disturbances: fire, logging and insects. The forest dynamics were characterized using aboveground biomass (AGB), gross primary productivity (GPP) and leaf area index (LAI) datasets. Our results showed that stand-replacing fire, insects and logging resulted in AGB losses of 5.03 Mg/ha yr^{-1}, 6.63 Mg/ha yr^{-1}, 7.66 Mg/ha yr^{-1}, respectively. In the post-disturbance periods, it takes more than 10 years for ABG to recover fully after all types of disturbances, 8 years for GPP and LAI to recover fully after fire, and 2 years for GPP and LAI to recover fully after logging.

Comparisons of Three Tree Distribution Patterns in Simulating Canopy Gap Fraction and BRF for Forest Plantations

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Abstract: Tree distribution strongly influences canopy gap fraction(GF) and BRF. Three tree distribution patterns (the hypergeometric model, grid-shape, and line-shape) in simulating the canopy GF and BRF for forest plantations are compared, and a simple equation describing the overlap degree among trees to determine the relationship among the three distribution patterns is presented. The results show that the relationship between the hypergeometric model and the two particular patterns (grid and line shape) are closely related with forest coverage, mean distance among trees, crown height, and view direction (including view zenith angle (VZA) and azimuth angle (VAA)). (1) For sparse and medium forests, there is no difference in canopy GF and BRF among the three distributions in most view directions (e.g., VZA > 50°), meaning the latter two patterns can be replaced by the former one. (2) For dense forests, as the overlaps among trees increase seriously with the increment of VZA, the differences in canopy GF and BRF between the hypergeometric model and two particular patterns increase with VZA. The largest difference in canopy gap fraction and BRF among these three tree distributions exists in VAA=0° and VAA=20°, which can reach up to 220% and 18% for GF and BRF, respectively. The results show that tree distribution is a non-negligible factor while it is often ignored for modeling GF and BRF for forest plantation.

Estimation of Glacial Lake Dynamics in the Sikkim Himalayas by the Inferential Statistical Techniques

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Abstract: Warming climate-driven mass loss of glaciers produces numerous glacial lakes across high mountain regions, prominently in the eastern Himalayas. To some extent, these glacial lakes are identified as critical glacial lakes to have great potential for glacial lake outburst floods (GLOFs). Therefore, this study intends to estimate the rate of glacial lake area change (RGLAC) for the entire Sikkim Himalaya by extracting twenty-four glacial lakes samples using inferential non-parametric statistics. These sample glacial lakes comprise various types. Moreover, these lakes were also different in size, shape and situated at different elevations. Hence, these sample glacial lakes are employed to infer the status of all glacial lakes in the study area. The lakes area was extracted through a manually delineated process by utilizing remotely accessed Landsat-TM/ETM/OLI data for 1988, 2000, 2008, 2013, 2016, 2018, and 2020. Furthermore, the RGLAC has been computed using samples of glacial lakes for the entire region by non-parametric Friedman test and Wilcoxon signed-rank statistical tests. Finally, the glacial lakes with an area greater than 0.5 km^2 and expanded more than 5% were further considered for the volume estimation using an empirical formula. The study showed that the highest RGLAC was observed during 2008-2013; afterward, it decreased continuously. Although, the most significant volumetric expansion among all the large glacial lakes, which expanded more than 5%, was observed in GL-12. Continuous real-time monitoring is essential for the rapidly expanding glacial lakes, which further help to plan a better mitigation strategy against GLOFs.

Estimation of Grassland Aboveground Biomass by Remote Sensing Assimilation

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Abstract: Due to global climate change and human activities, grassland degradation is becoming more and more serious. Thus, monitoring of grassland aboveground biomass is very important. Based on remote sensing data assimilation method and a grassland aboveground biomass dynamics model (ModVege model), this study simulated the daily grassland aboveground biomass change during 2012 in Xilinhot city, Inner Mongolia. Firstly, Sobol algorithm was used to select parameter sets including 7 parameters as follows SLA, %LAM, minMEA, maxMEA, RUE and NI, whose sensitivity indexes are greater than 0.05. Secondly, study area was divided into 10 zones according to the grassland type, and we adopted MCMC algorithm for calibration of ModVege model in each zone. Compared with resultes from ModVege model with default parameters, the accuracy of model simulation value at observation points after calibration was significantly improved. Finally, taking LAI as the state variable, MCD15A3 product was assimilated into ModVege model through 4DVar algorithm to realize inversion of grassland aboveground biomass and LAI in remote sensing method.

Evaluation of Four Topographical Corrections for Continuous Canopies Based on DART

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Hefei University of Technology

Abstract: Rugged terrain seriously affects the quantitative retrieval accuracy of mountain remote sensing parameters and the application of mountain remote sensing products. Therefore, topographical corrections are deemed as essential steps for images processing in remote sensing. In this study, four topographical correction methods (CC, SCS, D-S, and PLC) for a continuous canopy on sloping terrains are evaluated based on a 3D radiation transfer model: DART, which is widely used in evaluation of many canopy reflectance models. Taking canopy BRFsimulation on flat terrains as the true values, four topographical corrections are used to correct canopy BRFsimulation on sloping terrains. The results show that: (1) all the four methods significantly reduce the topographic effects, while SCS and D-S show obvious overcorrection for canopy reflectance in the down-slope directions; PLC has better correction effect than the other three methods because both path length in up-slope and down-slope directions are considered. We deem that the slope change canopy BRF by means of changing the four component area ratios in the directions. The latter should be taken as an important factor in topographical corrections.

First Retrieval of High-Resolution Vegetation Optical Depth from the Sentinel-1 over Grassland

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Abstract: Monitoring global vegetation dynamics is of great importance for many environmental applications. The Vegetation optical depth (VOD) is a remotely sensed indicator characterizing the attenuation of the Earth's thermal emission at microwave wavelengths by the vegetation layer, which has been used as an important proxy for monitoring the vegetation dynamics at large scales. However, operationally available VOD products only exist with medium to coarse spatial resolution (≥ 25 km), unable to meet the needs for heterogeneous surface vegetation monitoring. Therefore, retrieval high-resolution VOD at fine scale has the important application value and the practical significance.

This study retrieved grassland VOD from the C-band Sentinel-1 (S1) Synthetic Aperture Radar (SAR) backscatter data over the Heihe River Basin, by using the Water Cloud Model (WCM) coupled with the Ulbay Model. The novelty of this approach is to use gamma-naught () rather than sigma-naught () as the backscatter data for estimation of VOD. VOD were evaluated by comparing with vegetation indexs (NDVI, EVI and LAI), the results showed that VOD had a generally good correlation with vegetation indexs, with temporal mean R values of 0.72, 0.71 and 0.65, respectively.

Greening Dominated the Increasing Net Ecosystem Productivity in the Loess Plateau of China from 2000 to 2015

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Abstract: The Chinese government announced that it will achieve carbon neutrality before 2060, the impact of vegetation restoration on carbon sequestration will play an important role in achieving carbon neutrality. The Loess Plateau of China has experienced substantial vegetation restoration during the past decades by a large-scale Green for Grain Program, we estimated net ecosystem productivity (NEP) of the Loess Plateau from 2000 to 2015 using a satellite-data drive carbon budget model for quantifying the contributions of the "greening" on carbon sequestration. Results showed that, NEP increased remarkably at a rate of 3.12 Tg C a^{-1} (p 0.05) during 2000–2015, the multi-year average NEP was estimated to be 60.80 Tg C a^{-1}. Enhanced vegetation index (EVI) increased significantly over the period, by 0.07 a^{-1} (p 0.01), greening was the most like cause of the increasing NEP in the Loess Plateau of China, explaining 81% of the NEP trend. Climate change and land cover change have little influence on the changing trend of NEP, explaining 13% and 4%, respectively. The asymmetric response of photosynthesis and respiration to EVI was the dominant factor in the increase of NEP. An increase of annual mean EVI by 0.1 will cause a 5.70 g C m^{-2} a^{-1} and 1.38 g C m^{-2} a^{-1} increase in gross primary productivity and ecosystem respiration, respectively. This result revealed the positive effect of Green for Grain Program in Loess Plateau on carbon sequestration, implying the potential of China's large-scale ecological restoration to the realization of carbon neutrality.

Integration of Active Fire in Burnt Area Detection

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Abstract: Active fire is usually observed on remote sensing data with radiometer of different satellite like MODIS, Landsat, sentinel 2, and sentinel 3 or else, especially in thermal band. Many indices have been developed to detect burnt area like BAI or NBR indices, those indices are useful for fire monitoring but generally neglect the fire front. Finding how to integrate effectively fire front in burnt area is the objective of this study. The method used is based on experimentation of combining band index like NDVI, BAI, NBR and making histogram anamorphosis for image enhancement. It have been noticed that the best color composition is SWIR 2-NIR-R. A new algorithm has been developed to integrate active fire in burnt area. The analysis of histogram of BAI index and the multiplication of three indices show effectively their integration. The result of the classification shows that the fire front is also classified, the classification was automatically obtained via the density slice. Thus, the result of multiplication of NDVI, BAI and NBR can be used for better fire monitoring, even to quantify biomass burning at the moment of the measure of the energy by the radiometer.

Inversion of Soil Moisture in Summer Maize Based on Unmanned Aerial Vehicle Multispectral Remote Sensing

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Abstract: Soil moisture content is an important indicator for crop growth. Rapid monitoring of soil moisture content is significant for drought prediction and irrigation decision-making. In order to solve the problem of microwave backscatter attenuation caused by multiple scattering between canopy and surface during inversion of soil moisture with higher maize plant height (> 2.5 m), an inversion study based on UAV (Unmanned Aerial Vehicle) multispectral remote sensing was developed to invert soil moisture and took jointing stage and milk ripe stage of summer maize in Xunxian County, China as an example for case study. Based on UAV multispectral data, thermal infrared data, field measured data and Sentinel-1A SAR satellite data, four methods were used, namely, water cloud model, improved water cloud model, TVDI (Temperature Vegetation Dryness Index), and improved water cloud model with MIMICS model parameters. The results showed that both the water cloud model method and the improved water cloud model method had poor effects on inversion of soil moisture content (R2 < 0.3), which indicated that the two methods were not suitable. The TVDI method results for two depths (10cm and 20 cm) are: R2 = 0.4942 and 0.4634, while the improved water cloud model method with MIMICS model parameters for two depths are: R^2 = 0.7751 and 0.7373, which are better than the other three methods. This study shows that the improved water cloud model method with MIMICS model parameters can better realize high precision inversion of soil moisture with higher plant height.

Localization of Densely Arranged Rotating Objects in Remote Sensing Images

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Abstract: Deep-learning methods have achieved considerable results for object detection in remote sensing field recently. However, these existing methods still have sub-par performance when coping with remote sensing images which could contain closely clustered objects that might occur in various orientations. When dealing with these complex scenes, these methods typically suffer from limited distinctive feature extraction and fail to resolve the object orientations.

Here we propose a novel rotation-aware region extraction model. It aims to solve the redundant labeling problem caused by conventional methods that harm local feature extraction and hence curtail detection accuracy. To solve the insufficient local feature extraction problem, the model adopts a rotation-aware region propose network that explicitly describes the spatial position and rotation angle of oriented objects according to the oriented anchor boxes and oriented proposals. In order to perform well in scenes that the objects are densely arranged, a rotation-based region extraction method is designed to estimate the feature transformation procedure according to the spatial position and angle of the object. This method enables the model to extract features from arbitrary-oriented regions. Additionally, we bench-marked our model against the DOTA dataset and a more challenging dataset FAIR1M, which has a total of 5 general classes and 38 sub-classes. By incorporating the features mentioned above our model are able to achieve higher accuracy and efficiency.

Palm Trees Counting Using Remote Sensing and GIS Techniques

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University of Technology-Iraq

Abstract: Iraq is considered as one of the major suppliers of dates in the world. Dates are a strategic product in Iraq. The decreasing in dates production from 2004 until now. the Ministry of Agriculture and the Ministry of planning made a project for palms trees census and studies to identify the imbalance and find solutions.

So a pilot project study was made by using high resolution satellite images with remote sensing and GIS techniques to count palms, suggest a method can reduce the time and save money comparing with field counting. Two techniques (manually and automatic) and two types of satellite images (0.5m and 6&7 1.5m) were used in the study.

Accuracy assessment was made by counting palms trees manually in the farm. The results of the study illustrate that palm trees counting can be done by using Pleiades satellite images 0.5m resolution in two methods of counting manually and automated, while only automated technique can be used in 1.5m resolution. Using images with 0.5m resolution provides more than 90% accuracy by automated counting and more than 95% by manual counting, but images in 1.5m resolution got lower accuracy ranged from 61–86% regarding to the dense of trees.

Precipitation Microphysics of the Record-Breaking Typhoon In-Fa (2021) Revealed by Joint Observations from GPM Satellite and Disdrometer Network

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National university of defense technology

Abstract: In July 2021, Typhoon In-Fa attacked eastern China and broke many records for extreme precipitation over the last century. With the spports of 66 networked surface disdrometers over eastern China and collaborative observations from the advanced GPM satellite, we are able to reveal the unique precipitation microphysical properties of the record-breaking Typhoon In-Fa (2021). After separating the typhoon precipitation into convective and stratiform types and comparing the drop size distribution (DSD) properties of Typhoon In-Fa with other typhoons from different climate regimes, it is found that typhoon precipitation shows significant internal differences as well as regional differences in terms of DSD-related parameters, such as mass-weighted mean diameter (Dm), normalized intercept parameter (Nw), radar reflectivity (Z), rain rate (R), and intercept, shape, and slope parameters (N0, μ, Λ). Comparing different rain types inside Typhoon In-Fa, convective rain shows higher raindrop concentration than stratiform rain due to more graupels melting into liquid water while falling. Large raindrops occupy most of the region below the melting layer in convective rain due to a dominant coalescence process of small raindrops (featured by larger ZKu, Dm, and smaller N0, μ, Λ), while small raindrops account for a considerable proportion in stratiform rain, reflecting a significant collisional breakup process of large raindrops (featured by smaller ZKu, Dm, and larger N0, μ, Λ). Compared with other typhoons in Hainan and Taiwan, the convective precipitation of Typhoon In-Fa shows a larger (smaller) raindrop concentration than that of Taiwan (Hainan), while smaller raindrop diameter than both Hainan and Taiwan.

Raindrop Size Distribution in Persistent Precipitation over Central China during the Integrative Monsoon Frontal Rainfall Experiment (IMFRE-II)

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Abstract: The statistical properties of persistent precipitation over the central China were investigated using a two-dimensional video disdrometer(2DVD) from the Integrative Monsoon Frontal Rainfall Experiment (IMFRE-II) during Meiyu season. The characteristics of different precipitation type (stratiform vs convective) presented are bulk properties (radar reflectivity, rain water content and rainfall rate), and the distributions of axis ratio was also analyzed. The evolution of DSD shows higher mass-weighted mean diameter (Dm) and lower normalized intercept (log10Nw) parameters in rain rate above 5 mm h^{-1}. The averaged DSD for convective (CV) and stratiform (ST) rains over central China is similar to that over eastern China, the number concentration of small raindrops for CV and ST over central China is approximately one-order lower than that over southern China, the number concentration of small raindrops for CV and ST over central China is higher than that over northern China. This result is related to the coalescence and breakup between raindrop. Moreover, higher raindrop diameter and relatively lower raindrop concentrations are found in convective precipitation compared to summer convective precipitation over other regions in East China and Taiwan China. The differences of raindrop concentrations and diameters are related to local atmospheric aerosol and moisture conditions. In our study, raindrop shape is more spherical than the results of BC87 model and NCAR_fit when the diameter is higher than 3 mm.

Research on Defects Detection of Shield Tunnel Based on 3D Laser Point Cloud and LRF Algorithm

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Abstract: The shield tunnel lining defects such as shield tunnel lining falling off and water leakage should affect the safe operation of subway. The efficient and robust detection methods for shield tunnel defects is one of the current research hotspots. Based on the 3D laser point cloud data of shield tunnel lining, a novel method to detect shield tunnel lining defects based on local region fitting (LRF) algorithm is presented in this paper. It is composed of three parts as follows:(1) unfolding 3D point cloud of shield tunnel lining to generate 2D grayscale images, (2) detecting shield tunnel lining falling off and water leakage via LPF algorithm, and(3)visualization and quantitative analysis of the detected shield tunnel lining falling off and water leakage defects areas. The testing results show that, this method can accurately and quickly identify the defects of the tunnel lining based on point cloud data, the detection accuracy rate is about 95%, and the missing detection rate is about 6%.

Research on the Sea Surface Roughness and Tilt Changes Caused by Internal Waves Based on ALOS PALSAR Images

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Abstract: Internal waves can cause changes in the roughness of the sea surface. Based on the X-Bragg model, ALOS PALSAR images were used to study this change. The traditional Bragg model cannot describe the phenomenon of sea surface depolarization and cross-polarization effects, so it cannot further describe the rough sea surface disturbance caused by internal waves. The introduction of the X-Bragg model realizes the description of the rough disturbance effect, and obtains the angle β that can characterize the rough inclination of the sea surface. The internal wave-induced sea surface roughness change index $\Delta\beta$ is constructed, and the sea surface roughness change caused by internal waves is calculated by using ALOS PALSAR images to range from 0 to 30%. There is a positive correlation between the sea surface roughness change caused by internal waves and its amplitude. The larger the amplitude of the internal wave, the larger the sea surface roughness change caused by it.

Satellite Records Reveal Carbon Sink of China during 2013–2019

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Abstract: The China biomes, as one of the largest global carbon sink, plays a pivotal role in the global carbon cycle, but current assessments of aboveground biomass carbon (AGC) are uncertain. This study aimed at estimating China AGC dynamics during 2013–2019 to understand its role in global carbon budget. We proposed the combination of vegetation optical depth and optical vegetation indices to quantify annual AGC changes in China during 2013–2019 using a random forest model. During 2013–2019, AGC change in China represents a net increase of 0.17 Pg C yr^{-1}, of which 76% can be attributed to forest. The regions with the largest carbon sink are southern China, which account for 56% of the total carbon sink. Our study reveals the potential ability of combining vegetation optical depth and optical vegetation indices to estimate AGC at large scale and provides some insights for understanding national carbon budgets in China.

Scale in Scale for SAR Ship Instance Segmentation

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Abstract: Ship detection in synthetic aperture radar (SAR) images has received extensive attention in recent years. Yet, SAR ship instance segmentation is rarely studied. In this paper, we report an idea of Scale In Scale (SIS) for synthetic aperture radar (SAR) ship instance segmentation. Its essence is to establish multiscale modes in a single-scale. In consideration of the characteristic of the targeted SAR ship instance segmentation task, SIS is equipped with four tentative modes in this paper, i.e. an input-mode, a backbone-mode, an RPN-mode (region proposal network), and an ROI-mode (region of interest). Combined with them, a SIS network (SISNet) is reported dedicated to high-quality SAR ship instance segmentation on the basis of the prevailing Mask R-CNN framework. For Mask R-CNN, we also redesign 1) its feature pyramid network (FPN) for better small ship detection, and 2) its detection head (DH) for more refined box regression. Experiments confirm each mode's effectiveness. On the open SSDD and HRSID datasets, SISNet surpasses the other 9 competitive models. Specifically, the segmentation average precision (AP) index is superior to the suboptimal model by 4.4% on SSDD and 2.5% on HRSID.

Self-Attention Path Aggregation Feature Pyramid Network with Adaptive Anchor Learning for SAR Ship Detection

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Abstract: Ship detection in synthetic aperture radar (SAR) images is a fundamental but challenging issue. To solve this issue, this paper proposes a self-attention path aggregation feature pyramid network (SAPA-FPN) with adaptive anchor learning (AAL) for multi-scale SAR ship detection. First, a bottom-to-top path aggregation (PA) branch is designed to enrich the spatial location information of feature pyramid network (FPN). Then, a lateral self-attention (SA) connection branch is proposed to make features of each resolution level more discriminative. Finally, an AAL network is presented to generate high-quality location- and shape-adaptive proposals/anchors in region proposal networks (RPN). Extensive ablation studies are conducted to confirm the effectiveness of the proposed method. Experimental results on five open SAR ship detection dataset reveal the state-of-the-art performance of SAPA-FPN-AAL, in contrast to the other state-of-the-art convolutional neural network (CNN) based methods. Furthermore, the satisfactory ship detection results in two large-scene Sentinel-1 SAR images indicate SAPA-FPN's superior migration application merit in marine surveillance (MS).

Source Model And Hazard Assessment of the Ms 6.4 Yangbi Earthquake in Yunnan, China Based on InSAR Observatio

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Abstract: In this paper, we obtained the coseismic deformation of the Yangbi earthquake in Yunnan Province based on the InSAR observation. After that, we obtained the fault geometry and slip distribution model of this earthquake via two-step inversion method. The maximum deformation in the ascending orbit along LOS (Line of Sight) direction is 7.3 cm, and the maximum deformation in the descending orbit along the LOS direction is 8.9 cm; the slip distribution model shows that the slip distribution of this earthquake is concentrated at a depth of 1-14 km, and the maximum slip is 0.6 m at a depth of 5 km. Based on the modeling result, it's inferred that the seismogenic fault of this earthquake is a dextral strike-slip fault on the west side of the Weixi-Qiaohou-Weishan fault. Combining the existing geological data and the changes in Coulomb stress caused by this earthquake, the seismic hazard and seismogenic structure in the area near the epicenter are analyzed and discussed, and the result shows that in the west of the Weixi-Qiaohou fault zone, there will have an increased hazard of future earthquake in the NW trend, however, the possibility of an earthquake of magnitude 7.0 or higher is low.

Status of Temporal Variations of Glacier Response in the Garhwal Himalaya, India

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Abstract: The current study aims to identify the temporal status of the glacial response around three decades in the Garhwal Himalaya. Thirty-two glaciers from the Garhwal Himalaya have been analyzed, and using inferential statistics, conclusions have been made for the entire Garhwal Himalayas. At first, medium resolution Landsat TM data for the year 1993 & 2010, ETM+ for the year 2000, and OLI data for the year 2013 & 2020 has been manually digitized to identify glacial boundaries and glacial area for the years 1993, 2000, 2010, 2016, and 2020. As the time span in the various time frames is not equal, the average annual area changes have been calculated between these time frames where 1993–2000 is marked as a time frame one, 2000-10 as time frame two, and so on. Further, the exact boundaries were used to calculate average annual glacial retreats by averaging the difference between different year's glacial boundaries along the central flow line of the glacier. On the other hand, the DEM differencing method has been used to calculate average annual surface elevation changes from 2000 to 2008 and 2008 to 2020. After that, to evaluate the temporal status of the glacial response, the Non-parametric Friedman Test and Dunn's pairwise test has been introduced. Finally, the 95% confidence interval was made from the bootstrapping sampling procedure. The result shows that the glacial response has been accelerated after the year 2016 in the Garhwal Himalaya. Therefore, systematic and continuous monitoring is essential to avoid glacial hazards.

The Influence of Different Weather Conditions on the Ozone Sensitivity in Changzhou

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Abstract: Based on the remote sensing data of Sentinel-5 Precursor, the spatial distribution of ozone (O_3) sensitivity in Changzhou under different weather conditions were studied using the ratio of HCHO and NO_2 as an indicator of O_3 sensitivity. It was found that the meteorological circulation patterns of O_3 pollution in Changzhou in 2019 could be divided into five types: the warm advection pattern, high pressure ridge pattern, the warm and wet advection pattern, subtropical high edge pattern, and typhoon impact pattern. The concentration of O_3 (196 μg/m^3) was highest under the warm advection pattern. The VOCs-limited area was mainly concentrated in Tianning District and Wujin District, and other districts were mainly dominated by NOx-limited area in Changzhou. The range of VOCs control area increased under the condition of high temperature and relatively low humidity. It indicated that the prevailing weather conditions should be considered to control the O_3 pollution in different areas.

多线激光雷达应用于火箭起飞漂移量的研究

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Abstract: Before the rocket takes off from ignition to leaving the launching tower, the rocket flies vertically upwards. At this stage, the rocket oscillates due to control delay and overshoot, which is shown as lateral drift. The amount of drift refers to the deviation of the reference trajectory during the vertical take-off of the rocket, which is mainly used to evaluate the flight control performance of the rocket. At present, the take-off drift of the rocket is mainly realized by the intersection measurement of high-speed TV cameras, which requires high image interpretation and has low measurement accuracy (~20 cm). Therefore, we adopted the advanced multi-line lidar measurement technology to collect 3D point cloud data at the rocket launch stage in a variety of measurement modes and sent the 3D point cloud data to the service display through the fiber optic transceiver to further fit the ellipse and ellipse center of each scanning layer according to the 3D point cloud data. According to the ellipse center fitted by each scanning layer, the central axis of the rocket in the launch stage is fitted. The drift parameters of the rocket in the launch phase can be measured by comparing the central axis fitted in the launch phase with the reference central axis in a static state.

湖泊水环境关键参数遥感模型构建与应用

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Abstract: 湖泊 (含水库) 提供了中国近 7 亿人口集中式饮用水，是国家重要战略资源和“山水林田湖草沙”生命共同体重要组成部分，在区域和全球碳氮磷等生物地球化学循环中发挥着重要作用。湖泊遥感作为一门新型交叉学科，是湖泊科学和遥感科学的重要分支。该报告瞄准湖泊生态环境问题和国家需求，围绕水环境关键参数，主要介绍水体光学特性和机理、模型构建和验证、以及应用研究等方面开展的工作。

基于多源数据的南海中北部次表层叶绿素最大值反演研究

Jianqiang Chen and Xiang Gong

Qingdao University of Science and Technology

Abstract: 南海中北部普遍存在次表层叶绿素最大值（SCMs）现象，由于其发生在遥感可探测深度以外，目前对这一最大值现象的认识仍有待加强。本文基于南海中北部的多源数据（OCCCI 遥感资料、BGC-Argo 剖面数据和三维物理 - 生态耦合模式 CMEMS 结果）构建数据集，采用卷积神经网络（CNN）模型估算 SCMs 特征（深度、厚度和强度）。首先利用 CMEMS 模式数据（表层叶绿素和 SST）作为输入，对 CNN 模型进行预训练，进而对模型进行迁移学习，即利用遥感数据和 BGC-Argo 剖面数据对模型进行微调，得到最终的 CNN 模型，输出叶绿素垂直剖面。CNN 模型结果显示：该网络能够有效利用遥感数据（叶绿素和 SST）反演南海中北部 SCMs 的深度和强度，相关系数为 0.6，RMSE 低于 0.1mg/m^3；但对 SCMs 厚度的反演准确性仍待提高。

基于遗传算法选择最佳参数的有效且自动化的 OBIA 工作流程

Qi Jin, Xuqing Zhang, Changbao Yang and Guodong Yang

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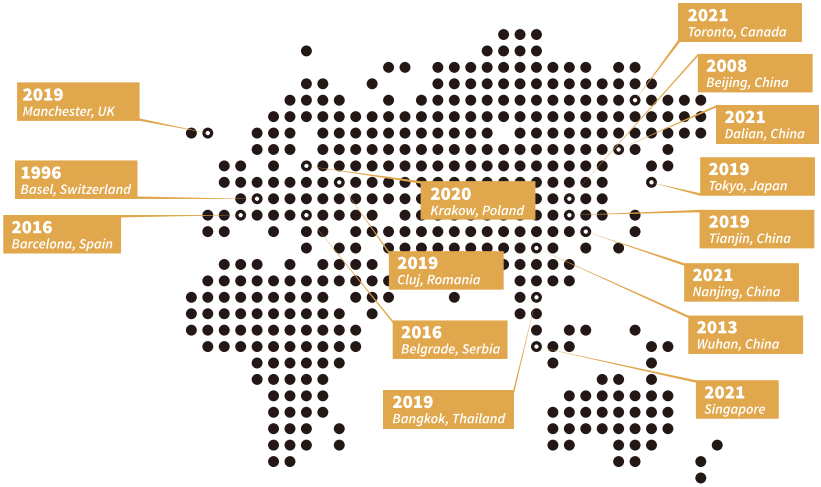
Abstract: 随着遥感影像空间分辨率的不断提高，基于对象的图像分析（OBIA）可以提供比基于像素的图像分类方法更合理的影像分类方法。但是，OBIA 需要分割算法来获取同质区域的对象。每个算法都需要参数来控制分割质量。因此，需要一种合理的参数优化方法。本文使用遗传算法（GA）将分割和分类这两个步骤集成到一个自动的 OBIA 工作流程中，并通过监督分类训练数据优化分割参数。我们使用分层逐步区域合并来提高分割的性能，GA 为其选择了最佳比例。分层逐步区域合并后，OA（总体精度）平均提高 6.3%，测试区域 A 平均 Kappa 系数增加 8.7%，测试区域 B 平均增加 5.0%，Kappa 系数平均增加 7.2%。我们还验证了 GA 选择的最优比例与其他规模只有很小的差异。本研究证明了分层逐步区域合并对于分割改进的必要性，以及 GA 选择最优参数并讨论基于 GA 的工作流程的一些优点和局限性的潜力。可以为未来 OBIA 领域的研发提供一定的参考。

关于 MDPI：



MDPI 由林树坤博士创办于 1996 年，是全球领先的开放获取出版公司之一，总部位于瑞士巴塞尔，同时在中国、西班牙、塞尔维亚、英国、日本、罗马尼亚、加拿大、波兰、新加坡以及泰国设有分公司。MDPI 在中国 5 个城市设有办公室，主要承担瑞士 MDPI 编辑出版相关的离岸外包业务，分别位于北京、湖北武汉、天津、江苏南京、辽宁大连。

MDPI 致力于开放获取出版服务，目前出版英文学术期刊 423 个，其中 SCIE 期刊 92 个。期刊领域覆盖生物、化学、医药、机械、能源、环境等各学科，其中包含众多国际知名期刊如 *Molecules* , *Sensors, International Journal of Molecular Sciences, Marine Drugs, Energies, Remote Sensing* 等。

扫描二维码进入 MDPI 中文官网了解更多信息

酒店信息：

南京白金汉爵大酒店

酒店地址：南京栖霞区玄武大道 888 号

“南京白金汉爵大酒店位于江苏省南京市栖霞区玄武大道，西临长江二桥，距离主城核心新街口约 14 公里，距离沪蓉高速路口约 1.7 公里路程，交通便利，地理位置优越，各大著名景点近在咫尺。

酒店拥有豪华客房 1200 余间，尊贵餐饮包厢 60 余间、豪华宴会厅及多功能厅 20 余个、棋牌包厢 30 余间以及 24 小时餐厅、咖啡厅等豪华配套设施。其餐饮规模庞大，其中大小宴会厅多达 20 余个，宴会厅达 3500 余平方米，气势恢宏，装潢奢丽大气，适合各类会议和宴席，是大型会议的理想选择。”

酒店周边：

钟山风景名胜区

——钟山龙蟠，石头虎踞，此帝王之宅也。

- 钟山风景名胜区位于南京市玄武区紫金山，是中国著名的风景游览胜地、首批国家级风景名胜区、首批国家 5A 级旅游景区、国家森林公园、国家文明风景名胜区、中国旅游胜地四十佳。
- 钟山风景区以中山陵园为中心，明孝陵和灵谷寺为依托，分布各类名胜古迹多达 200 多处，84 个可供游览景点，分为明孝陵景区、中山陵景区、灵谷景区、头陀岭景区和其他景点五大部分。

参考时间： 1 天（景区面积很大，推荐空出一天时间参观）

交通信息：

- 公交：乘坐公交 20 路、315 路至明孝陵站；乘坐 5 路、34 路、36 路、55 路、142 路至卫桥站；乘坐公交 34 路至下马坊站；或乘坐 5 路、36 路、55 路、142 路、315 路至小卫街站。
- 地铁：乘坐南京地铁 2 号线至苜蓿园站，1 号口出站；乘坐南京地铁 2 号线至下马坊站下车，2 号口出站，沿博爱路步行至观光车站然后换乘景区观光车前往；或换乘 34 路公交至中山陵停车场站。

开放时间：

- 钟山风景名胜区：2 月至 11 月 6:30–18:30，12 月至次年 1 月 7:00–17:30。
- 中山陵 “天下为公”陵门以上区域及墓室开放时间为：每日 8:30 至 17:00，每周一闭馆维护（法定节假日及孙中山先生诞辰、逝世纪念日除外）。

官方网站：

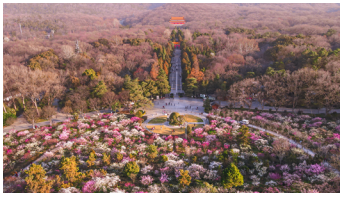
http://www.zschina.org.cn/

钟山景点：

中山陵

——功高不用碑文显，落定尘埃我为公。

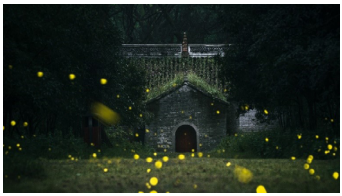
- 中山陵是中国近代伟大的民主革命先行者孙中山先生的陵寝及其附属纪念建筑群，陵寝面积 8 万余平方米。
- 中山陵前临平川，背拥青嶂，东毗灵谷寺，西邻明孝陵，整个建筑群依山势而建，由南往北沿中轴线逐渐升高，主要建筑排列在一条中轴线上，体现了中国传统建筑的风格，庄严简朴，被誉为“中国近代建筑史上的第一陵”。



明孝陵

——天为帐幕地为毡，日月星晨伴我眠。

- 明孝陵是是明太祖朱元璋与其皇后的合葬陵寝。因皇后马氏谥号“孝慈高皇后”，又因奉行孝治天下，故名“孝陵”。其占地面积达 170 余万平方米，是中国规模最大的帝王陵寝之一。
- 明孝陵承唐宋帝陵“依山为陵”旧制，又创方坟为圜丘新制。将人文与自然和谐统一，达到天人合一的完美高度，成为中国传统建筑艺术文化与环境美学相结合的优秀典范。



灵谷寺

——山深静者爱，日晏未知还。

- 灵谷寺始建于南梁天监十四年（515 年），是南朝梁武帝为纪念著名僧人宝志禅师而兴建的“开善精舍”，初名开善寺。明朝时朱元璋亲自赐名“灵谷禅寺”，并封其为“天下第一禅林”，为明代佛教三大寺院之一。

南京美景：

玄武湖风景区

——钱塘莫美于西湖，金陵莫美于后湖。

- 玄武湖风景区位于南京市玄武区，是紫金山脚下的国家级风景区，江南最大的城内公园，被誉为“金陵明珠”，与杭州西湖、嘉兴南湖并称“江南三大名湖”。
- 玄武湖方圆近五里，分作五洲（环洲、樱洲、菱洲、梁洲、翠洲），洲洲堤桥相通，浑然一体，处处有山有水。环湖有玄武晨曦、北湖艺坊、玄圃、玄武烟柳、武庙古闸、明城探幽、古阅武台等众多景点。

建议游玩时长： 3–4 小时

交通信息：

- 公交：玄武门入口：乘坐 1 路、8 路、22 路、25 路、28 路、30 路、33 路、35 路、56 路至玄武湖公园站；解放门入口：乘坐 2 路、3 路、31 路、44 路、52 路、70 路至太平北路鸡鸣寺站。
- 地铁: 乘坐南京地铁 1 号线至玄武门站，3 号口或 4 号口出站即可到达玄武门入口；乘坐南京地铁 1 号线或 3 号线至南京站，1 号口或 4 号口出站即可到达北环湖路。

开放时间：

- 环湖路 24 小时全天开放
- 五洲开放时间：夏季：早 5:00– 晚 10:00，冬季：早 6:00– 晚 9:00

官方网站：

http://www.xuanwuhu.net/index.aspx

南京美景：

鸡鸣寺

——南朝四百八十寺，多少楼台烟雨中。

- 鸡鸣寺位于南京市玄武区鸡笼山东麓山阜上，又称古鸡鸣寺，始建于西晋永康元年（300 年），至今已有一千七百多年的历史，是南京最古老的梵刹和皇家寺庙之一，香火一直旺盛不衰，自古有“南朝第一寺”，“南朝四百八十寺”之首的美誉。
- 寺中环境十分幽雅，佛殿精美，香火缭绕。此外寺内还有韦驮殿、志公墓、藏经楼、念佛堂、药师佛塔等主要建筑。1992 年《新白娘子传奇》剧组因当时杭州雷峰塔已倒而新的尚未建好，来到南京鸡鸣寺借用药师佛塔来拍雷峰塔相关场景。
- 寺内可以求签，还能写许愿牌然后挂起来。每当农历二月十九、六月初九、九月十九（即观音菩萨诞生、成道、出家纪念日），众多游客来此拜佛敬香。鸡鸣寺里的素斋也非常有名，并且价格实惠，不妨来此一试。

建议游玩时长：2–3 小时

交通信息：

- 公交：乘坐南京公交 2 路、3 路、31 路、44 路、52 路、70 路至太平北路鸡鸣寺站；或乘坐 11 路、20 路、48 路至北京东路鸡鸣寺站；或乘坐 304 路至鸡鸣寺站。
- 地铁：乘坐南京地铁 3 号线或 4 号线至鸡鸣寺站下，5 号口出站。

开放时间：

- 每日 7:30–17:00 开放；晚上仅在农历二月十九、六月初九、九月十九的前一天和除夕开放。

官方网站：

http://www.jimingsi.net/index.asp

南京美景：

总统府

——地即帝王宅，山为龙虎盘。

- 南京总统府至今已有 600 多年的历史，是中国近代建筑遗存中规模最大、保存最完整的建筑群，也是南京民国建筑的主要代表之一，中国近代历史的重要遗址。
- 南京总统府多次成为中国政治军事的中枢、重大事件的策源地，可追溯到明初的归德侯府和汉王府；清代被辟为江宁织造署、两江总督署等，康熙、乾隆南巡均以此为行宫；太平天国定都天京后，在此兴建规模宏大的天王府；1912 年 1 月 1 日，孙中山在此宣誓就职中华民国临时大总统。
- 南京总统府占地面积约 9 万平方米，分三个参观区域：中区主要有国民政府、总统府及所属机构；西区有孙中山临时大总统办公室、秘书处、西花园、孙中山起居室以及参谋本部等；东区主要有行政院、陶林二公祠、马厩和东花园等。

建议游玩时长： 3–4 小时

交通信息：

- 公交：乘坐南京公交 9 路、29 路、44 路、65 路、95 路、304 路至总统府站；乘坐南京公交 3 路、31 路、80 路至南京图书馆站，步行可达。
- 地铁：乘坐南京地铁 2 号线或 3 号线至大行宫站，5 号口出站。

开放时间：

- 旅游旺季（3 月 1 日至 10 月 14 日）08：30–18：00，17：00 停止售票，17：10 停止入馆。
- 旅游淡季（10 月 15 日至次年 2 月底）08：30–17：00，16：00 停止售票，16：10 停止入馆。
- 除法定节假日外，每周一全天闭馆（遇有重大活动或特殊事由，开放时间另行安排）。

官方网站：

http://www.njztf.cn/index.sh

南京美景：

夫子庙秦淮风光带

——烟笼寒水月笼沙，夜泊秦淮近酒家。

- 夫子庙秦淮风光带以夫子庙古建筑群为中心、十里内秦淮河为轴线、明城墙为纽带，串联起众多全国重点文物保护单位和文物古迹，东起东水关，西至西水关（今水西门）。
- 在这“江南锦绣之邦，金陵风雅之薮”，美称“十里珠帘”的夫子庙 - 秦淮风光带上，点缀着数不尽的名胜佳景，汇集着说不完的轶闻掌故。
- 她蕴涵着南京城市发展两千多年的历史文化积淀，是南京城市最早的重要发祥地之一，也是南京历史上最热闹的文化、商业中心，代表了南京历史上的繁华。

建议游玩时长： 4–6 小时

交通信息：

- 公交：乘坐南京公交 1 路、2 路、4 路、7 路、40 路、44 路、49 路、202 路至夫子庙站； 乘坐 16 路、23 路、33 路、43 路、46 路、63 路、81 路、87 路、301 路至长乐路。
- 地铁：乘坐南京地铁 1 号线至三山街站；或乘坐地铁 3 号线至夫子庙站。

开放时间：

- 全天

官方网站：

http://www.njfzm.net/index.php

南京美景：

南京博物院

——以史为鉴，可以知兴替。

- 南京博物院是中国三大博物馆之一，简称南院或南博，其前身是民国二十二年（1933 年）蔡元培等倡建的国立中央博物院，是中国创建最早的博物馆、中国第一座由国家投资兴建的大型综合类博物馆。
- 南京博物院占地 13 万余平方米，为“一院六馆”格局，即历史馆、特展馆、数字馆、艺术馆、非遗馆、民国馆。
- 南京博物院馆藏文物上至旧石器时代，下迄当代；既有全国性的，又有地域性的；既有宫廷传世品，又有考古发掘品，还有一部分来源于社会征集及捐赠，均为历朝历代的珍品佳作和备受国内外学术界瞩目的珍品。

建议游玩时长：4–6 小时

交通信息：

- 公交：乘坐南京公交 5 路、34 路、36 路、55 路、59 路至中山门站。
- 地铁：乘坐南京地铁 2 号线至明故宫站，由一号口出站向东步行 300 米。

开放时间：

- 周一 全天闭馆
- 周二至周日 9:00–17:00（16:00 停止检票）
- 周一逢国家法定节假日全天开放，除夕、大年初一闭馆

官方网站：

http://www.njmuseum.com/zh

南京景点：

侵华日军南京大屠杀遇难同胞纪念馆

——铭记历史，祈愿和平。

- 侵华日军南京大屠杀遇难同胞纪念馆是为铭记侵华日军攻占中国首都南京后制造了惨无人道的南京大屠杀的暴行而筹建，是中国人民承段全民族灾难的实证性、遗址型专史纪念馆，也是中国唯一一座有关侵华日军南京大屠杀的专史陈列馆及国家公祭日主办地。
- 目前，纪念馆含侵华日军南京大屠杀史实展、“三个必胜”主题展、“二战中的性奴隶——日军‘慰安妇’制度及其罪行展”等三个基本陈列，展示了南京大屠杀、日军“慰安妇”制度、中国人民抗日战争伟大胜利的历史。

建议游玩时长： 2–3 小时

交通信息：

- 公交：乘坐南京公交 7 路、37 路、61 路、63 路、166 路至江东门纪念馆站；乘坐公交 204 路至纪念馆站；或乘坐公交 48 路、109 路至茶亭东街站。
- 地铁：乘坐南京地铁 2 号线至云锦路站。

开放时间：

- 参观时间：周二至周日开馆时间为 8:30–17:30，16:30 关闭入口，停止进入
- 周一闭馆（国家法定节假日除外）

官方网站：

http://www.19371213.net/

南京美景：

南京先锋书店

——粗缯大布裹生涯，腹有诗书气自华。

- 南京先锋书店于 1996 年在南京创立，是国内知名的民营学术书店，自创立以来探索出一条以“学术、文化沙龙、咖啡、艺术画廊、电影、音乐、创意、生活、时尚”为主题的文化创意品牌书店经营模式，搭建一座可供开放、探讨、分享的公共性平台。
- 先锋书店是南京的著名文化名片，也是江苏最大的人文社科专业书店，是南京人民集体意志创造的结晶，它铸造的不仅是先锋风格的人文品牌，更是南京人民的精神品格和思想品质。
- 先锋书店五台山店为总店，地下车库改造而成的总店风景独特，其内独辟二手书店区，创意产品展售馆，先锋艺术咖啡馆，沙龙活动专区，另有十二家分店遍布江浙皖三省。

建议游玩时长： 2–3 小时

交通信息：

五台山总店：南京市鼓楼区广州路 173 号五台山体育馆地下车库

- 公交：乘坐南京公交 3 路、6 路、91 路、532 路至随家仓站。
- 地铁：乘坐南京地铁 1 号线至珠江路站，一号口出站，往儿童医院方向至古南都饭店，对面即见。

开放时间：

- 周一至周四 10:00–21:00
- 周五 10:00–22:00
- 周六至周日 9:30–22:00

官方微博：

https://weibo.com/nanjingxianfeng?refer_flag=1001030103_

南京美食：

鸭血粉丝汤

牛肉锅贴

盐水鸭

鸡汁汤包

梅花糕

桂花糖芋苗

皮肚面

煮干丝

热门餐厅：

金陵饭店·梅苑

- 大众点评评分：4.9
- 人均：389 元
- 地址：汉中路 2 号金陵饭店 2 楼，距地铁 1/2 号线新街口站 6 号口步行 150m
- 营业时间：周一至周日：11:30–14:30 17:30–22:00
- 推荐菜：金陵盐水鸭 蟹粉狮子头 驰名软兜

民国红公馆（老门东店）

- 大众点评评分：4.8
- 人均：307 元
- 地址：剪子巷 58 号，距地铁 3 号线武定门站 2 号口步行 640m
- 营业时间：周一至周日：10:30–21:00
- 推荐菜：金陵至味红烧肉 蒋宴香煎牛眼粒 焕章松鼠桂鱼

南京大牌档（夫子庙平江府店）

- 大众点评评分：4.8
- 人均：77 元
- 地址：大石坝街 48 号（中国建设银行旁），距地铁 3 号线夫子庙站 2 号口步行 330m
- 营业时间：周一至周日：11:00–21:30
- 推荐菜：民国美龄粥 古法糖芋苗 金陵烤鸭

热门餐厅：

南城燕归楼

- 大众点评评分：4.8
- 人均 113 元
- 地址：陶家巷 1 号（老门东 P3 停车场 1 号出口），距地铁 3 号线武定门站 2 号口步行 600m
- 营业时间：周一至周日：11:00–14:00 16:30–21:00
- 推荐菜：青柑普洱红烧肉 火茸鸡粥 古法糖醋牛里脊

江南里（新百店）

- 大众点评评分：4.8
- 人均 80 元
- 地址：中山南路 1 号新百商场 B 座 B1 层，距地铁 1/2 号线新街口站 8 号口步行 80m
- 营业时间：周一至周日： 10:00–21:00
- 推荐菜：宋嫂鱼羹 海胆虾仁豆腐 东坡肉

特色小吃：

李记清真馆（打钉巷店）

- 大众点评评分：4.6
- 人均：25 元
- 地址：打钉巷 1 号（近建邺路），距地铁 1 号线张府园站出入口步行 540m
- 营业时间：周一至周日：05:30–19:30
- 推荐菜：牛肉锅贴 牛肉馄饨 牛杂汤

章云板鸭（评事街店）

- 大众点评评分：4.6
- 人均：45 元
- 地址：评事街 208 号，距地铁 1 号线张府园站出入口步行 410m
- 营业时间：周一至周日：07:00–19:00
- 推荐菜：烤鸭 南京板鸭 盐水鸭

鸭得堡老鸭粉丝汤（丰富路店）

- 大众点评评分：4.4
- 人均：27 元
- 地址：丰富路 134–4 号（中央大酒店旁），距地铁 1/2 号线新街口站 15 号口步行 480m
- 营业时间：周一至周日：0:00–24:00
- 推荐菜：招牌鸭血粉丝汤 招牌老鸭粉丝汤 虾仁汤包