放射医学与辐射防护国家重点实验室

State Key Laboratory of Radiation Medicine and Protection

年度工作报告

ANNUAL REPORT

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Soochow University

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目　录

前　言

放射医学与辐射防护国家重点实验室是江苏省人民政府和科学技术部共同批准建设的江苏省首个省部共建国家重点实验室（国科发基[2018]161号），也是苏州市和苏州大学的第一个国家重点实验室。

放射医学与辐射防护国家重点实验室是为了满足我国人民健康、国家安全和核能可持续发展等重大需求而建立的。苏州大学放射医学是我国该领域中唯一的国家重点学科。实验室依托苏州大学苏州医学院放射医学与防护学院和核工业总医院，拥有一支由院士、国家重大专项首席科学家、杰青、长江学者等组成的放射医学及交叉科学研究的人才队伍，团队专业结构合理，涵盖放射医学、辐射防护、血液学、临床医学、药学、材料学、化学、核科学技术等多个学科。

放射医学与辐射防护国家重点实验室的定位是“以放射生物效应为基础、以放射诊治和辐射防护为目标”。围绕国家中长期发展规划和区域发展的战略布局，面对核技术在医学领域中的广泛应用，瞄准国际放射医学与辐射防护的重大科学问题，围绕放射生物效应及机理、先进放射诊断和治疗、辐射防护等3个重点研究方向开展高水平前沿研究，通过平台建设以及体制机制创新，建设和完善高水平研究团队，加强基础研究，努力提高研发能力，通过科技创新，促进区域经济社会发展，促进放射医学及相关学科可持续发展。

2023年实验室在科学研究、人才队伍、对外交流、开放服务和实验室科学规范管理等方面均取得了一定的成绩。 2023年7月8日在江苏省科技厅组织的国家重点实验室第一个5年建设验收中评价优秀。“放射医学专业”入选国家级一流本科专业建设点。实验室现有成员121人，其中中国科学院院士1人、中国工程院院士1人、欧洲科学院院士1人、俄罗斯工程院外籍院士1人、国际宇航科学院院士2人、杰青9人（含1名基金委外国资深学者项目获得者）、长江学者特聘教授1人、长江学者讲席教授1人、万人计划2人、优青11人（含2名海外优青）。2023年度柴之芳院士被授予 “环

境化学终身成就奖”， 胡士军教授荣获法国第六届“夏邦克-杜博赛”奖，路建美教授荣获全国创新争先奖，王殳凹教授荣获第 5 届“科学探索奖”，高明远教授牵头的“面向肿瘤高灵敏诊断及微环境定量可视化的智能探针研究”获得江苏省科学技术二等奖，田野教授牵头的“放射性大脑神经功能损伤防治新靶点及其机制研究”获得江苏省科学技术三等奖。国重实验室与中国疾控中心辐射医学与健康研究所合作主办的英文期刊《Radiation Medicine and Protection》2 月成立了苏州办公室，12 月被 ASCI 收录。

在科研方面，2023 年实验室新增包括国家重点研发计划、国家自然科学基金等科研课题 59 项，总金额 7500 万余元。王殳凹教授获批国防科工局核能开发项目，史海斌教授获批国家自然科学基金杰出青年基金项目，陈华兵教授获得科技部重点研发计划子课题资助，王亚星、吴德沛、陈华兵教授获得国家自然科学基金重点基金项目资助。实验室共发表 SCI 研究论文 255 篇，论文总引用近万次，篇均引用 40.5 次。授权发明专利 60 项，其中国际发明专利 2 项。

实验室在研发合作和成果转化方面继续保持良好势头。获批国防科工局等军民合作项目；深化了与中广核、好医生医药集团、和祐集团、鸿博集团、华克、华益等公司的合作。与埃及爱资哈尔大学合作获得省科技厅科技计划专项资金创新支撑计划国际科技合作/港澳台科技合作项目资助，并建立了联合实验室；与美国哥伦比亚大学合作，建立了苏州市粒子辐射效应及应用研究国际联合实验室。

实验室在科普宣传和社会服务方面成效显著。2023 年，实验室获批了江苏省、全国科学家精神教育基地；江苏省科普教育基地建设期满考核获评“优秀”。在全国科技周、全国科普日、全国科技工作者日等重要节点，举办“与核同行”系列科普活动，紧扣热点如 8 月福岛排放核污水积极开展核科学传播，柴之芳院士领衔的科学家团队在中国科协《科学家讲科学》、人民网、央视《新闻调查等节目开展有关核科普。累计线上线下受益达 10 万余人次，取得了良好的社会效益与成效，获得了社会的广泛好评。获国家及省部级以上各类奖项达 20 余项，包括国重室获中国科协全国科普日活动优

秀组织单位；“魅力之光”讲解员大赛优秀组织奖；全国“核+X”大赛一等奖 1 项； “强核有我，医心卫民”—辐射与健康科普志愿研习项目荣获 2023 年度长三角科技志愿服务先进典型；国重室志愿服务队荣获“典赞 2023 科普江苏”先进集体； “核你同行”科学家精神展览及“核星启航”科学家精神宣教活动获评 2023 年度江苏省科学家精神教育基地“特色展览”和“特色活动”；柴之芳院士领衔主编，相关专家编写的《辐射与健康科普丛书》荣获“典赞·科普苏州”年度优秀科普作品奖，其中一本《辐射对健康的影响》入选 2023 年全国中小学图书馆（室）推荐书目； 《放射性核素小侦探》科普系列丛书在原子能出版社 4 月正式出版；“核星启航”大学生科普志愿服务团获 2023 年苏州大学大学生暑期社会实践先进集体和优秀团队，另外还获批了苏州市科学家精神教育基地建设项目（场馆建设类）1 项。

实验室有 206 人次被邀请在国际国内学术会议上作各类学术报告；共有 53 人次被邀请来实验室作学术报告。另外，实验室成功举办了 2023 辐射生物学国际研讨会议（2023.09.22），2023 年中国核学会核应急医学分会学术交流研讨会（2023.11.08），第五届苏州国际医学影像研讨会暨第三届苏州国际眼科人工智能论坛（2023.11.11）和 2023 年放射医学与生物分析前沿交叉学术研讨会（2023.12.02）等学术会议。

学术委员会成员名单

职务	姓　名	职称	单位	研究方向
顾问	陈洪渊	院士	南京大学	生命分析
顾问	阮长耿	院士	苏州大学	血液学
主任	詹启敏	院士	中国医学科学院/北京大学	肿瘤学
副主任	陈凯先	院士	上海中医药大学	药物化学
副主任	于金明	院士	山东省肿瘤医院	放射医学
副主任	赵宇亮	院士	国家纳米中心	纳米毒理学
委员	王红阳	院士	上海交通大学	肿瘤与细胞信号转导
委员	欧阳晓平	院士	西北核技术所	核技术
委员	田　禾	院士	华东理工大学	材料化学
委员	叶朝辉	院士	中国科学院武汉物理与数学研究所	核磁共振技术
委员	柴之芳	院士	苏州大学	放射医学
委员	吴宜灿	院士	中科院合肥物质科学研究院核安全所	核技术
委员	Tom K.Hei	教授	美国哥伦比亚大学医学中心	放射医学
委员	汪小琳	教授	中国工程物理研究院	核安全
委员	常学奇	教授	中国辐射防护研究院	辐射防护
委员	周平坤	教授	军事医学科学院	放射医学
委员	邵春林	教授	复旦大学	放射生物学
特邀委员	郭子建	院士	南京大学	生物无机化学
特邀委员	魏于全	院士	四川大学	肿瘤免疫学
特邀委员	叶国安	院士	中国原子能研究院	核安全
特邀委员	陈春英	院士	国家纳米科学中心	纳米材料生物效应

一、研究队伍

实验室研究队伍建设的总目标：建设一支素质优良、结构合理、精干高效的科研队伍。实验室人员由三部分组成：专职研究团队、技术人员团队和管理团队。目前，实验室有固定人员 121 人，其中中国科学院院士 1 人、中国工程院院士 1 人、欧洲科学院院士 1 人、俄罗斯工程院外籍院士 1 人、国际宇航科学院院士 2 人、杰青 9 人（含 1 名海外杰青）、长江学者特聘教授 1 人、长江学者讲席教授 1 人、万人计划 2 人、优青 11 人（含 2 名海外优青），已建立了年龄层次和知识结构合理的研究团队。

实验室人员组成情况

序号	姓　名	性别	出生年月	专　业	技术职务
研究人员					
1	柴之芳	男	194209	放射化学/放射医学	名誉主任（院士、教授）
2	王殳凹	男	198506	放射化学	主任（特聘教授、杰青、长江学者）
3	时玉舫	男	196010	肿瘤学	副主任（教授、杰青）
4	高明远	男	196703	分子影像与核医学	副主任（教授、杰青）
5	华道本	男	197404	放射化学/辐射防护	副主任（教授、青蓝工程）
6	戴克胜	男	196508	血液学	副主任（教授、国际宇航院士）
7	阮长耿	男	193908	血液学	院士、教授
8	张学光	男	195111	免疫学	教授、杰青
9	钟志远	男	197404	药物化学	特聘教授、杰青
10	张正彪	男	197411	化学	教授、杰青
11	陈华兵	男	197811	纳米毒理学	教授、杰青
12	史海斌	男	197803	分子影像与核医学	教授、杰青
13	邵常顺	男	196210	遗传学	特聘教授、海外杰青
14	Tom k.Hei	男	195309	实验病理学	终身教授、长江讲席

序号	姓　名	性别	出生年月	专　业	技术职务
15	吴庆宇	男	195710	血液与血管生物学	教授、高层次人次
16	周光明	男	197007	放射医学/特种医学	特聘教授、国际宇航院士
17	陈新建	男	197905	分子影像学	特聘教授、优青
18	杨　凯	男	198308	放射医学	特聘教授、优青
19	葛翠翠	女	198311	辐射纳米毒理学	特聘教授、优青
20	汪　勇	男	198309	放射医学	特聘教授、优青
21	李培山	男	198407	生物学	特聘教授、优青
22	曾剑峰	男	198706	化学	特聘教授、优青
23	王亚星	男	198810	辐射防护	特聘教授、优青
24	崔家斌	男	198908	化学	特聘教授、海外优青
25	陈　冬	男	198212	生物学	教授、海外优青
26	谌　宁	男	198010	化学	特聘教授、青长
27	第五娟	女	198604	放射化学	教授、青长、省杰青
28	刘汉洲	男	198505	化学	特聘教授、青长
29	王艳龙	男	198604	化学	特聘教授、青长
30	李　桢	男	197608	分子影像与核医学	高层次人才、省双创人才
31	李瑞宾	男	198209	辐射纳米毒理学	特聘教授、高层次人次、省杰青
32	畅　磊	男	198705	生物与医药	特聘教授、高层次人才
33	何亦辉	男	198705	材料与化工	特聘教授、高层次人才
34	苗庆庆	女	198907	化学	高层次人才、省杰青
35	胡士军	男	198002	细胞生物学	特聘教授、高层次人才
36	何玉龙	男	196701	淋巴管与肿瘤	教授、新世纪人才
37	黄玉辉	男	197212	病理学与病理生理学	教授、省特聘教授
38	杨　林	男	196408	免疫学	教授、省“双创”
39	吴德沛	男	195802	血液学	教授、主任医师
40	刘玉龙	男	196608	放射损伤临床	教授、主任医师
41	武　艺	男	196503	血栓与血管生物学	特聘教授

序号	姓　名	性别	出生年月	专　业	技术职务
42	周泉生	男	195505	病理学与病理生理学	特聘教授
43	王建荣	男	196205	细胞生物学	特聘教授
44	徐　鹏	男	198904	生物学	特聘教授
45	杨光保	男	198911	化学	特聘教授
46	韩　悦	女	197002	血液学	主任医师
47	朱秀林	男	195510	材料化学	教授
48	路建美	女	196010	材料化学/辐射防护	教授
49	曹建平	男	196205	放射医学/特种医学	教授
50	王　畅	女	197601	放射医学	教授
51	许玉杰	男	196311	放射医学与核医学	教授
52	涂　彧	男	196507	放射医学/辐射防护	教授
53	郭正清	男	198105	放射医学	教授
54	张乐帅	男	198002	毒理学	教授
55	刘芬菊	女	195412	放射医学/特种医学	教授
56	杨红英	女	197211	放射医学	教授
57	陈　秋	女	197608	辐射免疫学	教授
58	孙　巧	女	197407	定量生物医学	教授
59	崔凤梅	女	197510	放射毒理学	教授
60	杨　巍	男	197609	特种医学	教授
61	田　野	男	196501	特种医学	教授
62	宋耀华	男	196103	化学	教授
63	邓　超	男	197511	化学	教授
64	刘志勇	男	198101	放射化学	教授
65	焦　旸	女	197711	放射医学	教授
66	吴书旺	男	199102	化学	教授
67	杨　涛	男	199110	药学	教授
68	张力元	男	197801	外科学	教授

序号	姓　名	性别	出生年月	专　业	技术职务
69	王杨云	女	198610	放射医学	教授
70	朱　然	女	197508	放射医学	教授
71	张昊文	男	198601	放射医学	教授
72	董宁征	女	197001	临床医学	研究员
73	李世红	男	197309	粒子物理与原子核物理	研究员
74	胡　亮	男	198402	核科学与技术	特聘副教授
75	赵　利	男	198302	放射医学	副教授
76	俞家华	男	198102	放射医学/特种医学	副教授
77	朱　巍	男	197009	放射医学	副教授
78	万　骏	男	196411	放射医学/辐射防护	副教授
79	孙　亮	男	197410	放射医学/辐射防护	副教授
80	胡文涛	男	198408	物理学	副教授
81	屈卫卫	男	198808	物理学	副教授
82	田　欣	男	198506	生物学	副教授
83	何伟伟	男	198710	高分子化学与物理	副教授
84	赵　琳	女	198710	放射医学	副教授
85	陈　娜	女	198508	基础医学	副教授
86	刘春毅	男	199003	生物医学工程	副教授
87	裴海龙	男	198801	生物医学工程	副教授
88	闫聪冲	男	198609	核科学与技术	副教授
89	王广林	男	198302	放射化学	副教授
90	张　朵	男	198512	材料学	副研究员
91	Matthew V. Sheridan	男	198608	哲学	副教授
92	单善善	女	199202	核磁共振成像	副教授
93	杨再兴	男	198209	定量生物医学	副研究员
94	孟烜宇	女	198306	定量生物医学	副研究员

序号	姓　名	性别	出生年月	专　业	技术职务
95	李　庆	男	1987096	分子影像与核医学	副研究员
96	代　星	男	198710	物理学	副研究员
97	崇　羽	男	198803	基础医学	副研究员
98	陈　龙	男	198810	放射性污染防控	副研究员
99	张海龙	男	199001	化学	副研究员
技术人员					
100	徐加英	女	197201	肿瘤放射生物	综合办主任（研究员）
101	白　霞	女	196809	血液学	高级实验师
102	吴　艳	女	198107	免疫学	高级实验师
103	聂　晶	女	197304	生物化学	高级实验师
104	吴安庆	男	198706	放射免疫学	高级实验师
105	刘胜堂	男	198702	放射医学	高级实验师
106	王敬东	男	197004	放射医学	实验师
107	陈兰花	女	198707	放射化学	实验师
108	闫思齐	女	198905	核物理	实验师
109	商冰雪	女	198612	免疫学	助理研究员
110	陈永井	男	197712	免疫学	助理研究员
111	盛道鹏	男	198507	放射化学	助理研究员
112	封　琼	女	198710	放射医学	助理研究员
113	王春宏	女	198001	生物学	助理研究员
管理人员					
114	王成奎	男	197108	心理学	副教授
115	朱本兴	男	197012	机关管理办公自动化	实验师
116	易　剑	女	196403	机关管理办公自动化	主管技师
117	彭　蓉	女	197704	机关管理办公自动化	助理研究员
118	燕　倩	女	199409	商务管理	财务秘书

序号	姓　名	性别	出生年月	专　业	技术职务
119	佟　鑫	女	199108	新闻与传播	行政秘书
120	岳清玉	女	199308	外交学	科普秘书
121	徐　悦	女	199401	会计	行政秘书

二、重要学术组织及期刊任职

1、重要学术组织任职

序号	人员	学术组织名称	职务
1	柴之芳	中国核学会	常务理事
2	柴之芳	英国皇家化学会	会士
3	柴之芳	科技部仪器评估专家组	组长
4	柴之芳	中国科学院咨询委员会	委员
5	曹建平	中国毒理学会	常委
6	曹建平	中国毒理学会放射毒理专业委员会	副主任委员
7	曹建平	国家核和辐射突发事件卫生应急队伍	领导小组成员
8	曹建平	中华医学会放射医学与防护学分会	常务委员
9	曹建平	中华预防医学会放射卫生专业委员会	常务委员
10	曹建平	中国卫生监督协会放射卫生专业委员会	常务委员
11	曹建平	中国核学会	理事委员
12	高明远	中国同位素与辐射防护行业协会	副理事长
13	高明远	意大利 CIMTEC 学术会议之“先进生物材料和纳米技术的医学应用”系列学术会议	国际顾问委员
14	高明远	中国医学科学院医学影像研. 究中心学术委员会	委员
15	高明远	中美纳米医学与纳米生物技术学会	Board of Directors
16	高明远	中国研究型医院学会肿瘤影像诊断学专业委员会	常委
19	王殳凹	中国环境科学学会环境化学分会	委员
21	王殳凹	核能材料产业发展联盟	第一届理事会理事
22	王殳凹	中国核学会核化工分会	第九届理事会理事
23	王殳凹	中国化学会第三十届理事会分子筛专业	委员会委员
24	王殳凹	中国化学会第三十届理事会晶体化学专业	委员会委员

序号	人员	学术组织名称	职务
25	周光明	国际空间研究委员会 COSPAR F2 组	主席
26	路建美	中国化工学会	会士
27	路建美	中国化学学会	会士
28	刘玉龙	中国应急管理学会核应急管理工作委员会	核应急智库专家
29	时玉舫	EU-MSC^2 (European MSC Consortia)	顾问
30	韩　悦	中国中西医结合学会血液学专业委员会	副主任委员
31	田　野	中国毒理学会特种医学毒理专业委员会	副主任委员
32	涂　彧	中国医学装备协会医用辐射装备防护与检测专业委员会	副主任委员
33	周光明	中国环境诱变剂学会辐射与健康专业委员会	副主任委员
34	田　野	中国辐射防护学会放射治疗分会	副理事长
35	周光明	中国核学会核应急医学分会	副理事长
36	周光明	中国生物物理学会辐射与环境生物物理学分会	副理事长
37	陈华兵	中国医药生物技术协会造影技术分会	常务委员
38	陈华兵	中国抗癌协会纳米肿瘤学专业委员会	常务委员
39	韩　悦	中国老年医学会血液学分会	常务委员
40	胡士军	中国生物工程学会干细胞工程技术分会	常务委员
41	涂　彧	中国计量协会医学计量专业委员会	常务委员
42	周光明	中国毒理学会特种医学毒理专业委员会	常务委员
43	刘芬菊	中国核医学辐射研究与技术分会	常务理事
44	钟志远	中国材料研究学会高分子材料与工程分会	常务理事
45	陈新建	生物医学工程学会	副主任委员
46	刘玉龙	中国核学会核与辐射应急分会	副理事长
47	武　艺	国际血栓与止血学会科学与标准化委员会	共同主席
48	杨　涛	中国抗癌协会纳米肿瘤学专业委员会	常务委员
49	田　野	中国抗癌协会肿瘤放射防护专业委员会	副主任委员

2、重要学术期刊任职

序号	姓　名	学术期刊名称	职务
1	柴之芳	Radiochimica Acta	主　编
2	柴之芳	Radiation Medicine and Protection	名誉主编
3	曹建平	Radiation Medicine and Protection	主　编
4	时玉舫	Cell Death & Disease	主　编
5	时玉舫	Oncogene	副主编
6	时玉舫	Cell Regeneration	副主编
7	时玉舫	Stem Cell Research & Therapy	副主编
8	时玉舫	Cell & Bioscience	副主编
9	钟志远	Journal of Controlled Release	副主编
10	邵常顺	Frontiers in Oncology	副主编
11	周光明	Life Sciences in Space Research	副主编
12	武　艺	Thrombosis Journal	副主编
13	陈新建	IEEE Transactions on Medical Imaging	副主编
14	陈新建	IEEE Journal of Translational Engineering in Health and Medicine	副主编
15	李瑞宾	NanoImpact	副主编
16	史海斌	Frontiers in Oncology	副主编
17	周光明	Journal of Radiation Research	副主编
18	周光明	British Journal of Radiology/Open	副主编
19	周光明	Life Science in Space Research	副主编
20	张乐帅	Toxicology and Industrial Health	副主编
21	张乐帅	Journal of Nanobiotechnology	副主编
22	刘芬菊	辐射研究与辐射工艺 学报	副主编
23	刘玉龙	《医学参考报-放射医学与防护频道》	副主编

三、研究方向

实验室以放射生物效应为基础、以放射诊治和辐射防护为目标，开展高水平的基础研究和应用基础研究。具体如下：

（1）放射生物效应及机理：探讨不同 LET 辐射生物效应、辐射对干细胞的作用及机理、空间辐射生物效应，不仅可以阐明电离辐射损伤的分子机制，还可以为提高放射治疗的精准性和载人航天的的安全性奠定科学基础；

（2）先进放射诊断和治疗：开展放射诊疗一体化分子影像、核医学影像组学、纳米诊疗药物和质子/重离子辐射治疗的研究，为恶性肿瘤、心脑血管病、神经退行性疾病的精准放疗提供三维空间影像数据和图谱，实现恶性肿瘤等重大疾病的早期诊断、转移预警、疗效评估；

（3）辐射防护：进一步开展辐射防护新原理、新机理和新方法研究，构建新型辐射防护药物体系，实现辐射剂量的精确测定和核能放射性污染的有效治理，为辐射防护和核应急提供科学依据和技术保障。

四、代表性科研成果

（一）放射生物效应及机理

1、放射性肺损伤机制学研究

作为胸部肿瘤的常用治疗方法之一，放疗常可诱发 RILI 这种严重的剂量限制性毒性作用，但因其机制不明导致目前临床尚无靶点明确的特异性防治措施。近年来，研究发现上皮-间充质转化（EMT）在 RILI 的发病机制中发挥重要作用，但其机制尚未完全阐明。团队经研究发现，电离辐射（IR）诱导的肺组织细胞 EMT 过程中，m6A RNA 甲基化修饰显著增加，同时检测到甲基转移酶类似物 3（METTL3）的表达上调和α-酮戊二酸依赖性双氧酶同源物 5（ALKBH5）的表达下调；阻断 METTL3 介导的 m6A 修饰可以抑制 IR 诱导的 EMT。进一步通过甲基化 RNA 免疫沉淀（MeRIP）法确定，FOXO1 是 METTL3 的关键作用靶点：METTL3 介导的 m6A 修饰通过 YTH 域家族 2（YTHDF2）依赖的方式下调 FOXO1 的表达，从而激活 AKT 和 ERK 信号通路。

这项研究的意义在于，发现了一种新型 RILI 表观遗传学调控机制，即 METTL3 介导的 m6A 修饰以 YTHDF2 依赖的方式下调 FOXO1 的表达，从而激活 AKT 和 ERK 信号通路，参与了 IR 诱导的 EMT 过程。这种新的机制为深入研究 RILI 的发病机制提供了新思路，也为 RILI 的精准防治提供了新的方向。

实验室焦旸教授联合苏州大学附属第一医院，开展了 N6-甲基腺嘌呤（m6A）修饰调控放射性肺损伤（RILI）的机制学研究，相关成果以“METTL3 Mediates Epithelial-Mesenchymal Transition by Modulating FOXO1 mRNA N6 -Methyladenosine-Dependent YTHDF2 Binding: A Novel Mechanism of Radiation -Induced Lung Injury”为题，发表于 Advanced Science（2023,10(17): e2204784）。

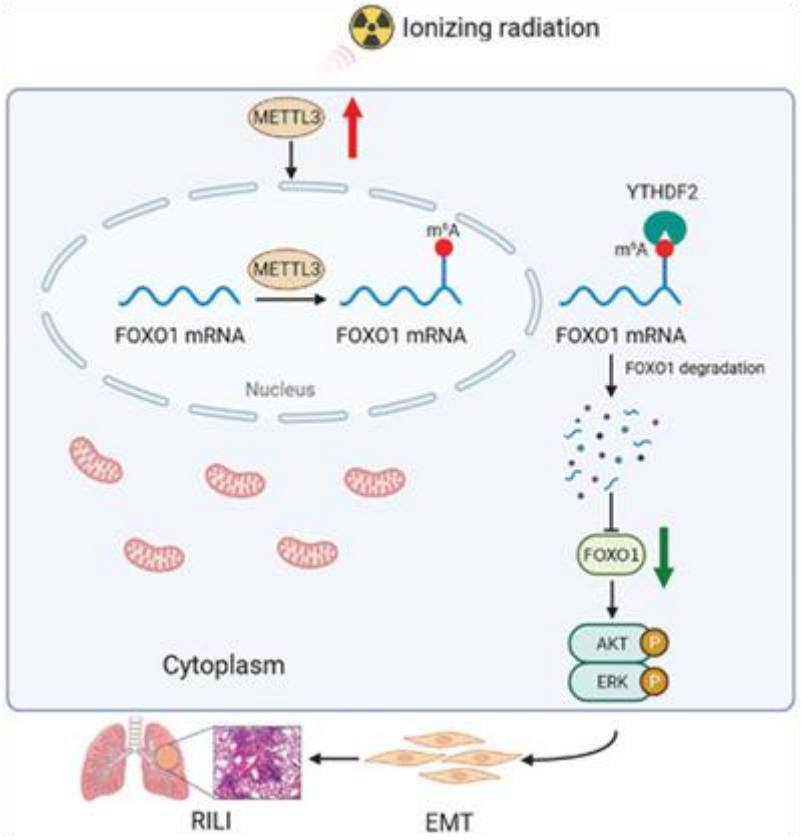

图 1.1 RILI 发生进展中辐射诱导 EMT 的作用轴示意图

2、电离辐射促进正常细胞恶性转化

人类转录组中约 98%的 RNA 是非编码 RNA，不具备翻译成蛋白质的能力；加之传统的基因注释过程往往过滤掉长度小于 100 个氨基酸的蛋白质，并将其视为“噪声”或假阳性，因此，我们容易忽略由“基因组噪声”等微小开放式阅读框编码的小“噪声蛋白”。研究团队采用 PhylCSF 和 ORF Finder 等生物信息学方法，搜索潜在的开放式阅读框，最终证实由 AFAP1-AS1 翻译、有 90 个氨基酸、定位于线粒体的小分子多肽 ATMLP，这是到目前为止发现的第一个由非编码 RNA 编码的线粒体定位肽。

实验室周光明教授和裴海龙副教授研究团队协同苏州大学附属第二医院研究团队发现由长链非编码 RNA 翻译的小分子多肽具有显著的促癌作用。该研究发现，电离辐射通过增强 AFAP1-AS1 的 1313 位腺嘌呤甲基化，诱导 ATMLP 小分子多肽的“非帽依赖”翻译。ATMLP 定位于线粒体，通过抑制受损线粒体与溶酶体的结合逃脱自噬，进而促进正常细胞的恶性增殖。相关成果在《Advanced Science》在线发表，题为“The Tumorigenic Effect of lncRNA AFAP1-AS1 is Mediated by

Translated Peptide ATMLP Under the Control of m6A Methylation ”，https://doi.org/10.1002/advs.202300314。

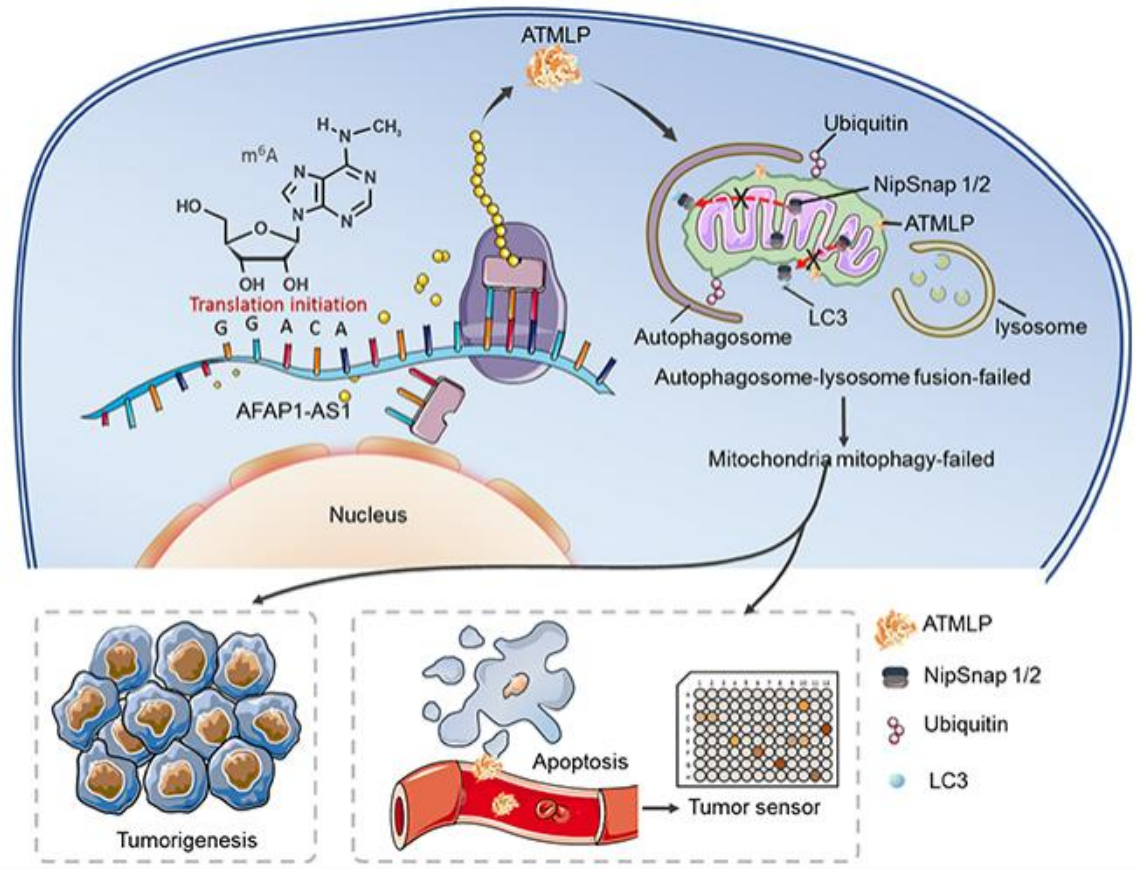

图 1.2 ATMLP 通过阻断受损线粒体与溶酶体的结合导致线粒体自噬逃逸

3、T 细胞免疫调控新机制

外周初始 CD4+T 细胞识别抗原并在特定因素刺激下被活化，分化为具有不同功能的 T 细胞亚群，如 Th1、Th17、Th2、Treg，是机体免疫应答与免疫调控的核心。以往研究从抗原浓度与亲和力、共刺激与共抑制分子信号、炎症因子类型和代谢调控等多角度，揭示了初始 CD4+ T 细胞分化为不同亚群的调控特征与机制。然而，是否外周初始 CD4+ T 细胞向不同亚群分化的能力可以被其在胸腺发育过程中所接触的微环境信号所决定仍不清楚。该研究发现，胸腺细胞的双阴性（DN）阶段是决定外周 Treg 分化命运的重要调控窗口，易于受到胸腺基质微环境中油酸可利用性的影响，为理解 CD4+ T 细胞的免疫调节提供新视角。

硬脂酰辅酶 A 去饱和酶（stearoyl CoA desaturase, SCD）是催化来源于食物或者从头合成的饱和脂肪酸转变为单不饱和脂肪酸（油酸与棕榈油酸）的限速酶。其中，人类基因组中的 2 个 SCD 基因均与小鼠 SCD1 基因高度同源。研究发现，

SCD1 缺失显著促进小鼠外周血、淋巴结以及主要组织器官中 Foxp3+ Treg 的数量与比例，并赋予其抵抗自身免疫性疾病的能力，这一现象与 SCD1 缺失促进初始 CD4+ T 细胞向 Treg 分化密切相关。利用条件性敲除小鼠、骨髓移植、胸腺移植和 T 细胞体外发育等体系，研究揭示 SCD1 在胸腺上皮细胞中的缺失是导致初始 CD4+ T 细胞向 Treg 的分化倾向性增加的主要原因，而非 SCD1 在 T 细胞中缺失所引起。更为重要的是，胸腺上皮细胞油酸的可利用性影响初始 CD4+T 细胞向 Treg 分化潜能的关键窗口期是胸腺细胞 DN2 向 DN3 的发育阶段。在油酸缺乏的胸腺微环境中，胸腺细胞内表观遗传修饰酶 DOT1L 活性上调，借以 H3K79me2 修饰促进 DN3 胸腺细胞中 Atp2a2 基因座的染色质开放水平。这一表观遗传学印记从 DN3 阶段一直保留至初始 CD4+ T 细胞，使其在接受 T 细胞受体激活信号时，通过 ATP2A2——calcium——NFAT——Foxp3 信号轴促进其向 Treg 分化。该项研究首次揭示胸腺基质微环境中的油酸信号影响和预编程外周 T 细胞亚群分化偏好性的细胞与分子机制，不仅为理解不同生理病理环境中 T 细胞免疫调控机制提供了新视角，也为 Treg 的定向高效诱导及其在器官移植、自身免疫性疾病等治疗中的应用提供新策略与新方向。

相关成果以“Oleic Acid Availability Impacts Thymocyte Preprogramming and Subsequent Peripheral Treg Cell Differentiation”为题发表于 Nature Immunology（2023, doi: 10.1038/s41590-023-01672-1.）。

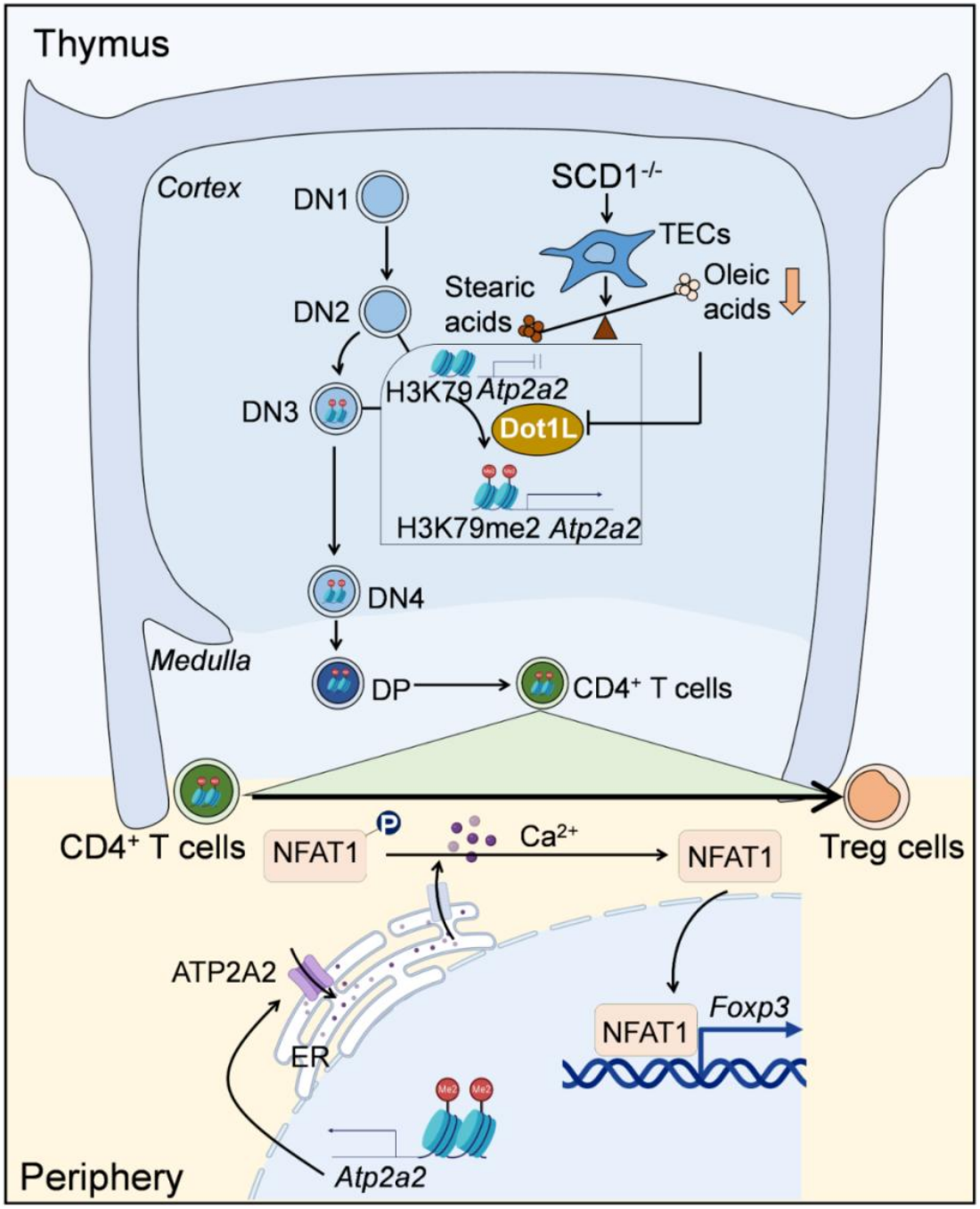

图 1.3 胸腺基质微环境中油酸的可利用性影响发育中 T 细胞，

预编程其成熟后向 Treg 分化的细胞与分子机制

（二）先进放射诊断和治疗

1、搭乘免疫细胞，促进放射免疫治疗

基于细菌的药物递送策略由于其可基因工程、物理化学修饰与免疫激活特性等，近年来在肿瘤治疗方面受到了广泛的关注。然而，无论是活细菌还是灭活细菌载体在进入体内后大部分会被免疫细胞吞噬并逐渐清除，这大大降低了基于细菌载体的递送效率。而利用免疫细胞（如巨噬细胞、中性粒细胞等）的趋炎效应实现对载体的靶向递送已经被证明是可行的，其不仅能够提高药物递送的效率，还能降低对正常组织的副作用。因此，在合适的时机借助吞噬类免疫细胞对微米级细菌载体进行增强递送可能是一个有效的策略，以优化基于细菌的递送方法。

放疗作为肿瘤治疗的最常用手段之一，除了可以直接通过高能电离辐射杀死或损伤肿瘤细胞外，还可以引起肿瘤局部产生更强烈的炎症反应从而招募更多的免疫细胞，因此，或许可以利用 X 射线产生的肿瘤炎症来进一步提高免疫细胞对细菌载体的递送。

实验室杨凯教授团队在前期的实验中，团队人员偶然发现尾静脉注射的微米级的灭活 VNP20009 细菌载体也可以在肿瘤部位富集，通过流式细胞术分析发现灭活 VNP20009 细菌进入体内后主要被 CD11b+免疫细胞内吞，并上调血液中 CD11b+免疫细胞的比例。因此，团队人员推测在肿瘤富集的 VNP20009 细菌可能主要是通过 $CD11b^{+}$免疫细胞的趋炎作用从而搭乘便车至肿瘤部位。基于上述观点，团队人员随后设计并通过一步还原法制备了双金属纳米酶涂层的 VNP20009 细菌载体（Au-Pt@ VNP20009，APV），在体外验证了 APV 的特性（高 CAT 活性、放疗增敏效应与激活 cGAS-STING 通路）。在体内，利用 2 Gy X 射线预照射引起更强的肿瘤炎症，进一步协助增强趋炎类免疫细胞对 APV 的递送效率。通过流式细胞术和 IVIS 荧光成像验证了 X 射线协助 APV 搭乘 CD11b+免疫细胞的便车增强肿瘤靶向递送策略的可行性。当 APV 被协助递送至肿瘤后，可以有效解除肿瘤缺氧微环境并促进巨噬细胞 M1 极化和 DC 细胞成熟，从而提高放疗疗效与抗肿瘤免疫反应。最后，在联合 6 Gy 放疗和αPD-L1 后可以促进 CD8+ T 细胞与 NK 细胞在肿瘤的浸润，显著抑制肿瘤的生长和转移。总之，本研究成功利用 X 射线协助增强微米级纳米酶涂层细菌载体的肿瘤靶向递送并阐明了其中机理，为优化细菌基载

体的递送策略开辟了新方法，同时为多功能细菌载体与肿瘤放射免疫治疗的有机结合提供了新思路。

相关成果以“Nanozyme-coated bacteria hitchhike on CD11b+ immune cells to boost tumor radio-immunotherapy”为题发表在《Advanced Materials》。

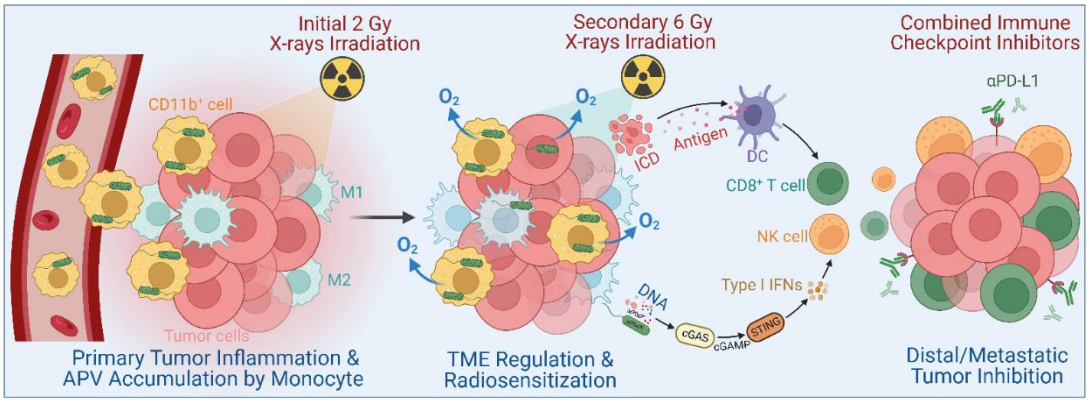

图 2.1 二氢卟吩 e4 的余辉发光过程示意图

2、抗肿瘤 BNCT 纳米硼药

硼中子俘获治疗（Boron Neutron Capture Therapy, BNCT）是一种近年来广受关注的肿瘤靶向放射疗法，于 2020 年在日本获批用于临床治疗。 BNCT 治疗需要先将足量的硼-10（10B）同位素递送到肿瘤组织中，再利用热中子对肿瘤进行照射，10B 原子与热中子碰撞发生核裂变反应产生具有高传能线密度的α粒子和反冲 7Li 从而杀死肿瘤细胞。临床 BNCT 治疗要求每克肿瘤组织 10B 含量不少于 20 μg，而且肿瘤组织和正常组织 10B 含量之比（T/N）大于 3。因此，开发肿瘤靶向硼药对提升 BNCT 疗效至关重要。目前临床上使用的第二代硼药，即 BPA 和 BSH，对肿瘤的靶向性都不够理想，而且在瘤内的滞留时间短。因此，亟需研发具有更高肿瘤 10B 递送效率和 BNCT 疗效的新一代硼药。含硼纳米颗粒可携带大量 10B，而且能通过增强渗透滞留（EPR）效应靶向蓄积于肿瘤组织，是一类具有潜力的新型硼药。

实验室赵利副教授团队及其合作者通过在富含 10B 纳米氮化硼纳米颗粒表面共价接枝聚丙三醇（PG）制备了一种新型 BNCT 硼药 h-10BN-PG（图 1a）。由于纳米 10BN 内核尺寸小（直径约 8 nm，图 1b）、PG 修饰层的亲水性高，h-10BN-PG

在各种水溶液中具有极高的分散性（生理盐水中> 6.0 mg 10B/mL）和胶体稳定性，有利于通过静脉注射方式给药。同时，PG 层抑制蛋白在 h-10BN-PG 表面非特异性吸附形成蛋白冠，从而有效规避单核吞噬细胞系统的识别与清除。体外实验表明 h-10BN-PG 兼具低细胞毒性和良好的三维肿瘤细胞球渗透能力。体内组织分布实验显示 h-10BN-PG 经尾静脉注射后能通过 EPR 效应在 CT26 皮下结肠癌中高效蓄积（图 1c），注射 12 小时后肿瘤内 10B 浓度可达 8.8%ID/g 或者 102.1 μg/g，而且 T/N 达到 7.6，远超临床 BNCT 治疗要求，亦明显优于目前临床上使用的硼药 BPA。进一步研究发现蓄积在肿瘤组织中的 h-10BN-PG 随时间逐渐被肿瘤细胞摄取。在此基础上，研究团队在京都大学反应堆中子源上开展了 h-10BN-PG 介导的 BNCT 治疗实验。得益于 h-10BN-PG 的高 10B 递送效率和高肿瘤渗透特性，仅一次药物注射和一次中子照射就几乎完全清除了 CT26 肿瘤病灶（图 1d, 1e），而且未引起明显的副反应。治疗机制研究发现 h-10BN-PG 介导的 BNCT 导致 CT26 细胞发生 DNA 双链断裂，进一步导致细胞死亡。同时，BNCT 产生的免疫原性细胞死亡激活了抗肿瘤免疫反应，因此在中子照射结束后仍然能够持续抑制肿瘤生长。上述结果表明 h-10BN-PG 是一种高效的 BNCT 硼药，同时具有制备方便、生物相容性好、能被代谢出体外等特点，因此具有良好的临床转化前景。在此基础上，研究团队进一步发现 h-10BN-PG 亦能在小鼠原位胶质瘤内高效蓄积，提示其在胶质瘤 BNCT 治疗方面具有潜力，相关研究正在进行之中。

该研究以“Tumor Eradication by Boron Neutron Capture Therapy with 10B-enriched Hexagonal Boron Nitride Nanoparticles Grafted with Poly(Glycerol)”为题于 7 月 20 日正式发表于 Advanced Materials（论文链接：https://doi.org/10. 1002/adma.202301479）。

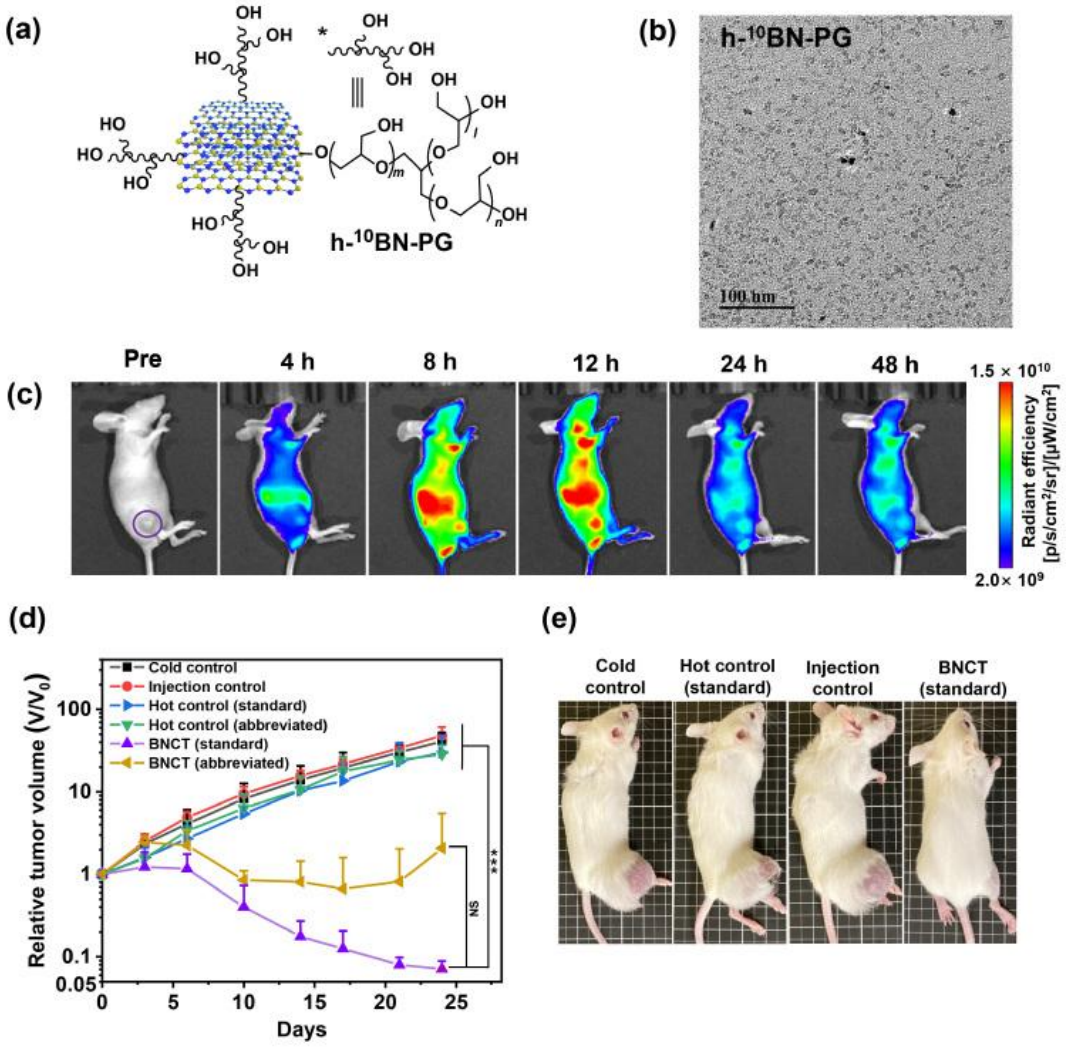

图 2.2 纳米硼药 h-10BN-PG 的化学结构、表征及治疗效果

3、治疗型核素 Ac-225 的体内监测

医用放射性核素 ^{225}Ac 半衰期为 10 天，多次衰变发射 5.8 到 7.1MeV 能量的α粒子，被认为是现阶段最具有应用潜力的α放射性核素。然而α粒子杀伤肿瘤细胞是没有选择性的，正常组织中 ^{225}Ac 核素会产生巨大的损伤。因此在治疗期间实时观测 ^{225}Ac 药物的生物分布具有十分重要的意义。治疗剂量的 ^{225}Ac 放射性核素不能产生足够的可成像光子（γ光子）或正电子（β+电子），阻碍了 ^{225}Ac 放射性药物的监测。近期国际同行提出了利用 ^{68}Ga（$t_{1/2}$= 67.7 min）、^{64}Cu（$t_{1/2}$= 12.7 h）以及镧系同位素（^{132}La，^{133}La，^{134}La，^{134}Ce）等作为 ^{225}Ac 的诊疗配对核素，用于间接的判断 ^{225}Ac 分布。然而，治疗过程中实时监测 ^{225}Ac 生物分布仍然是本领域未解决的问题，这进一步限制了 ^{225}Ac 医用核素的临床应用。

王殳凹教授和王亚星教授团队以发射高穿透性红色荧光的纳米 EuMOF 原位标记 ^{225}Ac。Eu^{3+}与 $^{225}Ac^{3+}$相近的离子半径以及相同的氧化态，可以将 $^{225}Ac^{3+}$限制在 Eu^{3+}的晶格位点上。相邻晶格中 ^{225}Ac 及其邻近 Eu 的范围为 4.750 到 13.083 Å，^{225}Ac 衰变产生的α粒子主要倾向于沉积在大原子序数 Eu^{3+}上，能够促进α粒子到 Eu^{3+}高效能量转移，进而产生足够的光子清晰成像。研究发现，EuMOF 对医用放射性核素 ^{225}Ac 具有良好的标记能力，1min 内达到 70%的标记率，同时具有良好的标记稳定性。另外，EuMOF 对 ^{225}Ac 的衰变子体也有良好的限制能力。利用小动物成像收集材料在 500 到 845 纳米处的自发荧光信号，相较于简单的 $^{225}Ac/Eu^{3+}$（1μCi）混合溶液而言，被限制在 Eu^{3+}晶格位点的 ^{225}Ac-labeled EuMOF 具有明显的荧光现象。活体实验证明 ^{225}Ac-labeled EuMOF 的生物分布与小动物成像的荧光信号成正相关。^{225}Ac-labeled EuMOF 对于肿瘤有着明显的抑制生长的效果，主要受益于纳米颗粒在肿瘤中长时间的滞留能力，以及 ^{225}Ac 及其子体衰变产生的α粒子对于肿瘤高效的杀伤效果。

相关研究成果以“A Radioluminescent Metal-Organic Framework for Monitoring ^{225}Ac in Vivo”为题发表在 *J.Am.Chem.Soc.*期刊。

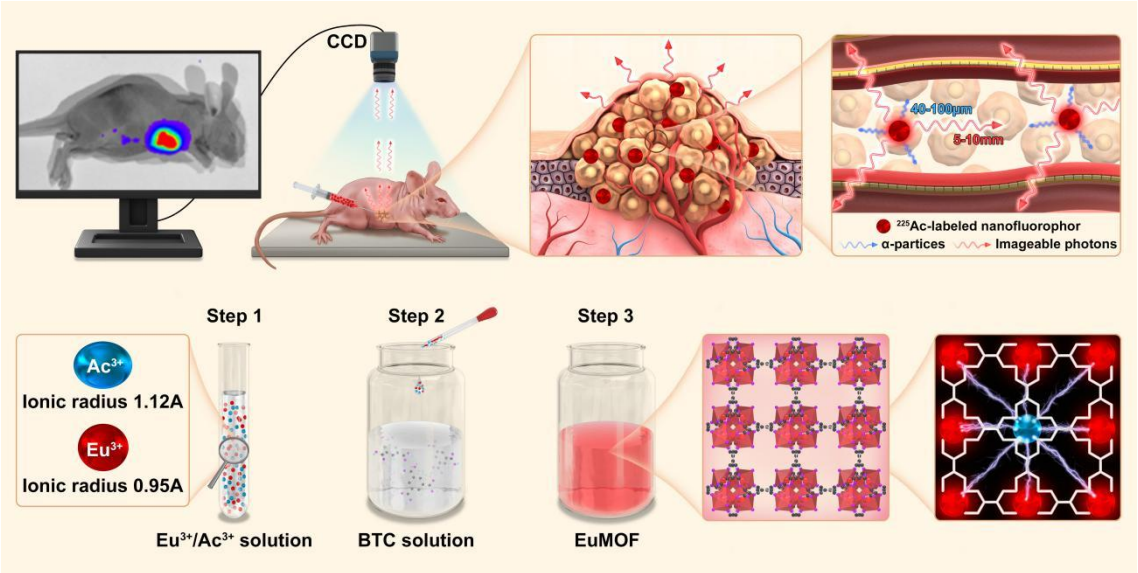

图 2.3 通过光学成像的方式利用放射性自发荧光材料监测 225Ac 在体内的生物分布

（三）辐射防护

1、镅的固体化学和分离化学研究

目前，能源短缺危机以及碳排放问题正让世界各国重新审视核电发展的重要性。然而，作为核能可持续发展的前提，如何安全高效处理处置核燃料循环所产生的强放射性核废料，仍是尚未解决的世界性难题。

研究表明，核废料经过铀钚分离后对于环境危害最大的是次锕系元素镅，其具有多个长半衰期放射性同位素（如镅-241 和镅-243）。镅是核能发电过程的副产物，也是核废料长期放射毒性的主要来源。镅的分离嬗变技术是目前最受认可的处置方式和研究热点，其核心思想是将镅进行高效分离并通过中子嬗变使其变为低毒性、短寿命的核素。此技术如能实现，将使得核能开发对人类社会带来的负面效应大幅降低，因此对全球核电的可持续发展具有重要意义。

传统的观点认为镅的化学性质与三价镧系元素十分相似，而镧系元素作为中子毒物又会显著影响镅的嬗变效率。因此，三价镧锕分离既是目前核废物处置中最具挑战的科学问题之一，又是为解决核废料长期放射毒性问题所要克服的一个重大技术瓶颈问题。如能将三价镅氧化到六价，利用六价镅与三价镧系在配位构型上的差异实现分离，可有望从根本上解决镧锕分离难题。然而，六价镅属于镅的非常规价态，在传统萃取分离过程中仅能存在数秒时间，极易被还原为三价，从而再次造成分离困难。此前，国际上未见可行性策略能够稳定六价镅从而实现有效的镧锕分离。

实验室王殳凹教授团队联合清华大学、美国科罗拉多矿业大学、德国于利希研究中心、上海科技大学等放射化学领域研究人员，从六价镅的配位化学性质出发，设计了一例可精准匹配六价镅配位构型的无机缺位多酸簇合物。该多酸簇合物通过与六价镅离子间的强络合作用形成水溶性纳米级复合物，从而率先实现了水溶液中六价镅的超长时间稳定。研究团队据此发展了一种基于镧锕物种尺寸差异的新型超滤分离方法（图 1），可潜在应用于我国乏燃料后处理、放射性污染控制、放射性同位素分离纯化、放射化学诊断分析等系列重要任务中。该研究成果以“Ultrafiltration separation of Am(VI)-polyoxometalate from lanthanides”为题于 2023 年 4 月 20 日发表在 Nature 期刊上，论文链接：https://www.nature.com /articles/

s41586-023-05840-z。

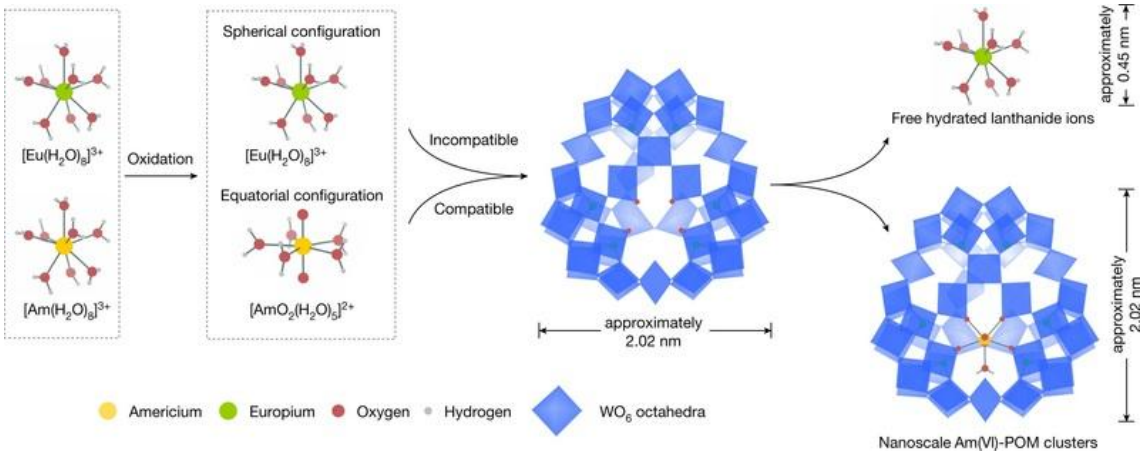

图 3.1 新型镧锕分离示意图

2、辐射化学合成富缺陷 ZIF-7 框架材料

金属有机框架材料（MOF）是由金属节点和有机配体构筑形成的一类新型多孔材料，具有高比表面积、高孔隙率和高度可修饰性等优点，在众多领域得到广泛的应用。在 MOF 中引入缺陷可以进一步调控材料的物理化学性质，在吸附分离、能带结构、机械响应和催化等重要领域得到了广泛的研究。目前合成缺陷 MOF 的主要方法是合成后处理，主要包括使用热、激光和无机酸或碱刻蚀材料，在材料中产生缺陷。通过合成后处理的方式可以提升材料中的缺陷含量，但会显著影响材料的结晶度，甚至导致材料转变为无定形产物。目前，在不牺牲母体 MOF 内在特性（例如稳定性、结晶度、表面积和孔隙率）的情况下，MOF 的缺陷工程仍有待进一步研究。苏州大学放射化学研究团队在国际上率先开展了辐射化学合成晶态多孔材料的研究，在共价有机框架材料（J. Am. Chem. Soc.2020, 142, 20, 9169-9174.）；沸石分子筛（Angew. Chem. Int. Ed., 2021, 60, 14858-14863.）；金属有机框架材料（Angew. Chem. Int. Ed., 2022, 61, e202212532.）中已经取得一系列前期研究成果，有望解决晶态多孔材料批量化工业生产的难题。近期，我们进一步拓展了该合成方法，成功实现了原位一步合成富缺陷且高结晶度的 ZIF-7 框架材料。

实验室王殳凹教授研究团队率先使用工业钴源产生的伽马射线促进 ZIF-7 的合成。在室温常压下，前驱体溶液在伽马射线照射 50 kGy 后即可得到高结晶度的 ZIF-7 材料。同时，伽马射线可以原位刻蚀 ZIF-7 结构，从而产生晶体缺陷，实现等级孔结构的构筑，提供了一条缺陷 MOFs 合成的全新路径。通过粉末衍射

（PXRD）、固体核磁（MAS-SSNMR）和氮气吸附等测试，对 ZIF-7 材料进行系统表征。结果显示，辐射合成的 ZIF-7 材料相较于传统水热合成的 ZIF-7 材料具有更高的结晶度和比表面积。此外，可以进一步改变吸收剂量调控合成材料的富缺陷程度。通过二维 1H-13C 固体异核化学位移二维谱（HETCOR）、X 射线光电子能谱（XPS）和 X 射线吸收精细结构谱（XANS）确定了 ZIF-7 中-NH 和-OH 缺陷的存在形式。通过 13C 自旋晶格弛豫时间，半定量地表征样品体系中基团的局部运动性，确定了 ZIF-7-200 kGy 和 ZIF-7-solvothermal 中的缺陷含量。同时，通过三维电子衍射和原位高分辨透射电镜表征证明了辐射合成 ZIF-7 材料中的缺陷为无序缺陷，结构与常规溶剂热合成相同。

相关工作以 Article 形式发表于 Journal of the American Chemical Society 上（J. Am. Chem. Soc. 2023, DIO: 10.1021/jacs.3c07778）。论文链接：https://pubs. acs.org/doi/abs/ 10.1021/jacs.3c07778。

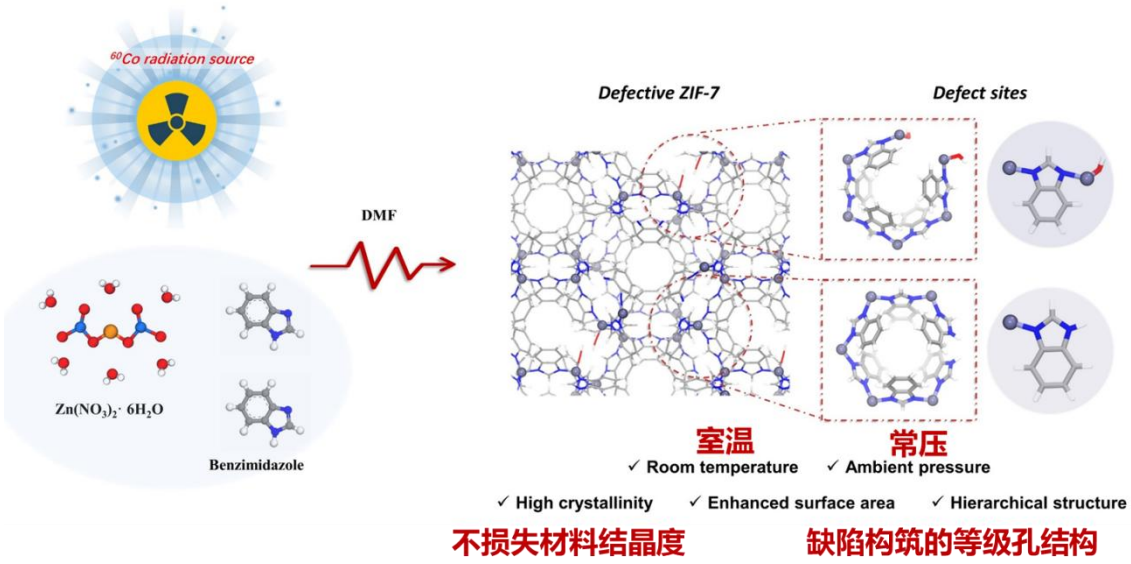

图 3.2 伽马射线辐射合成富缺陷 ZIF-7 框架材料

3、射线响应性水凝胶光子材料剂量计

实验室胡亮副教授和苏州大学材化部陈红教授团队等将 X 射线敏感性不同的化学交联剂引入 PNIPAm 微凝胶中，通过热镀金属和“涂覆”方法，成功构建 Au-微凝胶-Au 夹心光子材料。辐照致水分解产生 OH 自由基，从而导致交联剂发生断裂，因此微凝胶体积膨胀。微凝胶体积的膨胀增大两金属层之间的距离，因而光

子材料的光信号（λref）及其颜色发生变化。凭借这种新颖的化学-机械-光学信号转换策略，通过引入不同的交联剂，赋予光子材料不同的 X 射线剂量响应范围和不同的最低检测下限。其中，基于双碲键交联的 PNIPAm 微凝胶基光子材料显示出超高灵敏度（101.63 nm/Gy），最低检测下限为 0.2 Gy。

创新地构建了 X 射线响应性微凝胶基光子材料，并成功用于 X 射线剂量测量。成果以《X-Ray Triggered Color-Tunable Microgel-Based Interferometers for Radiation Dose Sensing》发表在《Chemical Engineering Journal》（2023，doi：10.1016/j.cej.2023.142519）。

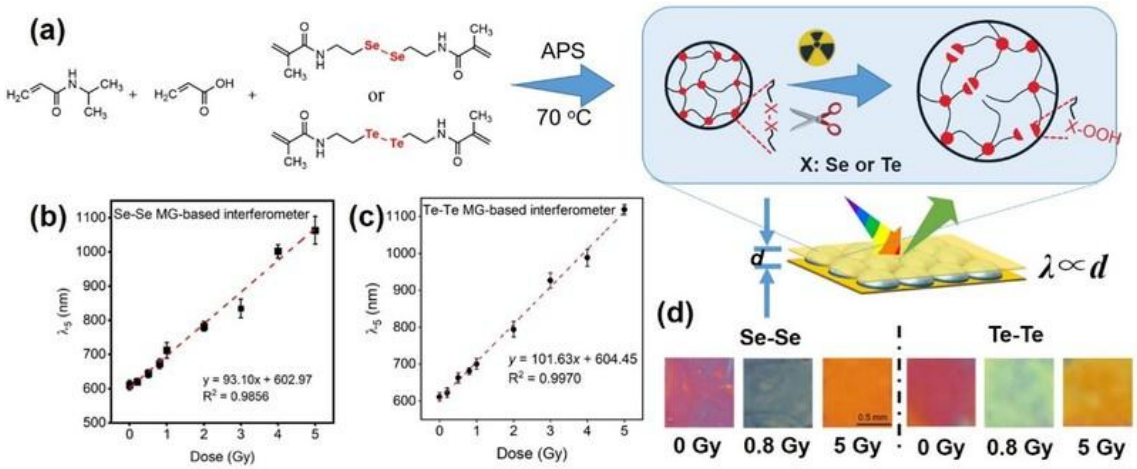

图 3.3 X 射线响应性微凝胶基光子材料合成及性能

五、新增科研项目

序号	项目类别	项目名称	项目编号	项目负责人	总经费(万元)
1	省协同创新中心	省放射医学协同创新中心	SX12800117	柴之芳	972
2	省优势学科	省特种医学优势学科	YX12800211	柴之芳	840.00
3	一流培育学科项目	特种医学一流培育学科	YL12800123	曹建平	200
4	国家重点研发计划子课题	细胞微颗粒纳米药物的体内过程与肿瘤靶向研究	2022YFA1206002	陈华兵	614.2
5	国家自然科学基金杰青项目	智能光控肿瘤诊疗研究	T2325019	史海斌	400
6	国防科工局核能开发项目	低活度含氚废水浓缩去除新材料与新工艺研究	######	王殳凹	350
7	“叶企孙”科学基金重点项目	面向乏燃料溶解液微颗粒筛分的复合膜制备及应用研究	U2341289	王亚星	259
8	国家自然科学基金重点项目	T 细胞代谢调控在 aGVHD 中的作用和机制研究	82330008	吴德沛	220
9	国家自然科学基金重点项目	用于胰腺癌光免疫协同治疗的单分子白蛋白纳米粒及其增敏机制研究	32330060	陈华兵	212
10	国家自然科学基金面上项目	中国南海环境中 Pu、Np 的清除机制和空间迁移模拟的研究	42373006	刘志勇	54
11	国家自然科学基金面上项目	富含硼-10 纳米氮化硼介导的脑胶质瘤靶向硼中子俘获治疗及其机制研究	12375347	赵　利	54
12	国家自然科学基金重点项目参与	热带海洋铀资源富集化学动力学增强机制研究	U23A20104	王宁（王艳龙）	52
13	国家自然科学基金面上项目	双重生物响应性自佐剂聚多肽载体构建高效 mRNA 癌症疫苗	52373299	邓超	50
14	国家自然科学基金面上项目	具有胞浆传输特性的智能生物高分子载体及其在 p53 突变型肿瘤免疫治疗中的应用	52373298	杨　涛	50
15	国家自然科学基金面上项目	用于富集和浓缩放射性气态流出物中 Kr、Xe 的多孔材料的理论设计与实验验证	22376153	王艳龙	50
16	国家自然科学基金面上项目	肿瘤微环境响应性多氧钨酸盐复合材料的构建及放射免疫治疗研究	52372270	杨光保	50

序号	项目类别	项目名称	项目编号	项目负责人	总经费(万元)
17	国家自然科学基金面上项目	TECRL 通过 EGR2 调控卫星细胞功能修复骨骼肌损伤的机制研究和治疗策略	82370501	宋耀华	49
18	国家自然科学基金面上项目	生物力学传导通路 mechano-YAP/TAZ 对放射损伤引起的勃起功能障碍中组织再生和功能修复的研究	82373525	畅　磊	49
19	国家自然科学基金青年项目	基于解析解的高精度介电特性成像方法及其在肿瘤诊断中的应用	62301351	刘春毅	30
20	国家自然科学基金青年项目	基于连续黄金角径向采样的胸部磁共振快速成像算法研究	62301352	单善善	30
21	2023 年度国家科学技术学术著作出版基金	简明核应急心理学	2023-174	刘玉龙	8
22	江苏省双创团队	江苏省双创团队	JSSCTD202211	高明远	300
23	江苏省杰出青年基金项目	超灵敏金辉发光探针用于肿瘤精准诊断分析的研究	BK20230009	苗庆庆	150
24	江苏省部级项目	环境中高 LET 粒子辐射生物效应及应用研究的联合研发	BZ2023008	周光明	120
25	江苏省特聘教授	江苏省特聘教授	/	徐　鹏	100
26	江苏省部级项目	225Ac 体外生物物理行为研究	CIRP-CAEA20230201	王广林	15
27	苏州市一流学科建设项目	特种医学（放射医学）基础研究项目	SJC2023001	柴之芳	600
28	市厅级项目	布拉格三联治疗方案改善晚期难治性结肠癌疗效的临床研究与机制探讨	GSWS2022028	张力元	100
29	市厅级项目	代谢异质性与白血病发生发展	ZXL2023344	陈　冬	50
30	市厅级项目	同步辐射近常压光电子能谱(AP-XPS)对 In/Co-MOFs 及其衍生物的气敏机理研究	KJS2307	张　朵	4
31	市厅级项目	南海环境中 Pu、Np 的清除机制和空间迁移模拟	KLSG2303	刘志勇	2
32	市厅级项目	单晶 X 射线衍射仪与全自动物理吸附仪联用原位解析惰性气体吸附在金属有机框架材料孔道里的结构模式	TC2023A041	陈兰花	2

序号	项目类别	项目名称	项目编号	项目负责人	总经费(万元)
33	苏州医学院青年科技人才项目（A 类）	人多能干细胞与心血管疾病干预策略	YXY2301001	胡士军	100
34	苏州医学院青年科技人才项目（A 类）	基于生物材料的肿瘤放射免疫治疗	YXY2301007	杨　凯	100
35	苏州医学院青年科技人才项目（A 类）	纳米颗粒的示踪与毒理学研究	YXY2301008	李瑞宾	100
36	苏州医学院青年科技人才项目（A 类）	面向核应急的锕系元素促排药物研究	YXY2301009	第五娟	100
37	苏州医学院青年科技人才项目（B 类）	生物高分子药物载体	YXY2302014	杨　涛	50
38	苏州医学院青年科技人才项目（B 类）	免疫调节佐剂构建与增效放射免疫治疗研究	YXY2302016	杨光保	50
39	苏州医学院青年科技人才项目（B 类）	成簇基因表达调控与血液疾病	YXY2302018	徐　鹏	50
40	苏州医学院医药学+X 重点项目	胸腺衰老的多维信息解码与免疫评价新模式	YXY2303020	时玉舫	100
41	苏州医学院医药学+X 重点项目	用于胰腺癌放疗增敏治疗的新型氧化铪纳米粒及其协同增敏机制研究	YXY2303024	陈华兵	100
42	苏州医学院医药学+X 重点项目	超小 Cu2-xSe 纳米颗粒用于脑胶质瘤免疫治疗的生物学效应机制研究	YXY2303025	李　桢	100
43	苏州医学院医药学+X 重点项目	基于“血管-免疫互作”影像特征的 AI 辅助肿瘤免疫治疗策略	YXY2303028	黄玉辉	100
44	苏州医学院医学交叉种子基金	铀促排的分子机理研究与促排剂的设计	YXY2304031	代　星	20
45	苏州医学院医学交叉种子基金	面向放疗/光疗协同的卟啉基星型聚合物及其单分子胶束材料的合成及抗肿瘤研究	YXY2304032	何伟伟	20
46	苏州医学院医学交叉种子基金	高暴露风险纳米材料对呼吸道菌群及肺癌进展的影响研究	YXY2304033	田　欣	20
47	苏州医学院医学交叉种子基金	双硒水凝胶放疗剂量计的构建及其机制研究	YXY2304034	胡　亮	20
48	苏州医学院医学交叉种子基金	基于 HMGB1 相关免疫因子探讨放射性肠炎早期防治策略	YXY2304035	赵　琳	20
49	苏州医学院医学交叉种子基金	高效、稳定的 225Ac 放射性微球的制备与放射栓塞研究	YXY2304038	王广林	20
50	企业合作项目	药物标记和生物分布验证 3	H230348	王广林	80.4

序号	项目类别	项目名称	项目编号	项目负责人	总经费(万元)
51	企业合作项目	药物标记和生物分布验证 4	H230966	王广林	80.4
52	企业合作项目	益生菌通过机体免疫调节辅助肿瘤放化疗的评价研究	H230473	王杨云	50
53	企业合作项目	核医学质控系统研发	H230820	屈卫卫	35
54	企业合作项目	军工保密	H230997	王杨云	35
55	企业合作项目	藏药辐照灭菌技术及效果评价研究	H230041	华道本	33.6
56	企业合作项目	孙亮科研（核与辐射事故…）	P112882523	孙亮	30
57	企业合作项目	高剂量率 r 射线对茶叶及阵列探测器的辐照服务	P112800923	周光明	25.5
58	企业合作项目	核医学生物技术服务	H230967	何伟伟	20
59	企业合作项目	基于钙钛矿($CsPbBr_3$)半导体的γ射线能谱测量技术研究	HS-2023J-025	何亦辉	20
合计					**7508.1**

六、国内外学术交流

1、主办、承办会议

序号	会议名称	会议类型	主办/承办	会议日期	参会人数	会议地点
1	2023 年放射医学与生物分析前沿交叉学术研讨会	区域性	主办	2023-12-02	300	苏州市
2	第五届苏州国际医学影像研讨会暨第三届苏州国际眼科人工智能论坛	全国性	主办	2023-11-11	150	苏州市
3	2023 年国家级继续教育项目《核和辐射损伤医学应急演练与临床处理》培训班	全国性	主办	2023-11-8	100	苏州市
4	2023 年中国核学会核应急医学分会学术交流研讨会	全国性	主办	2023-11-8	100	苏州市
5	2023 年有机高分子材料青年学者战略研讨会	区域性	主办	2023-10-31	60	苏州市
6	第二届苏港澳聚集诱导发光研讨交流会	全国性	主办	2023-10-29	200	苏州市
7	2023 辐射生物学国际研讨会议	全国性	主办	2023-09-22	141	苏州市
8	全国放射医学专业规划教材编写论证会	全国性	承办	2023-09-15	40	苏州市
9	2023 苏州大学东吴有机合成化学国际研讨会	全国性	主办	2023-04-17	200	苏州市

2、专家来访

序号	时间	报告人	主题	单位
1	2023-11-7	冉新泽	放射复合伤研究	陆军军医大学
2	2023-11-7	江其生	核应急体系建设	火箭军特色医学中心
3	2023-9-4	杜晓平	Crosstalk between integrins and G protein-coupled receptor pathway and implication in treating thrombo-inflammatory conditions	美国伊利诺伊大学
4	2023-07-14	李开龙	肿瘤功能基因组学研究	北京大学
5	2023-09-07	王立新	医学免疫学	东南大学
6	2023-10-31	庞代文	2023 年诺贝尔化学奖解读	南开大学
7	2023-3-02	张瑞平	近红外二区荧光成像	山西医科大学
8	2023-03-21	戴俊彪	酵母基因组的设计与合成	中国科学院深圳先进技术研究院
9	2023-03-21	马英新	单病毒标记与示踪	中国科学院深圳先进技术研究院
10	2023-03-28	宁甲甲	Phase-Effect in Colloidal Semiconductor Nanocrystals	吉林大学
11	2023-05-06	Sergei Remennik	Electron Diffraction for beginners	Hebrew University of Jerusalem
12	2023-05-08	余　瞬	Colloidal Semiconductor Magic-Size Clusters: Direct and ndirect Pathways of Isomerizatior at Room Temperature	四川大学
13	2023-10-18	钱　骏	近红外二区荧光活体成像：原理、探针、系统及应用	浙江大学
14	2023-10-30	陈巍海	生物大分子功能化 NMOF 材料的生物医用研究	武汉大学
15	2023-05-26	徐静娟	基于微纳探针的单细胞测量与分析策略	南京大学
16	2023-10-12	夏佳文	重离子治疗技术现状与未来	中科院近代物理研究所
17	2023-09-23	李川源	Identifying novel targets for cancer radiotherapy and immunotherapy	杜克大学

序号	时间	报告人	主题	单位
18	2023-09-23	Reitz	Radiation risk in Space	德国空间中心
19	2023-09-15	朱双龙	全国放射医学专业规划教材编写	人民卫生出版社
20	2023-05-12	Tom k.Hei	博士答辩	哥伦比亚大学
21	2023-03-20	宋明涛	加速器工作专班讨论	中科院近代物理研究所
22	2023-02-27	李力、刘效仿、陆嘉德	签订战略合作协议	和祐国际医院（筹）
23	2023-11-27	刘圆圆	极低本地人体痕量核素测量	北京师范大学
24	2023-11-18	周子健	针对小分子/离子的磁共振成像分子影像及其诊疗应用研究	厦门大学
25	2023-11-18	杨　军	肿瘤分子影像	云南省肿瘤医院
26	2023-05-19	郭　敏	高时空分辨率荧光显微成像	浙江大学
27	2023-04-10	平轶芳	胶质瘤血管病理学特征及诊疗意义	陆军军医大学病理学研究所
28	2023-04-04	刘晓丽	肝癌纳米磁热疗	西安交通大学第一附属医院
29	2023-04-04	高利增	纳米酶的酶学特性及生物医学应用研究	中国科学院生物物理研究所
30	2023-03-02	徐慧珊	如何在学术期刊发表文章	爱思唯尔出版社
31	2023-03-02	谢金兵	高分子纳米材料用于疾病诊疗的研究	东南大学
32	2023-04-01	Deivendran Rengaraj	Dissecting the developmental dynamics of the chicken germ cells together with the human fetal germ cells	浙江大学医学院附属第四医院
33	2023-04-04	焦建伟	神经干细胞及脑发育激励研究	中国科学院动物研究所
34	2023-04-04	赵建国	基因编辑猪的生物医学应用	中国科学院动物研究所
35	2023-04-04	柴人杰	通过基因治疗促进内耳干细胞再生功能性毛细胞的研究	东南大学
36	2023-04-13	邓文波	母体蜕膜异质性在分娩启动过程中的作用	厦门大学
37	2023-04-13	鞠振宇	器官衰老的共性机制研究	暨南大学

序号	时间	报告人	主题	单位
38	2023-04-13	王秀杰	人类心脏组织和多器官细胞模型的体外构建	中国科学院遗传与发育生物学研究所
39	2023-05-10	艾珊珊	Probing Epigenetic Basis Underlying Heart Development and Regeneration through Single-cell ChIP Sequencing	南方医科大学
40	2023-06-16	王永明	基因编辑工具开发与基因治疗	复旦大学
41	2023-06-16	孙　诚	LncRNA266 在诱导白色脂肪细胞棕色化中的作用研究	南通大学
42	2023-06-16	刘　东	Fishing the novel regulators in endothelial cells	南通大学
43	2023-06-16	史　辉	肺癌的细胞治疗和肿瘤疫苗的研究进展	上海市胸科医院
44	2023-07-05	应　征	细胞器质量控制系统和神经退行性疾病	苏州大学
45	2023-07-17	秦建华	器官芯片技术及其在生物医学领域应用	中国科学院大连化学物理研究所
46	2023-08-29	曲　静	Endogenous retrovirus as a hallmark and driving force of cellular senescence and tissue aging	中国科学院动物研究所
47	2023-09-04	Jianyi(Jay)Zhang	modRNA Therapeutics vs. hiPSC-derived Cell and Cell-products for Myocardial Repair in Large Mammals:Remuscularization of injured ventricle	University of Alabama at Birmingham(UAB)
48	2023-10-17	田维明	空间环境地面模拟国家大科学工程在空间生命研究中的应用	哈尔滨工业大学
49	2023-11-15	李天晴	干细胞多能性与组织器官修复	昆明理工大学
50	2023-11-7	冉新泽	放射复合伤研究	陆军军医大学
51	2023-11-7	江其生	核应急体系建设	火箭军特色医学中心
52	2023-11-30	刘圆圆	先进内污染人员直接监测	北京师范大学
53	2023-07-14	李开龙	肿瘤功能基因组学研究	北京大学

3、参加会议

序号	会议名称	会议地点	报告人	会议类别
1	The mechanism regulating lifespan of circulatory platelet and its clinical implications	北京市	戴克胜	全球性
2	Satellite cell-specific deletion of Cipc alleviates myopathy in mdx mice	Houston	宋耀华	全球性
3	核技术应用新突破-布拉格治疗	海盐市	张力元	全球性
4	Nanosafety Assessment: Limitations of Enzyme-base Assays	北京市	李瑞宾	全球性
5	Nanosafety Assessment: Limitations of Enzyme-base Assays	广州市	李瑞宾	全球性
6	Smart Probes with Photoresponsiveness for Tumor Diagnosis and Therapy	广州	史海斌	全球性
7	Smart Probes with Photoresponsiveness for Tumor Diagnosis and Therapy	南京	史海斌	全球性
8	R&D of radiation medicine: spear & shield	南宁	周光明	全球性
9	我国核应急医学救援的理论和实践探索	成都	刘玉龙	全国性
10	氚内污染人员的医学处理实践及思考	珠海市	刘玉龙	全国性
11	“核”去“核”从话应急	西安市	刘玉龙	全国性
12	我国核应急医学救援的理论和实践探索	温州市	刘玉龙	全国性
13	慢性放射病标准	南阳市	刘玉龙	全国性
14	“铱”想不到&“铱”犹未尽-局部放射损伤救治实践及思考	北京市	刘玉龙	全国性
15	血小板寿命调控机制及其临床应用研究	广州	戴克胜	全国性
16	移植相关性血栓性微血管病研究进展	北京市	韩　悦	全国性
17	移植相关血小板减少	青岛市	韩　悦	全国性
18	移植出凝血	天津市	韩　悦	全国性
19	人多能干细胞用于心血管机制研究	上海市	胡士军	全国性
20	视交叉上核对心肌损伤的调控	广州市	胡士军	全国性
21	多能干细胞用于心血管研究和疾病治疗	长春市	胡士军	全国性
22	人多能干细胞衍生细胞和类器官用于心血管研究	重庆市	胡士军	全国性

序号	会议名称	会议地点	报告人	会议类别
23	多能干细胞衍生细胞和类器官用于心血管研究	武汉市	胡士军	全国性
24	人多能干细胞与心血管研究	成都市	胡士军	全国性
25	太空失重条件下心肌细胞代谢重编程的分子机制和防护研究	北京市	胡士军	全国性
26	人多能干细胞与心血管研究	北京市	胡士军	全国性
27	人多能干细胞与心血管疾病转化研究	上饶市	胡士军	全国性
28	空间失重心脏代谢重编程的调控机制研究	北京市	胡士军	全国性
29	微重力环境下硫胺素介导人多能干细胞衍生心肌细胞的代谢重编程	湖州市	胡士军	全国性
30	空间生物学的干细胞研究	哈尔滨市	胡士军	全国性
31	人心脏类器官与心血管研究	无锡市	胡士军	全国性
32	人多能干细胞与空间生物学研究	十堰市	胡士军	全国性
33	心脏类器官与心血管研究	开封市	胡士军	全国性
34	利用人多能干细胞进行心血管基础转化研究	广州市	胡士军	全国性
35	人多能干细胞与心血管研究	遵义市	胡士军	全国性
36	纳米类酶催化毒理学研究		李瑞宾	全国性
37	针对有机底物的新型纳米酶及其应用研究	西安市	李瑞宾	全国性
38	mechanoregulated inhibitor of YAP/TAZ in cell plasticity and tumorigenesis	丽水市	畅　磊	全国性
39	The role of mechano-regulated YAP/TAZ in erectile dysfunction	惠州市	畅　磊	全国性
40	生物机械力学治疗男性勃起功能障碍（ed）的新策略和方法	上海市	畅　磊	全国性
41	基于光响应性探针的肿瘤诊疗研究	深圳	史海斌	全国性
42	智能光控肿瘤诊疗研究	长沙	史海斌	全国性
43	活体肿瘤成像与原位测量	丹东	史海斌	全国性
44	智能光控肿瘤诊疗研究	广州	史海斌	全国性
45	智能探针助力肿瘤精准放疗	苏州	史海斌	全国性
46	FLASH 光子放疗联合肿瘤免疫治疗的实践与思考	太原市	张昊文	全国性

序号	会议名称	会议地点	报告人	会议类别
47	放疗联合肿瘤免疫治疗中的 FLASH 效应——“DNA 完整性”假说的提出	重庆市	张昊文	全国性
48	FLASH 光子放疗联合肿瘤免疫治疗——“DNA 完整性”假说的提出与思考	绵阳市	张昊文	全国性
49	lncCRYBG3 对空间辐射效应的多靶调控	佛山	周光明	全国性
50	空间辐射环境致癌效应及其机制	福州	周光明	全国性
51	分子影像与脑疾病	苏州市	李　桢	全国性
52	分子影像与脑疾病	北京市	李　桢	全国性
53	超小纳米探针治疗脑疾病	深圳市	李　桢	全国性
54	超小纳米探针治疗脑疾病	上海市	李　桢	全国性
55	超小纳米探针治疗脑疾病	宜昌市	李　桢	全国性
56	超小纳米探针治疗脑疾病	重庆市	李　桢	全国性
57	分子影像与脑疾病	恩施市	李　桢	全国性
58	超小纳米探针治疗脑疾病	广州市	李　桢	全国性
59	分子影像与脑疾病	上海市	李　桢	全国性
60	分子影像与脑疾病	宁波市	李　桢	全国性
61	超小纳米探针治疗脑疾病	宁波市	李　桢	全国性
62	FLASH 光子放疗联合肿瘤免疫治疗的实践与思考	太原市	张昊文	全国性
63	放疗联合肿瘤免疫治疗中的 FLASH 效应——“DNA 完整性”假说的提出	重庆市	张昊文	全国性
64	FLASH 光子放疗联合肿瘤免疫治疗——“DNA 完整性”假说的提出与思考	绵阳市	张昊文	全国性
65	锕系元素与分离资源化新策略	衡阳市	王亚星	全国性
66	肿瘤肿瘤活体成像与原位测量 活体成像与原位测量	太原	史海斌	区域性
67	肠道辐射损伤的分子机理与治疗策略——从干细胞再生到免疫调控	苏州市（线上）	张昊文	区域性
68	放疗联合肿瘤免疫治疗中的 FLASH 效应——“DNA 完整性”假说的提出	苏州市	张昊文	区域性
69	肠道辐射损伤的分子机理与治疗策略——从干细胞再生到免疫调控	苏州市（线上）	张昊文	区域性
70	放疗联合肿瘤免疫治疗中的 FLASH 效应——“DNA 完整性”假说的提出	苏州市	张昊文	区域性

序号	会议名称	会议地点	报告人	会议类别
71	核来核去话应急	汕头市	刘玉龙	
72	放疗联合肿瘤免疫治疗中的 FLASH 效应——“DNA 完整性”假说的提出	上海市（线上）	张昊文	双边性
73	放疗联合肿瘤免疫治疗中的 FLASH 效应——“DNA 完整性”假说的提出	上海市（线上）	张昊文	双边性
74	首届干细胞与口腔再生医学高峰论坛	成都市	邵常顺	全国性
75	第六届中国生物物理学会代谢生物学分会学术研讨会	郑州	李培山	全国性
76	细胞治疗产品法规解读及产业研讨会	苏州	时玉舫	全国性
77	干细胞与口腔再生医学高峰论	成都	时玉舫	全国性
78	第五届南方医科大学基础医学学术年会	广东	时玉舫	全国性
79	中国细胞生物学学会 2023 年全国学术大会	苏州	时玉舫	全国性
80	中国抗癌协会肿瘤标志专委会肿瘤基础与临床前沿论坛-暨广州医科大学南山讲堂”	广东	时玉舫	全国性
81	全国医学前沿学术会议暨第十届江苏大学国际检验医学“金山论坛”	张家港	时玉舫	全国性
82	2023 年（第二届）长江国际免疫治疗峰会	上海	时玉舫	全国性
83	023 上海国际细胞生物医药技术与产业发展峰会	上海	时玉舫	全国性
84	中华预防医学会呼吸专委会年会	苏州	时玉舫	全国性
85	华东地区第十六届实验动物科学学术交流会	苏州	时玉舫	全国性
86	第四届全球生物医药前沿技术大会	苏州	时玉舫	全国性
87	第九届灵长类动物研究国际研讨会	昆明	时玉舫	全国性
88	第十二届肿瘤系统生物学国际研讨会	广州	时玉舫	全国性
89	第十届中国大连神经科学高峰论坛	大连	时玉舫	全国性
90	第九届 CMI 免疫学研讨会	合肥	时玉舫	全国性
91	第二届生物与医药高峰论坛·深圳	深圳	时玉舫	全国性
92	第二届中国细胞生物学学会细胞死亡研究分会学术年会	厦门	时玉舫	全国性
93	第十五届全国免疫学学术大会	苏州	时玉舫	全国性
94	中国细胞生物学会细胞代谢分会第三届学术会议	西安市	陈冬	全国性

序号	会议名称	会议地点	报告人	会议类别
95	第二届生物医用高分子材料大会	厦门市	陈华兵	全国性
96	微纳米技术与医疗健康创新大会	上海市	陈华兵	区域性
97	中国化学会第 33 届学术年会	青岛市	陈华兵	全国性
98	《中国科学:化学》2023 年全体编委会 & 化学与双碳战略论坛	青岛市	陈华兵	全国性
99	2022 年第十六届中国药物制剂大会	长沙市	陈华兵	全国性
100	China Nanomedicine 2023	广州市	陈华兵	全国性
101	2023 年有机高分子材料青年学者战略研讨会	苏州市	陈华兵	全国性
102	国家纳米科学中心二十周年庆	广州市	陈华兵	区域性
103	全国高分子学术论文报告会	武汉市	陈华兵	全国性
104	第二届生物医用高分子材料大会	厦门市	杨　涛	全国性
105	微纳米技术与医疗健康创新大会	上海市	杨　涛	全国性
106	中国抗癌协会纳米肿瘤学专业委员会 2023 年年会	宁波市	杨　涛	全国性
107	2023 中国生物材料大会	重庆市	杨 涛	全国性
108	China Nanomedicine 2023	广州市	杨　涛	全国性
109	2022 年有机高分子材料青年学者战略研讨会	苏州市	杨　涛	全国性
110	2023 年中国药学大会	南京市	杨　涛	全国性
111	第七届吴宪吴瑞国际学术研讨会	苏州市	徐　鹏	全国性
112	2023 智能材料化工国际峰会	大连	张正彪	全国性
113	2023 全国高分子学术论文报告会	武汉	张正彪	全国性
114	第 13 届 SPSJ 国际聚合物会议	日本	张正彪	国际
115	2023 中国化工学会科技创新大会	杭州	张正彪	全国性
116	江苏省放疗学科能力提升项目启动会	苏州市	张力元	区域性
117	广东省基层医药学会放射肿瘤专委会学术年会暨第三届肿瘤精准诊疗论坛	广州市	张力元	全国性
118	娄底市医学会肿瘤专业委员会第四届会员代表大会 2023 年学术会议	娄底市	张力元	全国性
119	2023 年广东省肿瘤免疫治疗高峰论坛暨广东省临床医学学会肿瘤免疫治疗专委会年会	湛江市	张力元	全国性

序号	会议名称	会议地点	报告人	会议类别
120	上海市抗癌协会肺癌专委会、放射治疗专委会第六届胸部肿瘤”四化“论坛	上海市	张力元	全国性
121	卫生健康人才发展国际交流会	苏州市	张力元	全球性
122	2023 绿色低碳高质量发展大会“核技术点亮健康生活“专题会议	烟台	张力元	全国性
123	中国病理生理学会血管医学专业委员会第六届学术会议暨“筑梦医路，惟实励新”---上海交通大学医学院附属上海儿童医学中心建院 25 周年系列活动	福州市	何玉龙 李桃桃 徐蓓蓓	全国性
124	江苏省第二十七次血液学学术会议	江苏省连云港市	韩　悦	区域性
125	2023 年全国毒理学大会	珠海市	李瑞宾	全国性
126	第十二届全国化学生物学会议	大连市	李瑞宾	全国性
127	“污染物示踪与致毒机制”学科发展战略研讨会	宿迁市	李瑞宾	全国性
128	“新污染物环境暴露与生态安全”学术研讨会	太原市	李瑞宾	全国性
129	美国化学会年会(ACS Fall 2023)	线上	李瑞宾	全球性
130	2023 环境化学青年学者研讨会	宜昌市	李瑞宾	全国性
131	第 24 界全国色谱学术报告会	大连市	李瑞宾	全国性
132	第八届全国生态毒理学大会	绍兴市	李瑞宾	全国性
133	全国放射化学发展战略与学术交流大会	南昌市	李瑞宾	全国性
134	2023 化学品专委会学术年会	大连市	李瑞宾	全国性
135	环境质谱大会	青岛	李瑞宾	全国性
136	2023 全国放射化学发展战略与学术交流大会	南昌市	代　星	全国性
137	China Nanomedicine	广州	葛翠翠	全球性
138	分析化学岳麓前沿论坛（2023）	长沙	汪　勇	全国性
139	2023 汇聚独墅湖生物医学工程论坛	苏州	汪　勇	全国性
140	中国化学会首届生物传感学术研讨会	济南	汪　勇	全国性
141	第十六届生物无机化学会议暨金属化学生物学学术会议	广州	汪　勇	全国性
142	2023 年喀什分析化学论坛	喀什	汪　勇	全国性

序号	会议名称	会议地点	报告人	会议类别
143	2023 分子影像与生命分析学术研讨会	青岛	汪　勇	全国性
144	中国化学会第十四届全国分析化学年会	深圳	汪　勇	全国性
145	2023 年中国化学会第 33 届学术年会	青岛	汪　勇	全国性
146	2023 中国生物材料大会	重庆	汪　勇	全国性
147	2023 全国放射化学发展战略与学术交流大会	南昌	陈　龙	全国性
148	2023 年中国辐射防护学会超铀核素辐射防护分会辐射健康效应专题研讨会暨材料研究所放射医学与辐射生物效应研究中心学术论坛	江油市	崔凤梅	全国性
149	中核集团 2023 年学位与研究生教育研讨会	天津市	崔凤梅	全国性
150	长三角（华东）辐射联合会第十七届（2023 年）年会	瑞昌市	崔凤梅	全国性
151	2023 年全国放射化学发展战略与学术交流大会	南昌市	华道本	全国性
152	2023 年全国放射化学发展战略与学术交流大会	南昌市	王子昱	全国性
153	2023 年全国放射化学发展战略与学术交流大会	南昌市	王文文	全国性
154	2023 年全国放射化学发展战略与学术交流大会	南昌市	李语林	全国性
155	2023 年全国放射化学发展战略与学术交流大会	南昌市	李成琪	全国性
156	第四届全国氚科学与技术学术交流会	海南市	华道本	全国性
157	第四届全国氚科学与技术学术交流会	海南市	徐美芸	全国性
158	第四届全国氚科学与技术学术交流会	海南市	陈福龙	全国性
159	海水提铀联盟学术高峰论坛	海南市	徐美芸	全国性
160	海水提铀联盟学术高峰论坛	海南市	刘　鹏	全国性
161	第二届大湾区分离纯化技术论坛	线上	徐美芸	区域性
162	第三届中国细胞骨架前沿学术会议	徐州市	裴海龙	全国性
163	第十二届中国辐射与环境生物物理大会	惠州市	张昊文	全国性
164	Flash Radiotherapy & Particle Therapy Conference (FRPT 2022)	西班牙 巴塞罗那（线上参会）	张昊文	全球性

序号	会议名称	会议地点	报告人	会议类别
165	第 12 届中国生物物理学会辐射与环境分会 2022 年度理事会议暨国际学术交流会议	在线	周光明	全国性
166	江苏省毒理学会 2023 工作讨论会	在线	周光明	区域性
167	国自然重大项目进展汇报暨特种医学学术交流会	北京	周光明,王后禹闫聪冲,裴海龙刘宁昂	区域性
168	基因测序与蛋白质检测专题研讨会	在线	周光明	全国性
169	放射医学协同创新中心年会	太原	周光明	区域性
170	首届交叉融合中西医结合创新发展大会	连云港	周光明	全国性
171	空间环境地面模拟大科学装置应用暨航天医学工程研讨会	哈尔滨	周光明	全国性
172	特种医学和纳米医学专委会联合学术年会	重庆	周光明	全国性
173	中国科学院学部科学与技术前沿论坛“未来太空药物”	宁波	周光明	全国性
174	2050 国际可持续发展实验室会议	上海	周光明	区域性
175	代谢疾病基础与临床国际研讨会	新疆	周光明	全国性
176	苏州市医学会第 11 届放射肿瘤学学术年会	苏州	周光明	全国性
177	质子重离子放射治疗专业委员会学术年会暨第三届全国粒子放射治疗大会	北京	周光明	全国性
178	第三届中国细胞骨架前沿学术会议	徐州市	裴海龙	全国性
179	中国毒理学会第十次全国毒理学大会	珠海市	胡文涛	全国性
180	2003 年 RMP 第四次定稿会	高平市	胡文涛	全国性
181	中华放射医学与防护杂志第十一届编委会成立大会	合肥市	胡文涛	全国性
182	2023 年辐射防护大会	成都市	陈兰花	全国性
183	2023 年全国放射化学发展战略与学术交流大会	南昌市	陈兰花	全国性
184	国家自然科学基金重大项目“航天极端环境机体应激与防护策略”进展汇报会暨特种医学高峰论坛	北京市	闫聪冲,沈江燕,李清	区域性
185	第十六届全国蒙特卡罗方法及其应用学术交流会议	汉中市	闫聪冲,朱坤,沈江燕,李清	全国性

序号	会议名称	会议地点	报告人	会议类别
186	第十六届全国蒙特卡罗方法及其应用学术交流会议	汉中市	闫聪冲,朱坤,沈江燕,李清	全国性
187	江苏省研究生“核应急医学救援”学术创新论坛	苏州市	闫聪冲,朱坤,沈江燕,李清	区域性
188	中国辐射防护学会 2023 年辐射防护大会	成都市	闫聪冲,沈江燕,朱坤,李清	全国性
189	中国辐射防护学会 2023 年辐射防护大会	成都市	闫聪冲,朱坤,沈江燕,李清	全国性
190	中国辐射防护学会 2023 年辐射防护大会	成都市	闫聪冲,朱坤,沈江燕,李清	全国性
191	中国辐射防护学会 2023 年辐射防护大会	成都市	闫聪冲,李清,朱坤,沈江燕	全国性
192	中华预防医学会放射卫生专业委员会“思变求新 笃行致远”放射卫生全国学术交流培训会	汕头市	闫聪冲,沈江燕	全国性
193	国家自然科学基金重大项目《航天极端环境机体应激与防护策略》进展汇报暨 2023 特种医学高峰论坛	苏州市	闫聪冲,朱坤,李清,张德颂	区域性
194	全国放射化学发展战略与学术交流大会	南昌市	谌　宁	全国性
195	“团簇构造、功能及多级演化”重大研究计划年度学术交流会	哈尔滨市	谌　宁	全国性
196	首届长三角区域放射医学与防护学术交流会	上海市	焦旸	区域性
197	中国辐射防护学会 2023 年辐射防护大会	成都	焦旸	全国性
198	第十二届中国辐射与环境生物物理大会	惠州市	张昊文	全国性
199	Flash Radiotherapy & Particle Therapy Conference (FRPT 2022)	西班牙 巴塞罗那（线上参会）	张昊文	全球性
200	ICRP 年会	日本，东京	田　野	全球性
201	中-澳先进磁共振成像技术联合研究中心项目启动会暨先进磁共振成像技术研讨会	北京	单善善	双边性
202	苏州大学-青岛科技大学分子影像与生命分析学术研讨会	青岛	单善善	双边性
203	中华预防医学会放射卫生专业委员会关千举办“思变求新笃行致远“放射卫生全国学术交流培训会	广东汕头	涂　彧	全国性

序号	会议名称	会议地点	报告人	会议类别
204	全国职业病危害工程防护技术支撑机构第二次联席会暨第三届职业卫生工程学术交流会	山西长治	涂　彧	全国性
205	第七届吴宪吴瑞国际学术研讨会	苏州市	徐　鹏	全国性
206	第二届生物医用高分子材料大学	厦门	钟志远	全国性

七、授权专利目录

序号	专利号	专利名称	授权公告日	国家	完成人(固定人员)
1	US 11,759,445 B2	Use of rivastigmine in preparation of anti-radiation medicament	2023-09-19	美国	陈　秋 崔凤梅
2	US 11,577,229 B2	Phosphorus-doped tubular carbon nitride micro-nano material and application thereof in catalytic treatment of exhaust gas	2023-02-14	美国	路建美
3	ZL 2022 1 0150545.5	dGMP 在制备提高肿瘤对放射治疗敏感性的药物中的应用	2023-03-10	中国	陈　秋 崔凤梅
4	ZL 2020 1 1461448.5	Caspase-2 抑制剂在制备抗辐射药中的应用	2023-07-21	中国	陈秋, 崔凤梅
5	ZL 2018 1 1500608.5	一种疾病视网膜光学相干断层影像仿真生成方法	2023-02-24	中国	陈新建
6	ZL 2018 1 1516615.4	一种基于三维卷积神经网络的视网膜 OCT 图像分类方法	2023-03-24	中国	陈新建
7	ZL 2020 1 1237202.X	一种视网膜 OCT 图像水平配准和图像增强方法	2023-06-16	中国	陈新建
8	ZL 2020 1 0089915.X	一种基于注意力机制的早产儿视网膜图像分类方法和装置	2023-05-12	中国	陈新建
9	ZL 2020 1 0073201.X	一种从眼底 OCT 图像中分割脉络膜新生血管的方法及系统	2023-04-21	中国	陈新建
10	ZL 2021 1 0920602.9	一种多肽及其在制备治疗血小板增多症或抗肿瘤转移药物中的应用	2023-04-25	中国	戴克胜
11	ZL 2019 1 0492397.3	一种纳米凝胶的制备方法与应用	2023-01-06	中国	邓　超 钟志远
12	ZL 2022 1 0984485.7	一种基于聚氨基酸的大分子吲哚胺 2，3-双加氧酶抑制剂及其制备方法与应用	2023-10-10	中国	邓　超 钟志远
13	ZL 202210409998.5	一种非晶态 MOF 纳米光敏剂及其制备方法与应用	2023-06-23	中国	郭正清
14	ZL 202111455607.5	一种具有荧光活性的 7-乙基-10-羟基喜树碱 2023 药物前体及其制备方法和应用	2022-03-24	中国	郭正清
15	ZL 202111455607.5	一种线粒体靶向光敏剂及其制备方法和应用	2023-03-17	中国	郭正清

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16	ZL 202210712493.6	一种辣椒素衍生化光敏剂及其制备方法与应用	2023-06-23	中国	郭正清, 王广林
17	ZL 2022 1 0181380.8	用于 X 射线剂量测量的蛋白质荧光剂量计及其制备方法	2023-04-14	中国	胡亮
18	ZL 202110559884.4	间歇性饥饿促进心肌细胞成熟的方法	2023-03-24	中国	胡士军
19	ZL 202210712499.3	一种功能性大孔有机硅胶材料及其制备方法与应用	2023-08-11	中国	华道本
20	ZL 202011314660.9	检测碘蒸气的探针及 ECL 检测器	2023-03-21	中国	华道本
21	ZL 2022 1 1181757.6	含有 Zn-N-C 活性中心的纳米材料在去除细菌生物膜中的应用	2023-07-25	中国	李瑞宾, 高　梦, 郑会珍, 刘曦,潘嘉琦
22	ZL 2022 1 1227434.6	一种基于金属有机框架的热释光材料及其制备方法与应用	2023-10-27	中国	刘汉洲 王殳凹
23	ZL202210507163.3	一种靶向增效滞留型纳米颗粒及其制备方法与应用	2023-11-03	中国	史海斌
24	ZL202210201837.7	一种比率光声型探针及其制备方法和在检测射线辐射剂量中的应用	2023-10-26	中国	史海斌
25	ZL 2021 1 1656850.3	磷酸钙纳米载药体系及其制备方法与应用	2023-04-28	中国	汪　勇, 张乐帅, 王杨云
26	ZL 202210503051.0	一种凝胶微球制剂、制备方法、药盒以及在制备放射性凝胶微球中的应用	2023-08-04	中国	王广林
27	ZL 2022 1 0607373.X	一种放射性核素标记的 PSMA-αvβ3 双靶点偶联体及其应用	2023-09-26	中国	王广林
28	ZL 2020 1 1454576.7	Stap2 基因点突变敲入模式小鼠的打靶载体和构建方法	2023-05-12	中国	王建荣 袁娜,魏雯
29	ZL 2022 1 0026015.X	一种二维硫属化合物的制备方法及其应用	2023-02-10	中国	王殳凹 陈兰花
30	ZL 202210190770.1	一种手性钙钛矿发光材料及其制备方法和应用	2023-03-24	中国	王殳凹 王亚星
31	ZL 202210232044.1	二价铕硫化物近红外闪烁体及其制备方法	2023-06-27	中国	王殳凹 王亚星
32	ZL 202210249332.8	高光产额的柔性硫化物闪烁体及其制备方法	2023-06-02	中国	王殳凹 王亚星

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33	ZL202211212997.8	一种硒钨多酸及其制备方法与在超滤分离锕系离子中的应用	2023-07-11	中国	王殳凹,张海龙,王亚星
34	ZL 2021 1 1674339.6	一种急性 T 淋巴细胞白血病药物靶点及其应用	2023-01-17	中国	吴德沛,安竞男,徐杨,胡淑鸿,刘天会,齐丽娟,赵涔竹,周莉莉,雷蕾,朱婷婷
35	ZL 2022 1 0462263.9	达格列净在制备预防或治疗急性移植物抗宿主病药物中的应用	2023-06-02	中国	吴德沛,程巧,徐杨,王栋,赖小璇,刘吟,雷蕾
36	ZL 2022 1 0578560.X	一种核素标记的抑制肽及其制备方法和应用	2023-02-17	中国	杨　凯
37	ZL20211444469.4	一种可分散碳纳米角/金颗粒纳米复合物及其制备和应用	2021-04-21	中国	赵　利
38	ZL 2018 1 0379367.7	雷公藤内酯酮治疗肥胖和脂肪肝的用途	2023-08-11	中国	周泉生
39	ZL 2020 1 0963969.4	具有不对称膜结构的载药聚合物囊泡及制备方法与在制备治疗急性髓系白血病药物中的应用	2023-01-31	中国	钟志远
40	ZL 201910751079.4	基于二氧化钛/四氧化三钴/氧化石墨烯的复合材料及其在处理污水中的应用	2023-02-28	中国	路建美
41	ZL 202110715454.7	金属离子掺杂二硫化锡纳米花及其在压电催化降解污染物中的应用	2023-03-17	中国	路建美
42	ZL 201911320266.3	负载钯铜合金纳米颗粒的介孔沸石及其制备方法及应用	2023-03-21	中国	路建美
43	ZL 202010815126.X	二硫化锡碳纳米纤维复合材料的制备方法及其在压电催化去除有机污染物中的应用	2023-03-24	中国	路建美
44	ZL 201711023309.2	基于碘掺杂碳酸氧铋纳米片和二硫化钼修饰的纳米碳纤维复合材料及其制备方法与应用	2023-02-28	中国	路建美

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45	ZL 202111266688.4	Pt@Ti3C2Tx MXene 催化材料及其电极与制备方法和在还原氯霉素中的应用	2023-04-07	中国	路建美
46	ZL 201910955506.0	基于单层修饰的Mxene的电存储材料制备方法与电存储器	2023-05-02	中国	路建美
47	ZL 202010340900.6	基于有机小分子染料的电存储器件及其制备方法	2023-05-02	中国	路建美
48	ZL 202210403842.6	兼具快速吸附与高效降解污染物的花基胶束及其制备方法	2023-05-02	中国	路建美
49	ZL 201911245275.0	聚磷酸铵忆阻器及其制备方法与在制备人工突触模拟器件中的应用	2023-05-05	中国	路建美
50	ZL 202110242253.X	一种利用四氧化三钴十二面体/氮化碳纳米片复合物处理废气的方法	2023-06-06	中国	路建美
51	ZL 202111212344.5	一种铜单原子催化材料与电极的制备方法及其在硝酸盐还原产氨中的应用	2023-06-13	中国	路建美
52	ZL 202210798290.3	钛酸钡纳米颗粒复合共价有机骨架异质结及其制备方法	2023-07-04	中国	路建美
53	ZL 202010011336.3	电阻式薄膜二氧化氮传感器及其制备方法与应用	2023-08-01	中国	路建美
54	ZL 202110758904.0	一种可用于高湿度环境下痕量检测二氧化氮的克酮酸菁聚合物传感器及其制备方法与应用	2023-08-08	中国	路建美
55	ZL 202011166319.3	Cs3Bi2Br9@TiO2 钙钛矿异质结及其制备方法与在光催化甲苯氧化中的应用	2023-10-13	中国	路建美
56	ZL 202011177643.5	CuPc@Ti3C2Tx MXene 催化材料及电极与在硝酸根还原中的应用	2023-10-13	中国	路建美
57	ZL 202011160066.9	锶掺杂有序介孔锰酸镧负载贵金属钯的复合材料及其制备方法与催化氧化甲苯中的应用	2023-11-03	中国	路建美
58	ZL 202210656966.5	一种三维大孔碳锚定的单原子铁催化剂及其制备方法与应用	2023-11-03	中国	路建美

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59	ZL 202110715453.2	二硫化锡纳米催化剂在压电催化分解水产氢中的应用	2023-11-10	中国	路建美
60	ZL 202111473456.6	一种超快去除速率和超高吸附容量的杯芳烃类多孔聚合物及用于染料的选择性分离	2023-11-24	中国	路建美

八、论文目录

序号	论文名称	期刊名称	所有作者	卷、期、页
1	Ultrafiltration separation of Am(VI)-polyoxometalate from lanthanides	Nature	Hailong Zhang,Ao Li,Kai Li,Zhipeng Wang,Xiaocheng Xu,Yaxing Wang, Matthew V. Sheridan,Han-Shi Hu,Chao Xu,Evgeny V. Alekseev,Zhenyi Zhang, Pu Yan,Kecheng Cao,Zhifang Chai,Thomas E. Albrecht-Schönzart, Shuao Wang	2023, 616, 482-487
2	Ribosome biogenesis in disease: new players and therapeutic targets	Signal Transduction and Targeted Therapy	Lijuan Jiao,Yuzhe Liu,Xi-Yong Yu,Xiangbin Pan,Yu Zhang,Junchu Tu,Yaohua Song,Yangxin Li	2023, DOI: 10.1038/s41392-022-01285-4
3	Oleic acid availability impacts thymocyte preprogramming and subsequent peripheral Treg cell differentiation	Nature Immunology	Liangyu Lin, Mingyuan Hu, Qing Li, Liming Du, Li Lin, Yueqing Xue, Fanjun Zheng, Fei Wang, Keli Liu, Yu Wang, Jiayin Ye, Xu Jiang, Xuefeng Wang, Jiaqi Wang, Jingjie Zhai, Benming Liu, Hongzhen Xie, Yanqin You, Jinyong Wang, Xiangyin Kong, Dechun Feng, Douglas R Green, Yufang Shi, Ying Wang	2023, doi: 10.1038/s41590-023-01672-1.
4	Holographically Activatable Nanoprobe via Glutathione/Albumin-Mediated Exponential Signal Amplification for High-Contrast Tumor Imaging	Advanced Materials	Ting Li,Shuangxiu Tan,Mengjuan Li,Jie Luo,Yueyue Zhang,Zhen Jiang,Yibin Deng,Liang Han,Hengte Ke,Junkang Shen,Yong'an Tang,Fan Liu,Huabing Chen,Tao Yang	2023,35,10,2209603
5	A pH-Activatable Copper-Biomineralized Proenzyme for Synergistic Chemodynamic/Chemo-Immunotherapy against Aggressive Cancers	Advanced Materials	Ting Li,Ying Zhang,Jie Zhu,Fangrui Zhang,An'an Xu,Tian Zhou,Yaoqi Li,Ming Liu,Hengte Ke,Tao Yang,Yong'an Tang,Jing Tao,Liyan Miao,Yibin Deng,Huabing Chen	2023,35,14,2210201

序号	论文名称	期刊名称	所有作者	卷、期、页
6	Reversing Acute Kidney Injury Through Coordinated Interplay of Anti-inflammation and Iron Supplementation	Advanced Materials	Ruixue Duan#*,Yueping Li#,Ruru Zhang,Xuelan Hu,Yi wang,Jianfeng Zeng*,Mingyuan Gao*	2023, 35, 28, 2301283
7	A Tumor Microenvironment-Activatable Molecular Pro-theranostic Agent for Photodynamic and Immunotherapy of Cancer	Advanced Materials	Hui Zhou,Yuan Zhang,Ruru Zhang,Min Zhao,Wan Chen,Yinghua Liu,YueJiang,Qing Li,Qingqing Miao*,Mingyuan Gao*	2023, 35, 30, 2211485
8	An Activatable Phototheranostic Probe for Anti-hypoxic Type I Photodynamic- and Immuno-Therapy of Cancer	Advanced Materials	Min Zhao,Yuyang Zhang,Jia Miao,Hui Zhou,Yue Jiang,Yuan Zhang,Minqian Miao,Wan Chen,Wei Xing, Qing Li,Qingqing Miao	2023, DOI: 10.1002/adma.202305243
9	Tumor Eradication by Boron Neutron Capture Therapy with 10B-enriched Hexagonal Boron Nitride Nanoparticles Grafted with Poly(Glycerol)	Advanced Materials	Yucai Zhang,Heon Gyu Kang,Hua-zhen Xu,Honghui Luo,Minoru Suzuki,Qing Lan*,Xiao Chen*,Naoki Komatsu*,Li Zhao*	2023, 35, 2301479
10	Exogenous Antigen Upregulation Empowers Antibody Targeted Nanochemotherapy of Leukemia	Advanced materials	Shujing Yue,Jingnan An,Yifan Zhang,Jiaying Li,Cenzhu Zhao,Jingyi Liu,Lanlan Liang,Huanli Sun,Yang Xu,and Zhiyuan Zhong	2023, 35(32), e2209984.
11	Immunomodulatory properties of mesenchymal stem cells/dental stem cells and their therapeutic applications	Cellular & Molecular Immunology	Peishan Li,Qianmin Ou,Songtao Shi,Changshun Shao	2023, DOI: 10.1038/s41423-023-00998-y.
12	Mesenchymal stem/stromal cells (MSCs): origin, immune regulation, and clinical applications	Cellular & Molecular Immunology	Jun Zhou,Yufang Shi	2023, DOI: 10.1038/s41423-023-01034-9
13	Mesenchymal stromal cells in hepatic fibrosis/cirrhosis: from pathogenesis to treatment	Cellular & Molecular Immunology	Xue Yang, Qing Li, Wenting Liu, Chen Zong, Lixin Wei, Yufang Shi, Zhipeng Han	2023, 20(6), 583-599.
14	NAD+ salvage governs the immunosuppressive capacity of mesenchymal stem cells	Cellular & Molecular Immunology	Jiankai Fang,Pengbo Hou,Shisong Liu,Muqiu Zuo,Zhanhong Liu,Wangwang Chen,Yuyi Han,Yanan Li,Tingting Wang,Chao	2023, DOI: 10.1038/s41423-023-01073-2

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			Feng,Peishan Li,Changshun Shao,Yufang Shi	
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142	Appropriate pre-transplant strategy for patients with myelodysplastic syndromes receiving allogeneic haematopoietic stem cell transplantation after myeloablative conditioning	Frontiers in immunology	Hong Wang,Qingyuan Wang,Jiaqian Qi,Xueqian Li,Tiantian Chu,Huiying Qiu,Zhengzheng Fu,Xiaowen Tang,Changgeng Ruan,Depei Wu, Yue Han	2023,DOI:10.3389/fimmu.2023.1146619
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Partitioning of americium from lanthanides (Ln) present in used nuclear fuel plays a key role in the sustainable development of nuclear energy[1–3]. This task is extremely challenging because thermodynamically stable Am(III) and Ln(III) ions have nearly identical ionic radii and coordination chemistry. Oxidization of Am(III) to Am(VI) produces AmO_2^{2+} ions distinct with Ln(III) ions, which has the potential to facilitate separations in principle. However, the rapid reduction of Am(VI) back to Am(III) by radiolysis products and organic reagents required for the traditional separation protocols including solvent and solid extractions hampers practical redox-based separations. Herein, we report a nanoscale polyoxometalate (POM) cluster with a vacancy site compatible with the selective coordination of hexavalent actinides (^{238}U, ^{237}Np, ^{242}Pu and ^{243}Am) over trivalent lanthanides in nitric acid media. To our knowledge, this cluster is the most stable Am(VI) species in aqueous media observed so far. Ultrafiltration-based separation of nanoscale Am(VI)-POM clusters from hydrated lanthanide ions by commercially available, fine-pored membranes enables the development of a once-through americium/lanthanide separation strategy that is highly efficient and rapid, does not involve any organic components and requires minimal energy input.

Americium is a neutron-capture by-product of nuclear power generation and a major contributor to the long-term radiotoxicity of high-level waste. The efficient recovery of americium followed by transmutation into short-lived or stable nuclides using fast reactors would significantly reduce the environmental impact of nuclear energy. However, the coexistence of lanthanides (Ln) with high neutron capture cross-sections (for example, ^{157}Gd) severely limits transmutation efficiency. Overcoming this impediment requires the development of efficient separations between americium and lanthanides and has remained a long-standing challenge in the nuclear industry for decades. This difficulty originates primarily from their similar chemical behaviour because both americium and lanthanides exist in solution as thermodynamically stable trivalent cations that possess nearly identical ionic radii and coordination chemistry. Traditional separations exploit the subtle bonding differences between Am(III) and Ln(III) ions whereby extractants containing nitrogen or sulfur donors enable preferential partitioning of Am(III) over Ln(III)[4,5]. This separation strategy, however, is still hampered by limited discrimination between Am(III) and Ln(III), and, more notably, by the generation of large amounts of secondary radioactive liquid waste.

One proposed method for mitigating this separation challenge is the oxidation of Am(III) to the higher oxidation states of Am(V) and Am(VI)[6]. These cations possess coordination chemistry that parallels the linear dioxo early actinyl ions, such as UO_2^{2+} and NpO_2^{+}, with anisotropic coordination contrasting sharply with relatively isotropic Ln(III) ions[7]. This, in principle, leads to better discrimination between americium and lanthanides and a subsequent increase in separation efficiency. Although various techniques have been explored following redox-based protocol, including solvent extraction[8–11], precipitation[12] and ion-exchange chromatography[13], an unsolved issue is unavoidable reduction of high-valent Am back to Am(III) during the separation process. Am(VI) cations are strong oxidizing agents with reduction potentials of 1.6 V and 1.68 V for AmO_2^{2+}/AmO_2^{+} and AmO_2^{2+}/Am^{3+} couples, respectively (versus saturated calomel electrode (SCE))[6]. Therefore, Am(III) species can be produced in a few seconds once Am(VI) ions contact organic extractants/solvents or pass through a chromatographic column, making these separations impractical. In fact, both Am(VI) and Am(V) are traditionally thought to be unstable in aqueous solution because they can even be efficiently reduced by active radiolysis products, given that the two common americium isotopes related to the nuclear fuel cycle (^{241}Am and ^{243}Am) are both considerably radioactive.

We address these challenges by selecting a polyoxometalate (POM) that is tailored to the coordination requirements of Am(VI)

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Oleic acid availability impacts thymocyte preprogramming and subsequent peripheral T_{reg} cell differentiation

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The nature of activation signals is essential in determining T cell subset differentiation; however, the features that determine T cell subset preference acquired during intrathymic development remain elusive. Here we show that naive $CD4^+$ T cells generated in the mouse thymic microenvironment lacking *Scd1*, encoding the enzyme catalyzing oleic acid (OA) production, exhibit enhanced regulatory T (T_{reg}) cell differentiation and attenuated development of experimental autoimmune encephalomyelitis. *Scd1* deletion in $K14^+$ thymic epithelia recapitulated the enhanced T_{reg} cell differentiation phenotype of *Scd1*-deficient mice. The dearth of OA permitted DOT1L to increase H3K79me2 levels at the *Atp2a2* locus of thymocytes at the DN2–DN3 transition stage. Such epigenetic modification persisted in naive $CD4^+$ T cells and facilitated *Atp2a2* expression. Upon T cell receptor activation, ATP2A2 enhanced the activity of the calcium–NFAT1–Foxp3 axis to promote naive $CD4^+$ T cells to differentiate into T_{reg} cells. Therefore, OA availability is critical for preprogramming thymocytes with T_{reg} cell differentiation propensities in the periphery.

All jawed vertebrates are capable of an adaptive immune response driven by T cells and B cells[1]. T cells develop in the thymus from hematopoietic stem cell (HSC)-derived lymphoid progenitors, which are supported by factors such as Notch ligands, interleukin (IL)-7 and stem cell factor at specific locations[2,3]. T cells with newly rearranged T cell receptors (TCRs) are either positively or negatively selected against self-major histocompatibility complex plus self-peptides, depending on their avidity[4]. After maturation, naive T cells enter the periphery and differentiate into distinct T cell subsets in response to different types of antigens, co-stimulation molecules, cytokines and metabolites[5–7]. However, it is unknown whether the thymic microenvironment could preprogram naive T cells with properties that influence their subset differentiation in the periphery.

T_{reg} cells are a $CD4^+$ T cell population that has an essential role in guarding immune homeostasis[8]. T_{reg} cells are controlled by the transcriptional factor forkhead box protein P3 (Foxp3). Loss-of-function

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Glycolytic neutrophils accrued in the spleen compromise anti-tumour T cell immunity in breast cancer

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The coordination of immunity across organs is fundamental to cancer development and progression. It is well known that the hostile metabolic microenvironment in the tumour is a major obstacle to effective anti-tumour immunity. However, whether metabolic alterations in secondary lymphoid tissues beyond the tumour can affect anti-tumour immunity remains elusive. Using positron-emission tomography–computed tomography, we show that the spleens of humans and mice with breast cancer are metabolically reprogrammed to a glycolytic state. Such an increase in glucose consumption in the spleen primarily occurs in neutrophils generated by extramedullary haematopoiesis and recruitment from the bone marrow. These neutrophils in the white pulp create a glucose-deprived microenvironment, which, in turn, induces T cell anergy by impairing pyruvate kinase M2 and its action on STAT5, thus compromising their anti-tumour activities. Furthermore, CCL9 chemokine produced by splenic stromal cells is central to splenic neutrophil accumulation, and blockade of the CCR1 receptor favours tumour eradication. Thus, neutrophils metabolically influence the spleen microenvironment and control anti-tumour T cell responses.

Recent efforts in investigating the phenotypes and functions of immune cells in the tumour microenvironment have revolutionized cancer therapies[1]. Effective deployment of cytotoxic T cells into the tumour microenvironment is critical to sequester and eradicate tumour cells; however, irreversible dysfunction of cytotoxic T cells can occur and perturbs immunotherapy[2]. Although emerging evidence has suggested that immune cell dysfunction occurs before the arrival of cells at the tumour microenvironment, how anti-tumour T cell immunity is impaired outside of the tumour is largely unknown[3–5].

Tumour development is often accompanied by major changes in the systemic immune landscape and is associated with immune re-organization across peripheral lymphoid organs[6]. Whether, and how, such re-organization contributes to tumour-specific T cell responses and influences cancer progression remains largely undetermined. As the largest secondary lymphoid organ, the mammalian spleen is

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Confining Ti-oxo clusters in covalent organic framework micropores for photocatalytic reduction of the dominant uranium species in seawater

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SUMMARY

Photocatalytic reduction is a promising strategy for uranium extraction from seawater. However, due to the lack of accessible active sites, current photocatalysts work poorly under visible-light irradiation in reducing $UO_2(CO_3)_3^{4-}$, the dominant uranium species in seawater. Here, a one-pot precursor preorganized encapsulation strategy was applied to confine Ti-oxo clusters (TiOCs) within the micropores of a photosensitive covalent organic framework (TiOCs∈COF-TZ), leading to the first utilization of confined photocatalysis in uranium extraction. This strategy endows the material with photocatalytic reduction capability toward $UO_2(CO_3)_3^{4-}$ in natural seawater, where ~89.9% of $UO_2(CO_3)_3^{4-}$ was extracted by TiOCs∈COF-TZ under visible-light irradiation. In comparison with the unloaded COF-TZ and surface-loaded TiOCs@COF-TZ, the TiOCs∈COF-TZ exhibits a clear superiority both in catalytic activity and efficiency. Density functional theory (DFT) calculations infer that the photoinduced electrons are derived from the COF-TZ, whereas the TiOCs act as indispensable mediums during the electron transfer process.

INTRODUCTION

Uranium extraction from seawater (UES) has been regarded as one of the seven most important chemical separations that will change the world.[1] As the fuel of most nuclear power plants, uranium plays a vital role in producing clean and low-carbon energy, but its land reserves are being rapidly exhausted. Alternatively, there exists ~4.5 billion tons of uranium in seawater, almost one thousand times as those on land.[2–6] This quantity, if available, could greatly overcome the bottleneck of uranium shortage that currently restricts nuclear energy development.[7–10] Although various techniques have been explored for UES over the past few decades,[11–19] most of them are inefficient under practical conditions, thereby calling for massive material input or additional energy consumption. There is a strong motivation to develop novel strategies or materials for efficient and energy-saving UES.[7,20–23]

Photocatalytic uranium reduction by transforming soluble U(VI) to insoluble U(IV) emerges as a ground-breaking route to achieve sustainable UES, especially when sunlight is utilized as the energy source.[24–28] Although it has been reported that inorganic semiconductor TiO_2 can photocatalyze the reduction of U(VI) in seawater,[29] the realization of the result mostly relies on ultraviolet light, representing only 4% of the total sunlight. In contrast, organic photocatalysts with conjugated structures are outstanding candidates for this purpose owing to their excellent sunlight

THE BIGGER PICTURE

To ensure the sustainable development of nuclear energy, an efficient strategy of uranium extraction from seawater (UES) is crucial. Photocatalytic reduction is emerging as a promising UES strategy because it overcomes the thermodynamic limitations of sorbent methods. However, the photocatalytic reduction of the dominant uranium species ($UO_2(CO_3)_3^{4-}$) in natural seawater remains a challenge. Here, we employ a precursor preorganization strategy to confine active Ti-oxo clusters (TiOCs) within the micropores of a photosensitive covalent organic framework (COF) material (TiOCs∈COF-TZ). The TiOCs play an indispensable role during the reduction of $UO_2(CO_3)_3^{4-}$, which bridges the electron cloud of COF-TZ and $UO_2(CO_3)_3^{4-}$. Moreover, the confinement effect endows TiOCs∈COF-TZ with superior catalytic activity and enables efficient photocatalytic reduction of $UO_2(CO_3)_3^{4-}$ in natural seawater. This work represents a remarkable advance to sustainable photocatalytic UES under conditions close to practical scenarios.

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Spliceosome component Usp39 contributes to hepatic lipid homeostasis through the regulation of autophagy

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Regulation of alternative splicing (AS) enables a single transcript to yield multiple isoforms that increase transcriptome and proteome diversity. Here, we report that spliceosome component Usp39 plays a role in the regulation of hepatocyte lipid homeostasis. We demonstrate that Usp39 expression is downregulated in hepatic tissues of non-alcoholic fatty liver disease (NAFLD) and non-alcoholic steatohepatitis (NASH) subjects. Hepatocyte-specific *Usp39* deletion in mice leads to increased lipid accumulation, spontaneous steatosis and impaired autophagy. Combined analysis of RNA immunoprecipitation (RIP-seq) and bulk RNA sequencing (RNA-seq) data reveals that Usp39 regulates AS of several autophagy-related genes. In particular, deletion of Usp39 results in alternative 5′ splice site selection of exon 6 in Heat shock transcription factor 1 (*Hsf1*) and consequently its reduced expression. Importantly, overexpression of *Hsf1* could attenuate lipid accumulation caused by Usp39 deficiency. Taken together, our findings indicate that Usp39-mediated AS is required for sustaining autophagy and lipid homeostasis in the liver.

Non-alcoholic fatty liver disease (NAFLD) is the most common liver disease, with a global prevalence of 25%[1], and is strongly associated with metabolic syndrome, obesity, and diabetes[2]. Non-alcoholic steatohepatitis (NASH) is a more severe subtype of NAFLD characterized by diffuse fatty infiltration and inflammation[3]. NASH can lead to fibrosis, cirrhosis and hepatocellular carcinoma[4], and is now the second leading cause of liver transplantation. Currently, no drugs have been approved by the FDA for the treatment of NAFLD and NASH, and the pathogenesis of NAFLD is not clearly understood.

In NAFLD, hepatic fat accumulation is the result of an imbalance between lipid acquisition and disposal, and recent evidence suggests that autophagy is an important modulator of hepatic metabolism and that defective autophagy may contribute to the pathogenesis of NAFLD[5]. Autophagy mediates the breakdown of intracellular lipid droplets in hepatocytes through the process of lipophagy[6]. Hepatic loss of *Atg7* increases lipid accumulation due to defective autophagy, leading to NAFLD in mice[7], and *ATG7* gene mutations in human patients increase the risk of NAFLD[8]. In addition, liver-specific knockout of *Tfeb* promotes high-fat diet (HFD) induced hepatic steatosis[9].

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The role of mechano-regulated YAP/TAZ in erectile dysfunction

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Phosphodiesterase type 5 inhibitors (PDE5is) constitute the primary therapeutic option for treating erectile dysfunction (ED). Nevertheless, a substantial proportion of patients, approximately 30%, do not respond to PDE5i treatment. Therefore, new treatment methods are needed. In this study, we identified a pathway that contributes to male erectile function. We show that mechano-regulated YAP/TAZ signaling in smooth muscle cells (SMCs) upregulates adrenomedullin transcription, which relaxed the SMCs to maintain erection. Using single-nucleus RNA sequencing, we investigated how penile erection stretches the SMCs, inducing YAP/TAZ activity. Subsequently, we demonstrate that YAP/TAZ plays a role in erectile function and penile rehabilitation, using genetic lesions and various animal models. This mechanism relies on direct transcriptional regulation of adrenomedullin by YAP/TAZ, which in turn modulates penile smooth muscle contraction. Importantly, conventional PDE5i, which targets NO-cGMP signaling, does not promote erectile function in YAP/TAZ-deficient ED model mice. In contrast, by activating the YAP/TAZ-adrenomedullin cascade, mechanostimulation improves erectile function in PDE5i nonrespondent ED model rats and mice. Furthermore, using clinical retrospective observational data, we found that mechanostimulation significantly promotes erectile function in patients irrespective of PDE5i use. Our studies lay the groundwork for exploring the mechano-YAP/TAZ-adrenomedullin axis as a potential target in the treatment of ED.

Erectile dysfunction (ED), also known as impotence, is characterized by the inability to maintain sufficient rigidity of the penile erection to accomplish copulation. An erection is accomplished by arterial dilation smooth muscle relaxation, and venous constriction around the penis. Consequently, the corpus cavernosum fills with and retains blood to achieve and maintain an erection[1,2]. The most commonly used medicines for ED are phosphodiesterase type 5 inhibitors (PDE5i), widely known by its commercial name Viagra[3]. PDE5is bind to the catalytic site of PDE5 to block the degradation of cGMP in smooth muscle cells (SMCs), thereby potentiating the effects of cGMP on smooth muscle relaxation to prolong erections[4]. PDE5is, such as sildenafil and tadalafil, are the most common clinically used drugs to treat ED. However, approximately 30% of ED patients are classified as "nonresponders" to PDE5is[5], spurring interest in finding new treatment options.

During clinical practice, physiotherapies, such as vacuum erection devices (VEDs) and shock wave therapy (SWT), have been widely used to treat ED patients. VED relies on negative pressure to draw blood into the penis, and repeated application has been shown to improve ED[1,3,6,7]. SWT consists of noninvasive low-intensity sound waves that pass through erectile tissue, restoring natural erectile function[3,8]. However,

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Nanoparticle-mediated TRPV1 channel blockade amplifies cancer thermo-immunotherapy via heat shock factor 1 modulation

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The survival of malignant tumors is highly dependent on their intrinsic self-defense pathways such as heat shock protein (HSP) during cancer therapy. However, precisely dismantling self-defenses to amplify antitumor potency remains unexplored. Herein, we demonstrate that nanoparticle-mediated transient receptor potential vanilloid member 1 (TRPV1) channel blockade potentiates thermo-immunotherapy via suppressing heat shock factor 1 (HSF1)-mediated dual self-defense pathways. TRPV1 blockade inhibits hyperthermia-induced calcium influx and subsequent nuclear translocation of HSF1, which selectively suppresses stressfully overexpressed HSP70 for enhancing thermotherapeutic efficacy against a variety of primary, metastatic and recurrent tumor models. Particularly, the suppression of HSF1 translocation further restrains the transforming growth factor β (TGFβ) pathway to degrade the tumor stroma, which improves the infiltration of antitumor therapeutics (e.g. anti-PD-L1 antibody) and immune cells into highly fibrotic and immunosuppressive pancreatic cancers. As a result, TRPV1 blockade retrieves thermo-immunotherapy with tumor-eradicable and immune memory effects. The nanoparticle-mediated TRPV1 blockade represents as an effective approach to dismantle self-defenses for potent cancer therapy.

Intrinsic self-defense pathways of tumor cells severely impair therapeutic potencies[1–3], leading to frequent tumor recurrence and metastasis. For instance, heat shock proteins (HSPs) in tumor cells are stressfully upregulated to repair cell injury upon abnormal hyperthermia that can often be afforded by photothermal conversion agents such as copper sulfide (CuS)-based nanoparticles under light irradiation[4–7], or non-thermal factors such as oxidants and free radicals[8–10], while transforming growth factor β (TGFβ) pathway at tumor causes inaccessibility of antitumor therapeutics through elevated cascade proliferation and activation of cancer-associated fibroblasts (CAFs) to induce excessive enrichment of extracellular matrix (ECM) in tumors[11,12], further severely compromising antitumor efficacy of conventional therapeutic compounds against fibrotic tumors such as pancreatic ductal adenocarcinoma (PDAC) tumors, together with inevitable tumor recurrence and metastasis[11,13]. Although relevant small-molecule inhibitors have been extensively explored to dismantle self-defenses of tumors for improving therapeutic potencies[14–16], such compounds still suffer from severe dose-limiting off-target toxicities owing to their indiscriminate suppression of stressfully overexpressed proteins in tumor and normally expressed

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Actinide-lanthanide single electron metal-metal bond formed in mixed-valence di-metallofullerenes

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Understanding metal-metal bonding involving f-block elements has been a challenging goal in chemistry. Here we report a series of mixed-valence di-metallofullerenes, ThDy@C_{2n} ($2n$ = 72, 76, 78, and 80) and ThY@C_{2n} ($2n$ = 72 and 78), which feature single electron actinide-lanthanide metal-metal bonds, characterized by structural, spectroscopic and computational methods. Crystallographic characterization unambiguously confirmed that Th and Y or Dy are encapsulated inside variably sized fullerene carbon cages. The ESR study of ThY@D_{3h}(5)-C_{78} shows a doublet as expected for an unpaired electron interacting with Y, and a SQUID magnetometric study of ThDy@D_{3h}(5)-C_{78} reveals a high-spin ground state for the whole molecule. Theoretical studies further confirm the presence of a single-electron bonding interaction between Y or Dy and Th, due to a significant overlap between hybrid spd orbitals of the two metals.

Metal-metal bonding is a classic research topic in chemical bonding studies and has been applied as a tool for developing molecular magnets as well as for addressing challenges in biology, energy, and catalysis[1,2]. Thus far, most of the metal-metal bonding studies have focused on the interactions involving d orbitals. By contrast, direct bonds between f-block metals are extremely difficult to prepare by conventional synthetic methods due to the limited extension of 4f or 5f orbitals, and remained elusive until the very recent isolation of a dilanthanide complex featuring lanthanide metal-metal bonds[3]. In this study, Long, Harvey, and Chilton et al. significantly demonstrated that single electron lanthanide metal-metal bonds, which give rise to an enormous coercive magnetic field at liquid nitrogen temperature, can be obtained in mixed-valence dilanthanide complexes $(Cp^{iPr5})_2Ln_2I_3$ (Ln = Gd, Tb, or Dy) via salt metathesis reaction[4]. On the other hand, Liddle et al. also reported the synthesis of a tri-thorium cluster with a delocalized 3-center-2-electron Th-Th bond very recently by using $K_2[C_4(SiMe_3)_4]$ as the reduced reagent to generate thorium(III)-containing complexes which contains low-valence thorium ions in close proximity[5].

Endohedral doping of fullerenes with a variety of metal atoms or metallic clusters to form endohedral metallofullerenes (EMFs) provides many possibilities for the investigation of metal-metal interactions[6–8]. In particular, di-metallofullerenes (di-EMFs), with only two metal atoms trapped inside the carbon cages, i.e. $M_2@C_{2n}$, provide a unique platform to study these bonding interactions. In these di-EMFs, the two metal atoms generally adopt relatively long

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Uncertainty-inspired open set learning for retinal anomaly identification

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Failure to recognize samples from the classes unseen during training is a major limitation of artificial intelligence in the real-world implementation for recognition and classification of retinal anomalies. We establish an uncertainty-inspired open set (UIOS) model, which is trained with fundus images of 9 retinal conditions. Besides assessing the probability of each category, UIOS also calculates an uncertainty score to express its confidence. Our UIOS model with thresholding strategy achieves an F1 score of 99.55%, 97.01% and 91.91% for the internal testing set, external target categories (TC)-JSIEC dataset and TC-unseen testing set, respectively, compared to the F1 score of 92.20%, 80.69% and 64.74% by the standard AI model. Furthermore, UIOS correctly predicts high uncertainty scores, which would prompt the need for a manual check in the datasets of non-target categories retinal diseases, low-quality fundus images, and non-fundus images. UIOS provides a robust method for real-world screening of retinal anomalies.

Retina is part of the central nervous system responsible for phototransduction. Retinal diseases are the leading cause of irreversible blindness and visual impairment worldwide. Treatment at the early stage of disease is important to reduce serious and permanent damages. Therefore, timely diagnosis and appropriate treatment are important for preventing threatened vision and even irreversible blindness. Diagnosis of retinal diseases requires expertise of trained ophthalmologists, while there is always heavy demand for large number of patients with retinal diseases to limited number of specialists. A solution to this service gap is image-based screening that alleviates workload of ophthalmologists. Fundus photography-based screening has been shown to be successful to

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Radiolytic Water Splitting Sensitized by Nanoscale Metal–Organic Frameworks

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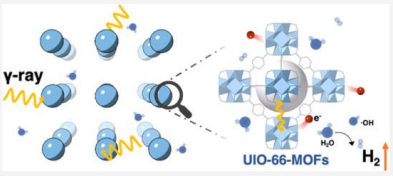
ABSTRACT: High-energy radiation that is compatible with renewable energy sources enables direct H_2 production from water for fuels; however, the challenge is to convert it as efficiently as possible, and the existing strategies have limited success. Herein, we report the use of Zr/Hf-based nanoscale UiO-66 metal–organic frameworks as highly effective and stable radiation sensitizers for purified and natural water splitting under γ-ray irradiation. Scavenging and pulse radiolysis experiments with Monte Carlo simulations show that the combination of 3D arrays of ultrasmall metal-oxo clusters and high porosity affords unprecedented effective scattering between secondary electrons and confined water, generating increased precursors of solvated electrons and excited states of water, which are the main species responsible for H_2 production enhancement. The use of a small quantity (<80 mmol/L) of UiO-66-Hf-OH can achieve a γ-rays-to-hydrogen conversion efficiency exceeding 10% that significantly outperforms Zr-/Hf-oxide nanoparticles and the existing radiolytic H_2 promoters. Our work highlights the feasibility and merit of MOF-assisted radiolytic water splitting and promises a competitive method for creating a green H_2 economy.



INTRODUCTION

Hydrogen (H_2) as an ultraclean fuel has potential to power the future and tackle climate change. However, to be completely green and sustainable, H_2 must be produced from abundant resources like water using renewable energy. Most technologies for producing green H_2 focus on thermochemical, electrolytic, and photolytic processes, yet they are still facing efficiency or economic challenges. In the midst of increasing environmental and energy crises, the extraction of H_2 from water with ionizing radiation stands out as an appealing choice and offers an uncomplicated pathway for energy diversity. It has been known for many decades that high-energy radiation (e.g., α-, β-, and γ-rays) ionizes and excites the water to produce H_2 (eq 1) mostly through reactions of solvated electrons, e_{sol}^-, and H atoms (eqs 2–4). Radiolytic H_2 release has been a fast-growing research subject because of its importance in broad technical and natural situations such as radioactive waste storage and disposal,[1] subsurface microbial ecosystems,[2] and astrobiology.[3] This method should also belong to some complements to conventional sustainable H_2 production using electricity or solar power as the driving forces. Indeed, Marie Curie once compared the radiolytic process to "an electrolysis without electrodes",[4,5] and it precludes any semiconductor materials since the primary electron-solvent cation (e^- and H_2O^+) is formed in the bulk solutions instead of on the surface of separated electrodes or light absorbents.

$$H_2O \rightsquigarrow e_{sol}^-\ (2.8),\ \cdot OH\ (2.8),\ H\cdot(0.62),\ H_3O^+(2.8),\ H_2O_2(0.73),\ H_2(0.42) \quad (1)$$

$$e_{sol}^- + e_{sol}^- + 2H_2O \rightarrow H_2 + 2OH^- \quad (2)$$

$$e_{sol}^- + H\cdot + H_2O \rightarrow H_2 + OH^- \quad (3)$$

$$H\cdot + H\cdot \rightarrow H_2 \quad (4)$$

Although there are obstacles to public acceptance, the radiolytic approach appears to have several advantages including all-day operation of chemical production driven by available radiation sources, low environmental impact, and the possible reuse of nuclear wastes. The past years have witnessed a sharp rise in the number of electron accelerators for wastewater treatment, which can be safely operated and powered by excessive electricity from intermittent energy like solar or wind energy. The ^{60}Co γ-ray sources manufactured by neutron bombardment of stable cobalt in a nuclear reactor have been used in widespread aspects including radiation remediation,[6] sterilization,[7] and medical treatments.[8] Thus, the use of ionizing radiations to produce H_2 can be a carbon-free routine when coupled with renewable and nuclear power sources. Moreover, abundant radioactive used nuclear fuels are daily discharged and stored in water pools, waiting for further valuable reprocessing. The prospect is continuously promoted

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Near-Unity Energy Transfer from Uranyl to Europium in a Heterobimetallic Organic Framework with Record-Breaking Quantum Yield

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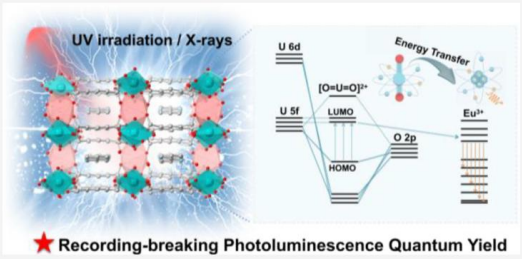
ABSTRACT: Lanthanide organic frameworks (Ln-MOFs) have attracted increasing research enthusiasm as photoluminescent materials. However, limited luminescence efficiency stemming from restricted energy transfer efficiency from the organic linker to the metal center hinders their applications. Herein, a uranyl sensitization approach was proposed to boost the luminescence efficiency of Ln-MOFs in a distinct heterobimetallic uranyl-europium organic framework. The record-breaking photoluminescence quantum yield (PLQY, 92.68%) among all reported Eu-MOFs was determined to benefit from nearly 100% energy transfer efficiency between UO_2^{2+} and Eu^{3+}. Time-dependent density functional theory and ab initio wave-function theory calculations confirmed the overlap of excited state levels between UO_2^{2+} and Eu^{3+}, which is responsible for the efficient energy transfer process. Coupled with intrinsically strong stopping power toward X-ray of the uranium center, SCU-UEu-2 features an ultralow detection limit of 1.243 μGyair/s, outperforming the commercial scintillator LYSO (13.257 μGyair/s) and satisfying the requirement of X-ray diagnosis (below 5.5 μGyair/s) in full.



INTRODUCTION

In the context of trivalent lanthanide ions (Ln^{3+}) with a low molar absorption coefficient originating from their electric-dipole forbidden 4f−4f transitions in diluted solutions, the direct excitation of Ln^{3+} is very inefficient unless high-power laser excitation is utilized.[1,2] This problem can be overcome via a well-known energy transfer process, termed the "antenna effect". It utilizes organic linkers with strong absorption chromophores to sensitize Ln^{3+} emission, leading to a high photoluminescence quantum yield (PLQY), which is perceived as a long-term goal pursued by luminescent materials.[3−7] However, nonradiative deactivation arising from the vibronic coupling (C−H, N−H, O−H) of organic linkers in the structure is one of the most important factors that weakens the luminescence efficiency of lanthanide compounds.[8] Selective ligand deuteriation is capable of attenuating the quenching effect of nonradiative deactivation, benefiting from the lower stretching frequencies of O−D, N−D, and C−D oscillators.[9] Utilizing conjugated ligands is another way to achieve high PLQY by lessening nonradioactive deactivation and facilitating intersystem crossing (ISC) efficiency.[10,11] However, only elaborately designed organic ligands can meet the requirement of boosting the energy transfer process, that is the lowest triplet state of the organic linkers should be located at an energy level slightly above the resonance level of Ln^{3+}.[12,13] Thus, these praised approaches are seriously limited when used for constructing highly luminescent materials. Searching for new sensitization pathways may favor the construction of high PLQY framework materials and extend their applications in a wide range of functional luminescent materials.[14−18]

Introducing metal ions is frequently used to sensitize the emission center in lanthanide inorganic compounds. Ce^{3+} has a broad absorption band originating from its parity-allowed 4f−5d transition. It is often used as a sensitizer to improve the luminescence efficiency of other ions (Tb^{3+}, Nd^{3+}, Eu^{3+}, Mn^{2+}) by absorbing UV radiation and then transfers the energy to the luminescence center.[19] Notably, the uranyl ion (UO_2^{2+}) also exhibits a broad absorption band ranging from 350 to 500 nm and usually possesses characteristic emissions in the green-yellow region where electrons of uranyl's molecular orbitals are excited to the nonbonding U-5f orbitals.[20−22] Characteristic emission peaks ranging from 470 to 590 nm (approximately

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A Radioluminescent Metal–Organic Framework for Monitoring ^{225}Ac *in Vivo*

Yugang Zhang, Feize Li, Zhencun Cui, Kai Li, Jingwen Guan, Longlong Tian,* Yaxing Wang,* Ning Liu, Wangsuo Wu, Zhifang Chai, and Shuao Wang*

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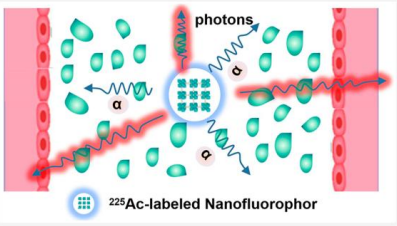
ABSTRACT: ^{225}Ac is considered as one of the most promising radioisotopes for alpha-therapy because its emitted high-energy α-particles can efficiently damage tumor cells. However, it also represents a significant threat to healthy tissues owing to extremely high radiotoxicity if targeted therapy fails. This calls for a pressing requirement of monitoring the biodistribution of ^{225}Ac *in vivo* during the treatment of tumors. However, the lack of imageable photons or positrons from therapeutic doses of ^{225}Ac makes this task currently quite challenging. We report here a nanoscale luminescent europium-organic framework (EuMOF) that allows for fast, simple, and efficient labeling of ^{225}Ac in its crystal structure with sufficient ^{225}Ac-retention stability based on similar coordination behaviors between Ac^{3+} and Eu^{3+}. After labeling, the short distance between ^{225}Ac and Eu^{3+} in the structure leads to exceedingly efficient energy transduction from ^{225}Ac-emitted α-particles to surrounding Eu^{3+} ions, which emits red luminescence through a scintillation process and produces sufficient photons for clearcut imaging. The *in vivo* intensity distribution of radioluminescence signal originating from the ^{225}Ac-labeled EuMOF is consistent with the dose of ^{225}Ac dispersed among the various organs determined by the radioanalytical measurement *ex vivo*, certifying the feasibility of *in vivo* directly monitoring ^{225}Ac using optical imaging for the first time. In addition, ^{225}Ac-labeled EuMOF displays notable efficiency in treating the tumor. These results provide a general design principle for fabricating ^{225}Ac-labeled radiopharmaceuticals with imaging photons and propose a simple way to *in vivo* track radionuclides with no imaging photons, including but not limited to ^{225}Ac.



INTRODUCTION

Alpha-therapy labeling an alpha-emitting radionuclide in medicine holds great potential for treating late-stage cancers for which therapeutic options are limited, benefiting from its high linear energy transfer (50–230 keV μm^{-1}) leading to dense radiation damage and its short tissue range (40–100 μm) minimizing negative effects on healthy surrounding tissues.[1−4] Considering the multiple α-particles with high energies (from 5.8 to 7.1 MeV) and a suitable half-life ($t_{1/2}$ = 10 days) for allowing sufficient therapy time, ^{225}Ac has been recognized as one of the most promising candidates for alpha-therapy, although more than 100 radionuclides can emit α-particles.[5−11]

Alpha-therapy using ^{225}Ac-labeled radiopharmaceuticals is still a double-edged sword. It will indistinguishably destroy the DNA double strand and render high cell toxicity, leading to efficient ablation of tumor cells and unavoidable damage to the healthy tissue where it migrates and when targeted therapy fails. Therefore, a suitable method should be provided to monitor the biodistribution of ^{225}Ac-labeled radiopharmaceuticals during the treatment. However, the lack of imageable photons or positrons from therapeutic quantities of ^{225}Ac hinders routine treatment planning and radiopharmaceutical tracking.[12−14] Positron emission tomography (PET) imaging is arguably one of the most powerful techniques for *in vivo* diagnostics, and it is also used to monitor the ^{225}Ac treatment method in contemporary preclinical and clinical studies.[15−22] However, direct PET imaging from ^{225}Ac is impossible, because it does not emit positrons. Among available PET imaging radiometals, ^{68}Ga ($t_{1/2}$ = 67.7 min) and ^{64}Cu ($t_{1/2}$ = 12.7 h) have been used previously as theranostic matched pairs for ^{225}Ac.[23−25] Unfortunately, these elements poorly represent the unique chemistry of ^{225}Ac because of their large differences in physicochemical properties. Benefiting from their similar ionic radius and coordination model, lanthanide isotopes (^{132}La, ^{133}La, ^{134}La, and ^{134}Ce) have been chosen as PET imaging surrogates for therapeutic ^{225}Ac. However, the challenge of monitoring the biodistribution of ^{225}Ac in real time during the treatment remains. Searching for a simple and general way to overcome this obstacle will promote the development of ^{225}Ac-labeled radiopharmaceuticals.

Optical imaging is a powerful technique with numerous advantages, including high sensitivity, low cost, and a short

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Radiation-Induced De Novo Defects in Metal–Organic Frameworks Boost CO_2 Sorption

Junchang Chen,[#] Mingxing Zhang,[#] Jie Shu,[#] Shengtang Liu, Xiao Dong, Chunyang Li, Linwei He, Mengjia Yuan, Yutian Wu, Jiahui Xu, Duo Zhang, Fuyin Ma, Guozhong Wu, Zhifang Chai, and Shuao Wang*

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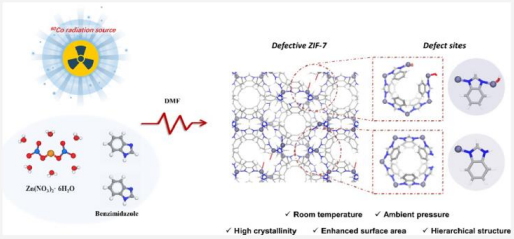
ABSTRACT: Defects in metal–organic frameworks (MOFs) can significantly change their local microstructures, thus notably leading to an alteration-induced performance in sorption or catalysis. However, achieving de novo defect engineering in MOFs under ambient conditions without the scarification of their crystallinity remains a challenge. Herein, we successfully synthesize defective ZIF-7 through ^{60}Co gamma ray radiation under ambient conditions. The obtained ZIF-7 is defect-rich but also has excellent crystallinity, enhanced BET surface area, and hierarchical pore structure. Moreover, the amount and structure of these defects within ZIF-7 were determined from the two-dimensional (2D) $^{13}C-^{1}H$ frequency-switched Lee–Goldburg heteronuclear correlation (FSLG-HETCOR) spectra, continuous rotation electron diffraction (cRED), and high-resolution transmission electron microscopy (HRTEM). Interestingly, the defects in ZIF-7 all strongly bind to CO_2, leading to a remarkable enhancement of the CO_2 sorption capability compared with that synthesized by the solvothermal method.



INTRODUCTION

Defect engineering in metal–organic frameworks (MOFs) is a powerful strategy to tailor their physicochemical properties[1] and has been widely studied in important application fields such as sorption,[2] separation,[3] band structures,[4] mechanical responses,[5] and catalysis.[6] Defective MOFs are usually derived from the absence of linkers or metal nodes during the de novo synthesis or postsynthetic treatment of parent MOFs, thereby leading to the formation of new chemical structures and hierarchical pore architectures, which provide more active sites and enhance the efficiency of mass transfer.[7] Despite the successful synthesis of defective MOFs with good crystallinity using acid modulators or the addition of ligand fragments during the synthesis process, the degree of defects is limited and this is not a general method for most MOFs.[1b,d,8] Postsynthetic treatment with thermal,[9] laser photolysis,[10] and inorganic acid or base[11] can be applied in defect engineering of MOFs. Although it enhances the defect content, it also inevitably leads to poor crystallinity or even transformation to amorphous products.[12] Additionally, additional energy consumption and waste are generated.[13] Until now, defect engineering in MOFs without sacrificing the intrinsic properties, e.g., stability, crystallinity, surface area, and porosity, of parent MOFs remains elusive.[14]

Ionization radiations such as electron beam and gamma ray are unique energy sources with the merits of high energy and excellent penetrating power, which can immediately produce various active species to trigger or promote chemical reactions.[15] In addition, these radiation energies are several magnitudes higher than the energy of any chemical bonds, which can facilely destroy local chemical structures to form defects within materials via the radiation etching effect.[16] Over the past few decades, ionization radiation has been applied in chemistry for the highly efficient synthesis of various organic polymers and inorganic nanoparticles.[17] As an advanced synthesis technique, ionization radiation has recently been extended to the synthesis of crystalline porous materials, including covalent organic frameworks (COFs),[18] grafted COFs,[19] inorganic zeolites,[20] MOFs, and MOFs@metal oxide heterostructures,[13b] demonstrating the advantages of high efficiency, maneuverable operation under ambient conditions, energy and time savings, and environmental friendliness.[21]

Zeolitic imidazolate frameworks (ZIFs) are a unique family of MOFs with similar topological structures as aluminosilicate

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Doped Graphene To Mimic the Bacterial NADH Oxidase for One-Step NAD^+ Supplementation in Mammals

Xi Liu, Jingkun Li, Andrea Zitolo, Meng Gao, Jun Jiang, Xiangtian Geng, Qianqian Xie, Di Wu, Huizhen Zheng, Xiaoming Cai, Jianmei Lu, Frédéric Jaouen,* and Ruibin Li*

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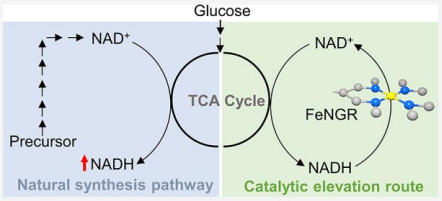
ABSTRACT: Nicotinamide adenine dinucleotide (NAD) is a critical regulator of metabolic networks, and declining levels of its oxidized form, NAD^+, are closely associated with numerous diseases. While supplementing cells with precursors needed for NAD^+ synthesis has shown poor efficacy in combatting NAD^+ decline, an alternative strategy is the development of synthetic materials that catalyze the oxidation of NADH into NAD^+, thereby taking over the natural role of the NADH oxidase (NOX) present in bacteria. Herein, we discovered that metal-nitrogen-doped graphene (MNGR) materials can catalyze the oxidation of NADH into NAD^+. Among MNGR materials with different transition metals, Fe-, Co-, and Cu-NGR displayed strong catalytic activity combined with >80% conversion of NADH into NAD^+, similar specificity to NOX for abstracting hydrogen from the pyridine ring of nicotinamide, and higher selectivity than 51 other nanomaterials. The NOX-like activity of FeNGR functioned well in diverse cell lines. As a proof of concept of the in vivo application, we showed that FeNGR could specifically target the liver and remedy the metabolic flux anomaly in obesity mice with NAD^+-deficient cells. Overall, our study provides a distinct insight for exploration of drug candidates by design of synthetic materials to mimic the functions of unique enzymes (e.g., NOX) in bacteria.



INTRODUCTION

Nicotinamide adenine dinucleotide (NAD) is an essential cofactor extensively expressed in all living cells.[1] Its oxidized and reduced forms (NAD^+ and NADH, respectively) play a key role in the electron transport chain (ETC) of metabolic processes, where NAD^+ serves as an electron acceptor in metabolic redox reactions of cells.[2,3] These reactions are crucial for cells to maintain their elemental biological functions by harvesting energy from fuel molecules such as glucose and fatty acids.[4] The physiological functions of NAD^+ as an essential coenzyme in metabolic networks have been highly underlined.[5] While the decline in NAD^+ levels is closely associated with aging,[6] metabolic diseases,[7,8] neurodegenerative disorders,[9] and cancers,[10,11] elevation of this cofactor by supplementing cells with precursors needed for NAD^+ synthesis has shown considerable benefits in preclinical trials.[12−15] This has aroused great interest in the exploration of efficient and affordable pathways to increase NAD^+ levels for biomedical applications.

Mammalian cells can produce NAD^+ via two pathways, namely, the de novo synthesis (DNS) pathway and the salvage pathway[16] (Figure S1). The former requires seven steps to synthesize NAD^+ from its main building block, namely, the amino acid tryptophan, and was shown to be poorly efficient in biomedical applications.[17] The salvage pathway utilizes vitamin B_3 derivatives, including niacinamide (NAM), nicotinic acid (NA), or nicotinamide ribose (NR), bypassing the synthesis of adenine and resulting in the synthesis of NAD^+ in fewer steps.[18] However, supplementation of B_3 derivatives may lead to NADH accumulation, resulting in side effects such as hepatic pressure, tissue-specific cytotoxicity, and even carcinogenesis.[19] In contrast to mammalian cells, the NADH oxidase (NOX) was found in some bacteria to be involved in the regulation of NAD^+ levels via the direct conversion of NADH into NAD^+.[20] The advent of synthetic nanomaterials with NOX-like activity holds great interest.

The rapid development of nanotechnologies allows the precise design of nanostructures that mimic the catalytic properties of natural enzymes, namely, nanozymes.[21,22] However, most nanozymes can merely catalyze the degradation of peroxides, oxygen and superoxide, while nanozymes with reactivity toward C−H bonds have rarely been reported. Synthetic metal-nitrogen-graphene (MNGR) materials originally developed for catalyzing O_2 electroreduction were recently investigated in the field of heterogeneous catalysis for the activation of C−H bonds.[23−25] The 3d transition metals are often chosen as the dopants due to their superior efficiency to catalyze reduction and/or oxidation reactions, low

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Alkaline Phosphatase-Controllable and Red Light-Activated RNA Modification Approach for Precise Tumor Suppression

Jing Fang, Yali Feng, Yuqi Zhang, Anna Wang, Jiachen Li, Chaoxiang Cui, Yirui Guo, Jinfeng Zhu, Zhengzhong Lv, Zhongsheng Zhao, Chenjie Xu, and Haibin Shi*

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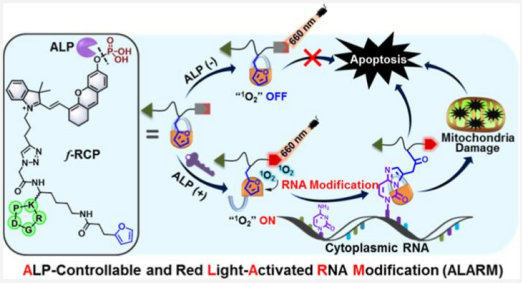
ABSTRACT: RNA interference (RNAi) has proved to be a promising modality for disease treatment. However, the promise of conventional RNA therapeutics for clinical application is severely impeded by low delivery efficiency and susceptibility of RNAs to serum RNases. Therefore, developing advanced RNAi technology is an increasing demand for achieving precise medicine. Herein, for the first time, we propose an alkaline phosphatase (ALP)-controllable and red light-activated RNA modification (ALARM) approach for anti-tumor therapeutic application. An ALP-responsive NIR fluorogenic probe *f*-RCP consisting of a tumor-targeting cyclic RGD peptide, an ALP-activated photosensitizer CyOP, and an $^1O_2$-susceptible furan module for RNA modification was rationally designed and synthesized. Studies have demonstrated that *f*-RCP can specifically target to liver carcinoma HepG2 cells and spontaneously emit activated NIR/photoacoustic signals upon cleavage by the ALP enzyme, allowing for sensitive detection of ALP-positive tumors. More notably, we surprisingly found that the capability of *f*-RCP producing singlet oxygen ($^1O_2$) under red light irradiation could be simultaneously unlocked, which can ignite the covalent cyclization reaction between furan and nucleobases of intracellular RNA molecules, leading to significant mitochondrial damage and severe apoptosis of tumor cells, in consequence realizing efficient tumor suppression. Most importantly, the potential therapeutic mechanism was first explored on the transcriptomic level. This delicate ALARM strategy may open up new insights into cancer gene therapy.



ALP-Controllable and Red Light-Activated RNA Modification (ALARM)

INTRODUCTION

The treatment of malignant tumor still faces huge challenges and bottlenecks such as tumor heterogeneity, drug resistance, and systemic toxicity.[1−5] Among the conventional therapeutic modalities, gene therapy as an emerging technique to regulate the expression of targeted gene holds immense potential for treating various human diseases including cancer.[6−14] Over the past decades, considerable efforts have been devoted to developing gene silencing techniques.[15−21] However, the low delivery efficiency, potential systemic toxicity, and high cost of gene therapeutics greatly hinder their extensive applications in clinical practices.[22−26] Therefore, it is highly urgent to explore advanced gene interference techniques for improving the therapeutic efficacy of tumors while minimizing its side effects for normal tissues and/or organs.

Ribonucleic acid (RNA) as a vital component of the Central Dogma has been well recognized for its roles in transcription and translation.[27−30] RNA interference (RNAi) technology has proved to be a promising modality for cancer and other disease treatments by silencing the target gene expression. Thus far, two types of RNAi therapeutic strategies have been developed to silence the RNA molecules that are associated with certain diseases by utilizing antisense oligonucleotides[31−34] and small molecules.[30,35−38] However, their promise for clinical application is greatly impeded by low delivery efficiency, susceptibility of RNA to serum RNases, poor gene silencing activity due to noncovalent interaction,[39−41] and potential systemic toxicity.[42−44] Numerous studies have recently demonstrated that the covalent modification of RNA strands can disturb the function of targeted RNA, leading to dysregulated expression of downstream proteins that may impact various cellular processes,[45−49] which has been considered to be a promising approach for gene silencing. Op de Beeck and Madder have previously reported a photo-induced cross-linking method to study the intermolecular interaction of DNA−DNA and protein−DNA through the $^1O_2$-initiated cycloaddition reaction between furan and

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Article

USc_2C_2 and USc_2NC Clusters with U−C Triple Bond Character Stabilized Inside Fullerene Cages

Hongjie Jiang,[⊥] Xiaojuan Yu,[⊥] Min Guo,[⊥] Yang-Rong Yao, Qingyu Meng, Luis Echegoyen, Jochen Autschbach,* and Ning Chen*

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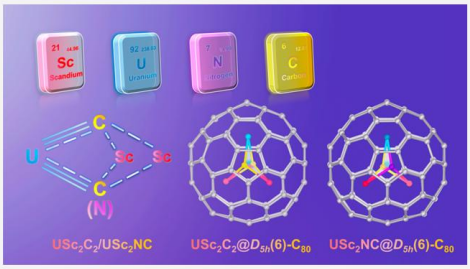
ABSTRACT: The chemistry of f-block metal−carbon multiple bonds is underdeveloped compared to well-established carbene complexes of the d-block transition metals. Herein, we report two new actinide-rare earth mixed metal carbides and nitrogen carbide cluster fullerenes, USc_2C_2@$D_{5h}(6)$-C_{80} and USc_2NC@$D_{5h}(6)$-C_{80}, which contain U−C bonds with triple bond character and were successfully synthesized and characterized by mass spectrometry, UV−vis−NIR spectroscopy, Fourier transform infrared spectroscopy, single crystal X-ray diffraction, and DFT calculations. Crystallographic studies show that the two previously unreported clusters, USc_2C_2 and USc_2NC, are stabilized in the $D_{5h}(6)$-C_{80} carbon cage and adopt unique trifoliate configurations, in which C_2/NC units are almost vertically inserted into the plane defined by the U and two Sc atoms. Combined experimental and theoretical studies further reveal the bonding structure of USc_2C_2 and USc_2NC, which contain C═U(VI)═C and C═U(V)═N bonding motifs. The electronic structures of the two compounds are determined as $U^{6+}(Sc_2)^{6+}(C^{4-})_2$@$D_{5h}(6)$-$C_{80}^{4-}$ and $U^{5+}(Sc_2)^{6+}(N)^{3-}(C)^{4-}$@$D_{5h}(6)$-$C_{80}^{4-}$, respectively. Quantum-chemical studies confirm that the U−C bonds in both molecules show unprecedented multicenter triple-bond character. The discovery of this unique U−C multiple bond offers a deeper understanding of the fundamentals of uranium chemistry.



INTRODUCTION

Understanding the nature of actinide-ligand multiple bonding is a burgeoning but challenging topic due to the complexity of the electronic structures.[1,2] In particular, the metal−carbon multiple bond chemistry of f-block elements, i.e. lanthanides and actinides, remains underdeveloped compared to the well-established carbene complexes of the d-block transition metals. Recent developments in the synthesis of ligand-stabilized molecular uranium complexes containing U═C double bonds such as $[U(BIPM^{TMS})(O)(Cl)_2]$ and $[U(BIPM^{TMS})_2]$[3−6] provide important insights regarding the bonding structures and the potential for uranium to engage in covalent multiple bonding involving chiefly the 7s, 6d, and 5f shells. Furthermore, the reaction of laser-ablated uranium atoms with halomethanes has also led to a successful path to uranium multiple bonds such as doubly bonded H_2C═UHF and H_2C═UF_2 molecules[7,8] and triply bonded HC≡UF_3 and FC≡UF_3 molecules.[9] Although these systems were prepared only in very small quantities in matrix isolation experiments, the bonding analyses based on infrared spectroscopy and quantum chemistry methods show the potential for uranium to form multiple bonds with different motifs.

Fullerenes, with their nanoscale hollow cavities, can behave as nanocontainers to stabilize metals and metal clusters with bonding motifs that cannot be obtained under conventional synthetic conditions.[10−20] In the past two decades, endohedral fullerenes containing variable unconventional lanthanide clusters and transition metal clusters have been reported, such as Ti_3C_3@$I_h(7)$-C_{80},[10] Sc_3C_2@$I_h(7)$-C_{80},[11] Sc_2O@$D_{3h}(24109)$-C_{78},[12] TbCN@$C_s(6)$-C_{82},[13] TiM_2C@$I_h(7)$-C_{80} (M = Lu, Sc, Tb, Dy),[14−17] and Dy_3C_2@$I_h(7)$-C_{80}.[18] The rather unique properties of fullerene cages led us to explore elusive uranium bonding motifs stabilized by fullerene cages, aiming to expand our understanding of fundamental uranium bonding properties. For example, a nonlinear U═C═U cluster, which contains two unprecedented axial U═C double bonds, was found to be stabilized inside an $I_h(7)$-C_{80} fullerene cage.[19] Recently, we reported the unique η^2 (side-on) coordination of U by a cyanide in a UCN cluster, which was stabilized inside a C_{82} fullerene cage.[20] These findings suggest that unique actinide clusters with elusive actinide bonding motifs can be captured and stabilized by fullerenes because of

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Synthesis and Characterization of U≡C Triple Bonds in Fullerene Compounds

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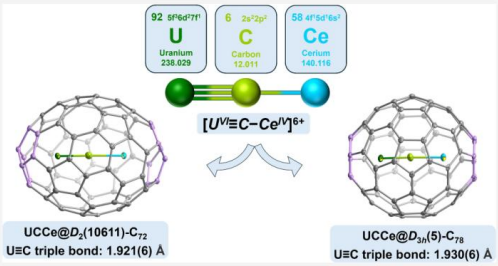
ABSTRACT: Despite decades of efforts, the actinide−carbon triple bond has remained an elusive target, defying synthesis in any isolable compound. Herein, we report the successful synthesis of uranium−carbon triple bonds in carbide-bridged bimetallic [U≡C−Ce] units encapsulated inside the fullerene cages of C_{72} and C_{78}. The molecular structures of UCCe@C_{2n} and the nature of the U≡C triple bond were characterized through X-ray crystallography and various spectroscopic analyses, revealing very short uranium−carbon bonds of 1.921(6) and 1.930(6) Å, with the metals existing in their highest oxidation states of +6 and +4 for uranium and cerium, respectively. Quantum-chemical studies further demonstrate that the C_{2n} cages are crucial for stabilizing the [U^{VI}≡C−Ce^{IV}] units through covalent and coordinative interactions. This work offers a new fundamental understanding of the elusive uranium−carbon triple bond and informs the design of complexes with similar bonding motifs, opening up new possibilities for creating distinctive molecular compounds and materials.



INTRODUCTION

The actinides are technologically important elements, where the understanding of their fundamental chemical properties and roles in the nuclear fuel cycle is critical for advancing nuclear technology,[1] which is important for building a diverse portfolio of carbon-free energy sources. Yet, despite this, the chemistry of the actinide series remains underdeveloped in comparison to transition metals and main group elements. Major in-roads into the understanding of the electronic properties and chemistry of the transition metals have been accomplished over the decades through the synthesis of molecular compounds possessing metal−ligand multiple bonds,[2] where the critical understanding of d-orbital participation in bonding motifs and reactivity has been elucidated. While extensive studies of the uranyl cation, $[O{\equiv}U{\equiv}O]^{2+}$, have shown the 5f orbitals to play a critical role in the formation of the formal uranium−oxygen triple bonds,[3−5] 5f orbital participation in other U═E and U≡E bonding remains less clear and an intensive area of study.[6−9] Indeed, efforts into the synthesis of uranium and actinide metal−ligand multiple bonds have intensified over the past two decades, with significant advances achieved in the synthesis of a variety of carbeno,[10−13] imido,[14−17] nitrido,[18,19] heavier-pnictogenido,[20−22] oxo,[23−26] and chalcogenido complexes.[27−29]

Notable is the progress that has been made in developing methods for the synthesis of new actinide−ligand multiple bonds. Yet, a significant gap exists in the domain of molecular actinide complexes possessing the so-called "true" alkylidene and alkylidyne bonds that are not stabilized through the possible heteroatom resonance contributions.[30] Pioneering matrix isolation experiments identified transient uranium methylidyne molecules $X_3U{\equiv}CH$ (X = F, Cl, Br)[31] and uranium carbides such as U≡C and C≡U≡C.[32] However, these molecules have been observed only through spectroscopic methods at low temperatures in noble-gas matrices and studied theoretically. A recent report shows that the use of a novel alkylidene transfer reagent leads to the isolation of the actinide allenylidenes possessing small but significant An═C═C═CPh_2 (An = Th, U) resonance contributions,[33] which is highly promising as it shows that actinide−carbon multiple bonds may potentially be synthetically accessible under less specialized laboratory conditions. The difficulty in isolating actinide−carbon multiple bonds is thought to arise from high bond polarization and orbital energy mismatch that lead to poor An−C π-overlap.[34]

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RNA Modification

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NIR Light-Mediated Mitochondrial RNA Modification for Cancer RNA Interference Therapeutics

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Abstract: Mitochondrial RNA (mtRNA) plays a critical role in synthesis of mitochondrial proteins. Interfering mtRNA is a highly effective way to induce cell apoptosis. Herein, we report a near-infrared (NIR) light-mediated mitochondrial RNA modification approach for long-term imaging and effective suppression of tumors. A tumor-targetable NIR fluorescent probe *f*-CRI consisting of a cyclic RGD peptide, a NIR fluorophore IR780, and a singlet oxygen ($^1O_2$)-labile furan group for RNA modification was rationally designed and synthesized. This probe was demonstrated to dominantly accumulate in cellular mitochondria and could be covalently conjugated onto mtRNA upon 808 nm irradiation resulting in prolonged retention in tumors. More notably, this covalent modification of mtRNA by *f*-CRI could perturb the function of mitochondria leading to remarkable tumor suppression. We thus envision that our current approach would offer a potential approach for cancer RNA interference therapeutics.

Introduction

Cancer is currently one of the major threats to human life and health worldwide. The conventional techniques for cancer treatment in clinics including surgery, chemotherapy, radiotherapy, photodynamic therapy, immunotherapy, gene therapy, etc, still encounter a huge challenge due to poor tumor-targeting specificity, low therapeutic efficacy, invasiveness, and adverse side effects to healthy tissues.[1] Therefore, it is highly meaningful to exploit novel advanced technique for achieving accurate diagnosis and effective treatment of malignant tumors.

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Ribonucleic acid (RNA), as a key component of Central Dogma, plays a vital role in gene regulation and protein synthesis.[2] RNA interference (RNAi) technology has been proven to be a promising therapeutic modality for various disease treatments by utilizing antisense oligonucleotides or small molecules to manipulate the expression of target genes.[3] Nevertheless, the conventional RNAi approaches still face substantial challenges to be widely applied in clinical practice due to the poor stability of oligonucleotides in blood, low delivery efficiency, insufficient gene silencing activity, and potential systemic toxicity.[3d,4] Thus, there is a highly demand to explore novel advanced and efficient gene therapy technique to achieve precise treatment of human disease. To this end, our group recently reported a red light-mediated RNA modification strategy in which the cytoplasmic RNAs in cancer cells could be specifically and covalently modified by probes through the cycloaddition reaction between furan and nucleotides under the initiation of $^1O_2$ generated by irradiation of photosensitizers with 660 nm laser light, which can cause severe cell apoptosis and significant tumor suppression along with prolonged imaging.[5] More recently, we further developed a smart RNA-reactive NIR probe *f*-RCP whose imaging and $^1O_2$ generation capability can be specifically activated by tumor-overexpressed ALP enzyme.[6] The therapeutic efficiency and accuracy of this system were remarkably improved highly implying the selective and covalent modification of genes within cancer cell has a great potential to realize effective cancer treatment. Nevertheless, the complicate construction and limited tissue penetration of 660 nm light in above system impedes its extensive applications, especially for deep tumors.

Mitochondria as one of the pivotal subcellular organelles have being increasingly recognized to be a promising druggable targets for cancer therapy because they are highly relevant to energy supply,[7] cell growth,[7d,8] and cell metabolism.[9] More importantly, mitochondria possess their own genetic materials and system, and are closely involved in cell differentiation,[10] cell information transmission,[11] and apoptosis.[12] Mitochondrial ribonucleic acids (mtRNA) that generally have a crucial role in guiding protein synthesis can decompose and oxidize the species such as protein, fat, and sugar.[13] Abnormalities occurring in mitochondria, such as interferences at any stage of mtRNA processing and translation, usually induce the damage and dysfunction of mitochondria leading to severe cell apoptosis.[14] Therefore, mitochondrial gene therapy mediated by the covalent

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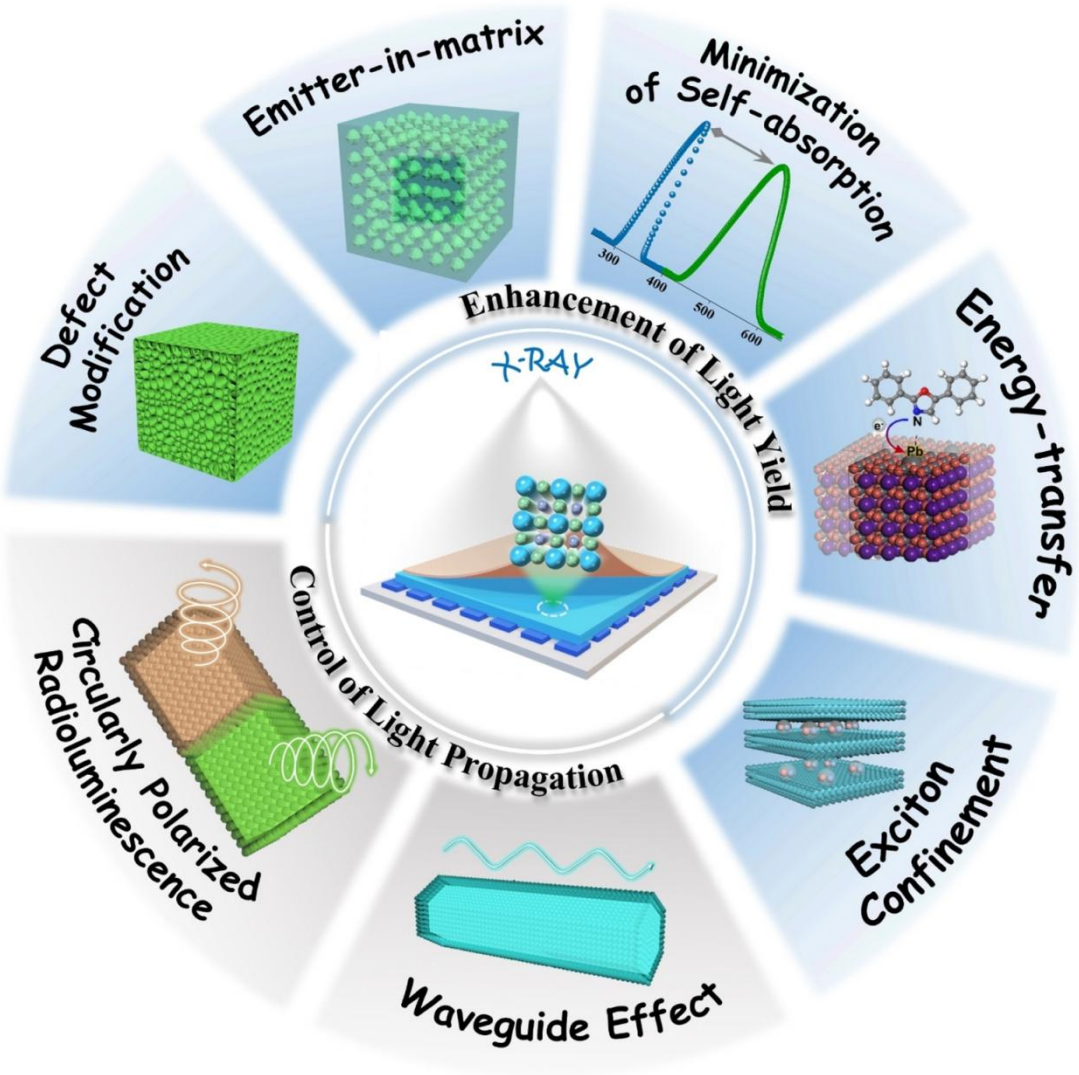
Perovskites

Perovskite Scintillators for Improved X-ray Detection and Imaging

Yumin Wang[+], Ming Li[+], Zhifang Chai, Yaxing Wang, and Shuao Wang**



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MOFs

Assembling a Heterobimetallic Actinide Metal-Organic Framework by a Reaction-Induced Preorganization Strategy

Sen Mei[+], Lixi Chen[+], Hailong Zhang[+], Zhiwei Li, Liwei Cheng, Junhao Lu, Xiaoqi Li, Qian Yang, Yanlong Wang, Zhiyong Liu, Zhifang Chai, and Shuao Wang**

Abstract: Periodically arranging coordination-distinct actinides into one crystalline architecture is intriguing but of great synthetic challenge. We report a rare example of a heterobimetallic actinide metal–organic framework (An-MOF) by a unique reaction-induced preorganization strategy. A thorium MOF (SCU-16) with the largest unit cell among all Th-MOFs was prepared as the precursor, then the uranyl was precisely embedded into the MOF precursor under oxidation condition. Single crystal of the resulting thorium-uranium MOF (SCU-16-U) shows that a uranyl-specific site was in situ induced by the formate-to-carbonate oxidation reaction. The heterobimetallic SCU-16-U exhibits multifunction catalysis properties derived from two distinct actinides. The strategy proposed here offers a new avenue to create mixed-actinide functional material with unique architecture and versatile functionality.

The burgeoning growth of actinide-containing materials in recent years derives from their benefits towards nuclear waste administration as well as the sustaining interests in exploring novel actinide-based architectures.[1] The unparalleled coordination chemistry of actinides has endowed the materials with higher structural complexity and unique properties compared with those composed of other group of metal ions.[2] Actinide metal–organic frameworks (An-MOFs) are a particularly attractive category of actinide functional materials owing to their unprecedented modularity, structural tunability and potential utilities that are rarely explored.[3] Considering the large diversity and uniqueness of An-MOF, this class of material is envisioned to meet infinite possibilities in the future, probably beyond that achieved by other metal-based MOFs.

A cutting-edge direction of An-MOFs is to further increase their structural complexity, for example, by introducing a second actinide node to the parent An-MOF.[4] In fact, many actinide species in nuclear waste are reduced to low oxidation states for long-term geological disposal to block their migration and diffusion in the environment, thus creating heterobimetallic An-MOFs would open a new door for spent fuel management and soil decontamination where different actinides coexist steadily in solid matrix.[5] In addition, the presence of a second actinide in the An-MOF brings the material with additional functionalities, thereby expanding the scope of An-MOF applications.[6] However, the synthesis of heterobimetallic An-MOF with definite crystal structure remains a great challenge at the present stage. Different actinides, especially those with different valence states, show distinct crystallization kinetics and thermodynamics,[7] so it is hard for two actinides to crystallize into one framework under the same reaction condition by one-pot synthesis. Post-metalation is a powerful tool to incorporate another coordination-distinct metal to a parent MOF[8] and has hit a sounding success in constructing structurally well-defined bimetallic MOFs.[9] This strategy usually requires the framework to possess another metal chelating site where a second metal can be firmly anchored to form long-range ordered structure.[10] The chelating site usually stems from the unique architecture of the parent MOF or from a preorganized linker,[11] but the complex coordination behavior of 5f elements makes them difficult to be periodically embedded in any predesigned binding site.[3b,12] Up to now, only one case applying the cluster extension approach successfully yields structurally well-defined heterobimetallic An-MOFs.[3a] Other efforts to this aim only yield mixed An-MOFs where the spatial arrangement of metals is unclear.[4b,13] The lack of unambiguous structure information of heterobimetallic An-MOFs vastly hinders the exploration of their utilities and frustrates the further elucidation of structure–property relationship. Therefore, synthesizing novel heterobimetallic An-MOFs with definite structure has fundamental significance to the development of An-MOFs.

Herein, we report a unique reaction-induced preorganization strategy to assemble two coordination-distinct actinides into one framework. A thorium MOF $[Th_6O_4(OH)_4(HCOO)_{6.5}(L)_3(H_2O)_3]\cdot 12.5\,H_2O\cdot 4\,DMF\cdot 0.5\,NH_2(CH_3)_2$ (SCU-16, L = 4,4′-(3,5-pyridinediyl)bis-benzoate, DMF = N, N-dimethylformamide) with the largest unit cell among all reported thorium MOFs was prepared first (Figure 1). Interestingly, SCU-16 contains a formate surrounded vacancy, which can transform to a carbonate decorated vacancy via the uranyl-mediated formate-to-carbonate reac-

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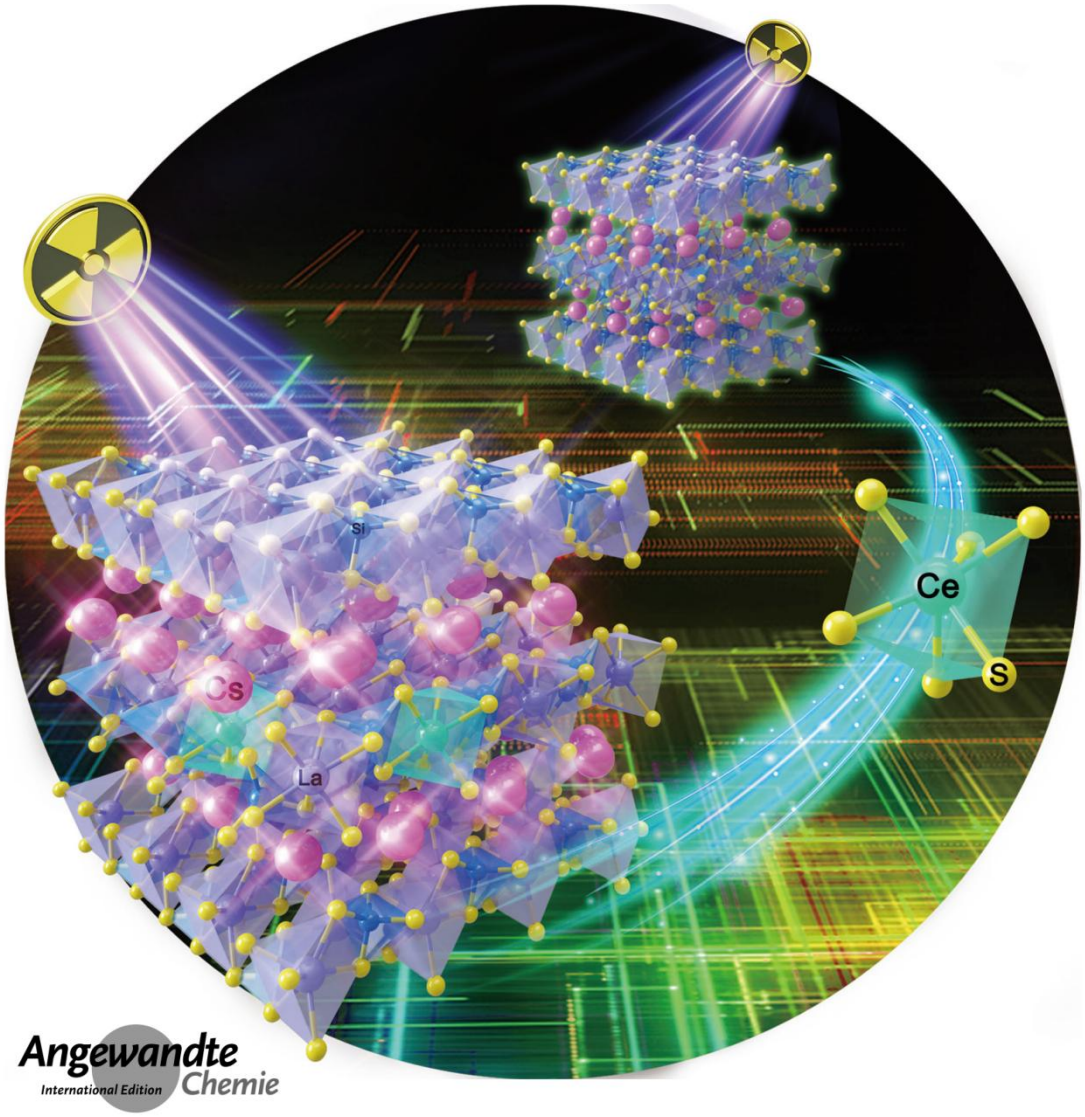
VIP X-Ray Scintillators Very Important Paper

Emergence of a Lanthanide Chalcogenide as an Ideal Scintillator for a Flexible X-ray Detector

Liangwei Yang, Zhenyu Li, Linwei He, Jiayu Sun, Junren Wang, Yumin Wang, Ming Li, Zibin Zhu, Xing Dai, Shu-Xian Hu,* Fuwan Zhai, Qian Yang, Ye Tao, Zhifang Chai, Shuao Wang, and Yaxing Wang**



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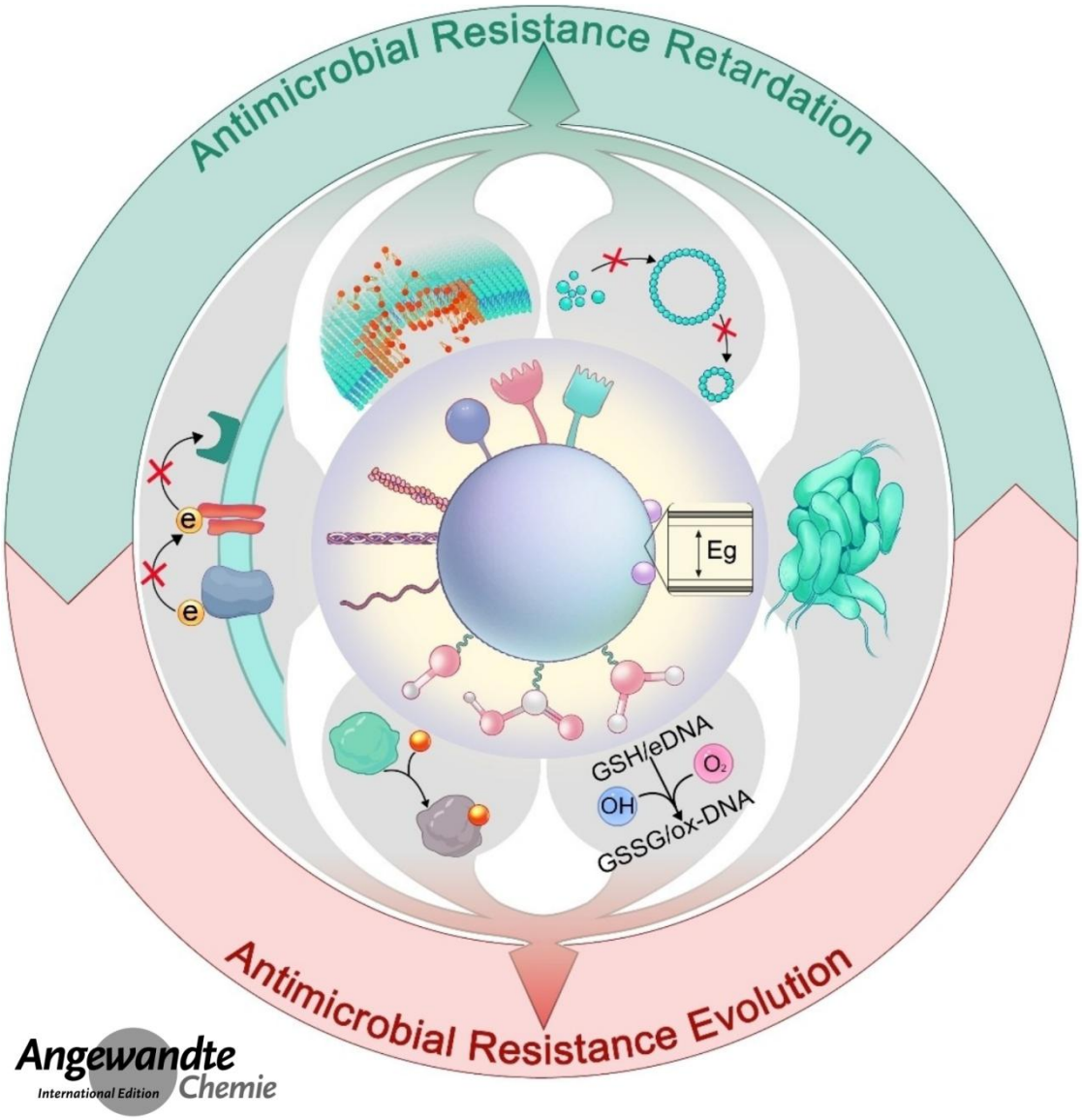
Nano-Bio Interaction

Antibacterial Nanomaterials: Mechanisms, Impacts on Antimicrobial Resistance and Design Principles

Maomao Xie[+], Meng Gao[+], Yang Yun[+], Martin Malmsten, Vincent M. Rotello, Radek Zboril, Omid Akhavan, Aliaksandr Kraskouski, John Amalraj, Xiaoming Cai, Jianmei Lu, Huizhen Zheng, and Ruibin Li**



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Antifouling Hot Paper

Nano-enabled Quenching of Bacterial Communications for the Prevention of Biofilm Formation

Meng Gao[+], Bolong Xu[+], Yang Huang, Jiayu Cao, Lili Yang, Xi Liu, Alisher Djumaev, Di Wu, Moxichexra Shoxiddinova, Xiaoming Cai, Behruz Tojiyev, Huizhen Zheng, Xuehua Li, Kunduz Normurodova, Huiyu Liu, and Ruibin Li**

Abstract: Biofilm formation is a major threat to industry, the environment and human health. While killing of embedded microbes in biofilms may inevitably lead to the evolution of antimicrobial resistance (AMR), catalytic quenching of bacterial communications by lactonase is a promising antifouling approach. Given the shortcomings of protein enzymes, it is attractive to engineer synthetic materials to mimic the activity of lactonase. Herein, an efficient lactonase-like Zn–N_x–C nanomaterial was synthesized by tuning the coordination environment around zinc atoms to mimic the active domain of lactonase for catalytical interception of bacterial communications in biofilm formation. The Zn–N_x–C material could selectively catalyze 77.5 % hydrolysis of N-acylated-L-homoserine lactone (AHL), a critical bacterial quorum sensing (QS) signal in biofilm construction. Consequently, AHL degradation down-regulated the expression of QS-related genes in antibiotic resistant bacteria and significantly prevented biofilm formation. As a proof of concept, Zn–N_x–C-coated iron plates prevented 80.3 % biofouling after a month exposure in river. Overall, our study provides a nano-enabled contactless antifouling insight to avoid AMR evolution by engineering nanomaterials for mimicking the key bacterial enzymes (e.g., lactonase) functioning in biofilm construction.

Introduction

Planktonic prokaryotic cells tend to colonize most environmental surfaces, secrete extracellular polymeric substances (EPSs) and communicate to form slimy polymeric conglomerations of extracellular polysaccharides, proteins, lipids and DNA, *a.k.a.* biofilms.[1] Mature biofilms exhibit great resistance to environmental stresses and pose significant threats to industry, the environment and human health. Marine biofilms, also known as biofouling, often grow on the surfaces of ship hulls, leading to increased hydrodynamic drag and fuel consumption during navigation, as well as increased labor and time costs for cleaning.[2] Pathogenic bacteria may also form biofilms inside food processing equipment, resulting in food deterioration and endangering consumer health.[3] Therefore, there is a significant research interest in preventing biofilm formation.[4]

Traditional anti-biofilm strategies can be categorized into three classes: physical, chemical and biological methods. Flushing,[5] ultrasonic scaling,[6] alternating magnetic field[7] and ionization radiation[8] are the common physical methods to eliminate biofilm. Antimicrobial agents, such as antibiotics, antibacterial peptide and nanomaterials, kill bacteria through chemical reactions to prevent biofilm formation. However, physical and chemical solutions have limit efficacy and are subject to rapid adaptive resistance evolution, making them challenging to use in practical applications.[9] Review of the construction process of biofilm may provide distinct insights for anti-biofilm. Bacterial cells sense their population density and tune biological functions through a

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Fluorescent Probes Hot Paper

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An Activatable NIR-II Fluorescent Reporter for In Vivo Imaging of Amyloid-β Plaques

Jia Miao[+], Minqian Miao[+], Yue Jiang, Min Zhao, Qing Li, Yuan Zhang, Yi An, Kanyi Pu,* and Qingqing Miao**

Abstract: Fluorescence imaging in the second near-infrared (NIR-II) window holds great promise for in vivo visualization of amyloid-β (Aβ) pathology, which can facilitate characterization and deep understanding of Alzheimer's disease (AD); however, it has been rarely exploited. Herein, we report the development of NIR-II fluorescent reporters with a donor-π-acceptor (D-π-A) architecture for specific detection of Aβ plaques in AD-model mice. Among all the designed probes, DMP2 exhibits the highest affinity to Aβ fibrils and can specifically activate its NIR-II fluorescence after binding to Aβ fibrils via suppressed twisted intramolecular charge transfer (TICT) effect. With suitable lipophilicity for ideal blood–brain barrier (BBB) penetrability and deep-tissue penetration of NIR-II fluorescence, DMP2 possesses specific detection of Aβ plaques in in vivo AD-model mice. Thus, this study presents a potential agent for non-invasive imaging of Aβ plaques and deep deciphering of AD progression.

Introduction

Alzheimer's disease (AD) represents the most widespread neurodegenerative disease that is clinically characterized by memory loss, cognitive decline and dementia, which seriously threatens people's health.[1] As the typical pathomorphological hallmark of AD, amyloid-β (Aβ) plaques derived from the assembly of monomeric Aβ peptides into high-ordered Aβ fibrils accumulate and deposit into brains to induce neurological disorders.[2] Up to now, there are no effective therapeutic strategies that can halt or reverse the progression of AD.[3] Early characterization creates an opportunity for well-timed intervention to delay the onset and progression of this disease. Among the diagnostic methods, the cerebrospinal fluid (CSF) test possesses high accuracy but the collection procedure (spinal tap) is invasive and hence not widely acceptable.[2,4] An alternative strategy is to develop imaging probes for the detection of Aβ plaques, which have been regarded as an important biomarker for AD and the prediction of AD progression.[5] Over the years, many probes with different modality such as positron emission tomography (PET), single photon emission computed tomography (SPECT) and magnetic resonance imaging (MRI) have been exploited to detect Aβ plaques.[6] However, these conventional imaging techniques have their drawbacks, for instance, relatively low sensitivity for MRI and high cost and hazardous ionizing radiation for PET and SPECT. Furthermore, these developed probes incessantly emit signals and thus are "always-on", which leads to high background signals and thereafter inadequate specificity and sensitivity.[7]

In comparison with conventional imaging techniques, fluorescent imaging possesses numerous advantages such as low cost, non-invasiveness, high sensitivity, and real-time longitudinal imaging.[8] Furthermore, by employing activatable fluorescent probes that can specifically turn on signals in response to stimuli, fluorescence imaging enables real-time visualization and specific detection of molecular alterations at the early stage of diseases.[9] Currently, fluorescent probes that are commercially available for imaging of Aβ plaques are thioflavin T (ThT) and thioflavin S (ThS). However, these probes can only be utilized in histological samples due to their short emission wavelength (480 nm) and poor blood–brain barrier (BBB) penetration ability to hamper their in vivo utility.[10] Though a series of activatable near-infrared (NIR) fluorescent probes have been developed for in vivo imaging of Aβ plaques,[11] the fluorescence emission of these probes is generally located in the first NIR window (NIR-I, 650–900 nm) that suffers from severe tissue absorption, light scattering and autofluorescence. Such intense light-tissue interactions will result in shallow penetration depth and poor signal-to-noise ratio (SNR), thereby making them inadequate for deep-tissue brain imaging with high fidelity.[12] By contrast, fluorescence

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RESEARCH ARTICLE

A Highly Bright Near-Infrared Afterglow Luminophore for Activatable Ultrasensitive In Vivo Imaging

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Abstract: Afterglow luminescence imaging probes, with long-lived emission after cessation of light excitation, have drawn increasing attention in biomedical imaging field owing to their elimination of autofluorescence. However, current afterglow agents always suffer from an unsatisfactory signal intensity and complex systems consisting of multiple ingredients. To address these issues, this study reports a near-infrared (NIR) afterglow luminophore (TPP-DO) by chemical conjugation of an afterglow substrate and a photosensitizer acting as both an afterglow initiator and an energy relay unit into a single molecule, resulting in an intramolecular energy transfer process to improve the afterglow brightness. The constructed TPP-DO NPs emit a strong NIR afterglow luminescence with a signal intensity of up to 10^8 p/s/cm^2/sr at a low concentration of 10 μM and a low irradiation power density of 0.05 W/cm^2, which is almost two orders of magnitude higher than most existing organic afterglow probes. The highly bright NIR afterglow luminescence with minimized background from TPP-DO NPs allows a deep tissue penetration depth ability. Moreover, we develop a GSH-activatable afterglow probe (Q-TPP-DO NPs) for ultrasensitive detection of subcutaneous tumor with the smallest tumor volume of 0.048 mm^3, demonstrating the high potential for early diagnosis and imaging-guided surgical resection of tumors.

Introduction

Optical imaging plays an essential role in biology and medicine as it enables the monitoring of physiological and pathological processes with non-invasiveness, high sensitivity, and real-time visualization.[1] As a conventional optical imaging technique, fluorescence imaging is widely used in diverse imaging regimes.[2] However, it always necessitates real-time light excitation, causing serious autofluorescence and thus compromised imaging fidelity with a decreased signal-to-background ratio (SBR) and reduced tissue penetration depth. In contrast, afterglow luminescence imaging has recently attracted increasing interest as it can achieve autofluorescence-free self-luminescence imaging via detecting the down-stream photon release stored in chemical defects after the termination of the light irradiation.[3] Hence, afterglow luminescence imaging has been extensively explored for in vivo imaging applications with high sensitivity and deep-tissue penetration ability, such as tumor imaging,[4] lymph node mapping,[5] drug-induced hepatotoxicity,[3a] image-guided therapy,[6] and monitoring therapeutic efficacy.[7]

Current afterglow luminescence probes mainly include rare earths materials-based inorganic and semiconducting polymers- or small molecules-based organic materials.[4f,8] Rare earths-based inorganic nanomaterials produce the release of photons stored in energy traps after light irradiation.[8h] Differently, organic systems utilize the unstable chemical defects to produce photons after light irradiation with the latter showing great superiority for in vivo utility by virtue of their better biocompatibility and structural tunability.[3a,1f,13] The organic afterglow luminescence probes usually consist of three components, a photosensitizer as an afterglow initiator to produce singlet oxygen ($^1O_2$) upon light irradiation, an afterglow substrate that reacts with $^1O_2$ to form high-energy peroxides (i.e., chemical defects), and an energy transfer molecule to absorb the stored energy from the chemical defects via energy transfer and emit long-lived downstream photons.[3h,8h,9] However, the three ingredients are always physically mixed, resulting in low afterglow brightness due to the low efficiency of intermolecular energy transfer between the afterglow substrate and the afterglow relay unit. In addition, it requires tedious procedures with time-consumption and low reproducibility, which precludes potentially clinical applications. Recently, the chemical conjugation between an afterglow substrate and an energy transfer unit has been reported, which shows great potential and superiority, since it has approximately 100-fold higher afterglow brightness than the mixed systems attributing to the higher efficiency of intramolecular energy transfer compared to intermolecular energy transfer.[7c,10] But the

十、获奖情况

序号	奖励编号	奖励名称	奖励类型	获奖等级	获奖人员（固定人员）
1	/	环境化学终身成	其他国家奖励	其他	柴之芳
2	XPLORER-2023-1034	2023 年科学探索奖能源环境领域获奖人	其他国家奖励	其他	王殳凹
3	/	全国创新争先奖	其他国家奖励	其他	路建美
4	/	法国夏邦克-杜博赛奖	国际级	其他	胡士军
5	2022-2-80-R1	面向肿瘤高灵敏诊断及微环境定量可视化的智能探针研究	江苏省自然科学奖	二等奖	高明远 史海斌 曾剑峰 汪　勇
6	2022-3-144-R1	放射性大脑神经功能损伤防治新靶点及其机制研究	江苏省科技进步奖	三等奖	田　野 张力元
7	2022J-208-2-079-066-R7	靶向肿瘤相关巨噬细胞介导肺癌免疫治疗的药物研发及临床应用	湖北省科技进步奖	二等奖	赵　利
8	2021-Z-2-004	多功能无机纳米材料在肿瘤放射治疗中的应用基础研究	山西省科技进步奖	二等奖	葛翠翠
9	/	肿瘤放疗损伤机制与精准防治技术体系研究及临床应用	山东省科技进步奖	二等奖	曹建平

十一、内部协作课题

序号	项目编号	申请人	职称	项目名称	资助经费(万元)	起止时间
1	GZN1202301	陈华兵	教授	用于胰腺癌放疗增敏的氧化铪白蛋白纳米粒及其成药性研究	75	2023.06-2026.05
2	GZN1202302	张力元	教授	基于多组学技术构建布拉格精准诊疗策略及临床转化研究	75	2023.06-2026.05
3	GZN1202303	张昊文	教授	FLASH 光子照射调控基因组 DNA 时空辐射易感性的机理研究	75	2023.06-2026.05

十二、科研创新课题

序号	项目编号	项目名称	负责人	资助金额（万元）	资助年度
1	GZC00501	仿生制备柔性水凝胶电离辐射剂量计	胡　亮	25	2023.06-2024.05

十三、开放课题

序号	项目编号	课题名称	申请人	申请人所在单位	项目执行期	资助金额（万元）
1	GZK1202301	辐射诱导的脂代谢异常在放射性肝损伤发生与进展中的作用机制研究	危少华	苏州大学附属第二医院	2023.08-2024.12	5
2	GZK1202302	KLF10 介导放射性核素铀诱发造血障碍的机制研究	黄海雯	苏州大学附属第一医院	2023.08-2024.12	5
3	GZK1202303	辐射响应性金簇凝胶的糖尿病足骨髓炎放射动力学治疗	秦建忠	苏州大学附属第二医院	2023.08-2024.12	5
4	GZK1202304	靶向肾脏缺血再灌注损伤的多模态诊疗一体化纳的研究	沈　罡	苏州大学附属独墅湖医院	2023.08-2024.12	5
5	GZK1202305	dmbx1a 在氚水诱发斑马鱼视觉发育异常中的作用及机制研究	张　积	苏州大学附属第二医院	2023.08-2024.12	5
6	GZK1202306	低剂量辐射促进子宫内膜修复改善胚胎植入的作用机制	张　弘	苏州大学附属第二医院	2023.08-2024.12	5
7	GZK1202307	基于 CR-39 探测器宽能谱中子剂量测定的研究	邓　磊	江西省职业病防治研究院	2023.08-2024.12	5
8	GZK1202308	超高剂量率放疗和常规放疗对小鼠肝细胞癌免疫应答的比较研究及其分子机制	张永胜	苏州大学附属第二医院	2023.08-2024.12	5
9	GZK1202309	IL-6 介导 RPECs 的铁死亡参与放射性视网膜病变的发病及其机制的研究	解来青	苏州大学附属第二医院	2023.08-2024.12	5
10	GZK12023010	EUS 引导下经直肠前壁注射功能性纳米药物在放射性直肠炎中的防护研究	程桂莲	苏州大学附属第二医院	2023.08-2024.12	5

序号	项目编号	课题名称	申请人	申请人所在单位	项目执行期	资助金额（万元）
11	GZK12023011	唐栀子提取物藏红花酸对小鼠放射性骨髓抑制的影响及机制研究	马　磊	南阳市第一人民医院	2023.08-2024.12	5
12	GZK12023012	丝素蛋白纳米气凝胶复合 SVF 敷料治疗外照射致皮肤烧伤的临床应用研究	徐龙江	苏州大学附属第二医院	2023.08-2024.12	5
13	GZK12023013	基于 DNA 修复基因的乳腺癌放疗敏感性分子标签的挖掘及机制研究	刘松柏	苏州卫生职业技术学院	2023.08-2024.12	5
14	GZK12023014	无创成像靶向 TLR4 的免疫 PET 分子探针研制	鲁　燕	苏州大学附属第一医院	2023.08-2024.12	5
15	GZK12023015	藏药辐照灭菌效果验证和标准建立	胥　萍	苏州大学附属传染病医院	2023.08-2024.12	5
16	GZK12023016	脂肪酸衍生物/前列腺素 E2 代谢通路在直肠癌放疗增敏中的机制研究	彭啟亮	苏州大学附属第二医院	2023.08-2024.12	5
17	GZK12023017	活性氧介导的瞬时受体电位离子通道在慢性放射性疼痛中的作用及机制研究	张玉松	苏州大学附属第二医院	2023.08-2024.12	5
18	GZK12023018	基于拮抗肽的预靶向肿瘤放射治疗探针构建及应用研究	吴曙华	苏州大学附属第二医院	2023.08-2024.12	5
19	GZK12023019	PGC-1α 介导的线粒体代谢重编程对胶质瘤放疗异质性的调控机制研究	戴晓晓	苏州大学附属第二医院	2023.08-2024.12	5
20	GZK12023020	131I 标记 BCMA 单克隆抗体治疗多发性骨髓瘤的临床前研究	李炳宗	苏州大学附属第二医院	2023.08-2024.12	5
21	GZK12023021	乳铁蛋白改善放射性肠损伤的机制研究	孙　骐	苏州大学附属常州老年病医院	2023.08-2024.12	5

序号	项目编号	课题名称	申请人	申请人所在单位	项目执行期	资助金额（万元）
22	GZK12023022	3D 打印病灶区预评估放射治疗结果	王师佳	苏州大学附属第二医院	2023.08-2024.12	5
23	GZK12023023	UMSC-Exo 通过调控 inflammasome 逆转辐射损伤的策略及机制研究	李杨欣	苏州大学	2023.08-2024.12	3
24	GZK12023024	基于类器官模型探索 HMGB1 通过 GADD45a 调控 STAT3 启动子去甲基化水平促进肺癌细胞的放疗抵抗	杨文涛	苏州大学附属第二医院	2023.08-2024.12	3
25	GZK12023025	靶向 MDSCs 的肿瘤放射免疫治疗及其动态可视	许经伟	苏州市立医院	2023.08-2024.12	3
26	GZK12023026	长链非编码 RNA HIFA-AS2 调控 HIF1a 促进 CypA 表达介导胶质母细胞瘤放疗抵抗的机制研究	黄仁华	上海交通大学医学院附属仁济医院	2023.08-2024.12	3
27	GZK12023027	藏红花酸通过 Tnfrsf10b 基因调控宫颈癌细胞放射敏感性的研究	张建东	南阳市第一人民医院	2023.08-2024.12	3
28	GZK12023028	铜-没食子酸新型纳米酶逆转脑胶质瘤替莫唑胺耐药的机制研究	刘航航	三峡大学	2023.08-2024.12	3
29	GZK12023029	基于多组学的直肠癌新辅助放疗联合免疫治疗疗效相关生物标志物的筛选及机制研究	冯正阳	苏州大学附属第二医院	2023.08-2024.12	3
30	GZK12023030	电离辐射通过改变 UVRAG 调控 IFN-I 对放射性皮肤纤维化的作用及机制	陶家龙	苏州大学附属第二医院	2023.08-2024.12	3
31	GZK12023031	基于药代动力学的硼中子俘获治疗蒙卡剂量学方法与机理研究	陈珍平	南华大学	2023.08-2024.12	3

序号	项目编号	课题名称	申请人	申请人所在单位	项目执行期	资助金额（万元）
32	GZK12023032	肿瘤相关粒细胞表达 GPSM3 抑制肺癌放射免疫疗效的作用与机制研究	谭丽萍	苏州大学附属第二医院	2023.08-2024.12	3
33	GZK12023033	131I 治疗 Graves 病中甲状腺功能减退的病理机制研究	谢　莹	苏州大学附属第二医院	2023.08-2024.12	3
34	GZK12023034	DPF2 通过调控 YAP 及 CLU 保护肠道辐射损伤的机制研究	干文娟	苏州大学附属独墅湖医院	2023.08-2024.12	3
35	GZK12023035	核素标记新型 HER2 纳米抗体在 HER2-low 乳腺癌精准诊疗的应用	葛书山	苏州大学附属第一医院	2023.08-2024.12	3
36	GZK12023036	负性共刺激分子 B7-H3 与 SEC61G 结合调控结直肠癌“干性”促进放疗抵抗的机制研究	朱彦博	苏州大学附属第一医院	2023.08-2024.12	3
37	GZK12023037	SLC16A8 通过抑制端粒结合蛋白 RAP1 通路改善直肠癌放疗抵抗的作用和机制	周　健	苏州大学附属第一医院	2023.08-2024.12	3
38	GZK12023038	电离辐射对精原干细胞 marker 蛋白 PLZF 的影响及机制研究	薛波新	苏州大学附属第二医院	2023.08-2024.12	3
39	GZK12023039	放射联合靶向（THZ1）和免疫（PD-1）对肿瘤微环境重塑及机制研究	苏锋涛	复旦大学附属肿瘤医院	2023.08-2024.12	3
40	GZK12023040	锥形束 CT 对口腔细菌影响的宏基因组和代谢组学研究	肖皖抒	苏州大学附属第一医院	2023.08-2024.12	3
41	GZK12023041	基于光谱 CT 评估肺癌放疗后急性放射性肺损伤研究	金　丹	苏州大学附属第二医院	2023.08-2024.12	3
42	GZK12023042	VISTA 在宫颈癌放射治疗中的作用及机制研究	李　莉	苏州大学附属第一医院	2023.08-2024.12	3

序号	项目编号	课题名称	申请人	申请人所在单位	项目执行期	资助金额（万元）
43	GZK12023043	富辛酸肠内营养防治慢性放射性肠炎营养不良的机制研究	李小华	苏州市吴中人民医院	2023.08-2024.12	3
44	GZK12023044	SCD1-siRNA 靶向干预增敏宫颈癌放疗的机制和新策略研究	邓琦程	苏州大学附属第二医院	2023.08-2024.12	3
45	GZK12023045	大尺寸柔性闪烁体膜材料制备、性能表征和发光机理研究	汪　遐	烟台大学	2023.08-2024.12	3
46	GZK12023046	基于多参数 MR 成像研究肾纤维化胶原纤维沉积的发生与演进机制	查婷婷	苏州大学附属第三医院	2023.08-2024.12	3
47	GZK12023047	低剂量 X 射线照射通过上调血管形成和血管生成途径对糖尿病足溃疡的作用及其机制研究	周凯龙	苏州大学附属第二医院	2023.08-2024.12	自筹
48	GZK12023048	99mTc-FAPI SPECT/CT 显像评估非小细胞肺癌顺铂疗效的临床前研究及分子机制研究	米宝明	苏州大学附属第二医院	2023.08-2024.12	自筹
49	GZK12023049	脂肪酸通过调控 MUFAs 合成途径抑制铁死亡在放射性皮肤损伤中的作用及机制研究	肖雨霁	苏州大学附属第二医院	2023.08-2024.12	自筹
50	GZK12023050	基于磷脂酰丝氨酸脂质体的靶向多模态纳米囊泡探针的肺癌诊疗一体化研究	范国华	苏州大学附属第二医院	2023.08-2024.12	自筹
51	GZK12023051	胶质瘤类器官放疗抵抗机制研究	许　亮	苏州大学附属第二医院	2023.08-2024.12	自筹
52	GZK12023052	CD19+B 细胞介导的血管内皮细胞损伤在放射性动脉硬化中的作用研究	张艳林	苏州大学附属第二医院	2023.08-2024.12	自筹

十四、体制机制和平台建设

重点实验室实行管理委员会领导下的主任负责制，学术委员会对实验室发展战略和重大决策提供咨询和指导。下设综合办公室，负责实验室日常事务管理；按照研究方向设立研究团队，进行项目的组织与实施；建设仪器开放共享平台，对内对外开放共享；通过实验室资助，2018 至 2023 年已购置或自研 22 台大型仪器设备，设备总金额六千余万元。

序号	设备型号	设备名称	产地国	购置时间	设备价格(万元)	国重室出资(万元)
1	ASAP2460	多站拓展式全自动快速比表面与孔隙度分析仪	美国	2018.01	60.1	60.1
2	Talos F200S G2	高分辨场发射透射电镜	美国	2018.12	794.38	794.38
3	E500-10/12	电子自旋（顺磁）共振波谱仪	德国	2018.12	297.78	297.78
4	D8VENTURE	X 射线单晶衍射仪	德国	2018.12	259	259
5	非标定制	空间零磁环境模拟设备	中国	2019.01	186.78	186.78
6	Invivo2 1000	低氧工作站	英国	2019.03	182.94	182.94
7	自研	辐射敏感器官剂量测量体模	中国	2019.06	430	430
8	CPL-300	全波长圆偏振光谱联用仪	日本	2019.08	298.34	240
9	FV3000	激光共聚焦显微镜	日本	2019.09	192.88	154.3
10	Fluidigm Hyperion Imaging System	组织质谱成像系统	加拿大	2019.11	779.9	479.9
11	TS10K	高性能计算集群	中国	2019.11	307.76	240
12	SPL-SC-Pro-7	双波段眼科 OCT 成像系统	中国	2019.12	144	116

序号	设备型号	设备名称	产地国	购置时间	设备价格(万元)	国重室出资(万元)
13	DMi8	倒置荧光显微镜	德国	2020.12	29.128	29.128
14	AX	高分辨多光谱亚细胞激光辐照仪	日本	2021.01	239.5	192
15	HDX-MS	氢-氘交换质谱	英国	2021.01	360	288
16	VIVO Intravital Imaging System	微循环活体成像显微系统	美国	2021.03	372.62	372.62
17	DDLH2.0/30-500	低能电子加速器	中国	2021.07	555	555
18	自研	辐射探测大体积单晶器件制备及表征测试平台	中国	2021.11	274.4	274.4
19	IVIS Lumina III	小动物活体成像系统	美国	2021.01	161.6	161.6
20	HM 525 NX U	冷冻切片机	中国	2021.01	24.9318	24.9318
21	自研	磁粒子二维成像系统	/	2022-	360	360
22	研发定制	蒸汽自循环节能高通量含氚废水处理装置	/	2022-	300	300
合计					**6620.3**	**5310.0**

十五、2023 大事记

2023 年 2 月 26 日，放射医学与防护英文刊

《Radiation Medicine and Protection》（RMP）苏州办公室成立

2023 年 3 月 3 日，苏州大学、海盐县人民政府、

秦山核电三方共建苏州大学海盐核创新研究院战略协议签约仪式

2023 年 3 月 25 日，江苏高校放射医学协同创新中心 2022 年度推进会

2023 年 3 月 27 日，苏州市科学技术局副局长顾万勇调研

2023 年 4 月 9 日-11 日“放射医学与辐射防护国家重点实验室·苏州大学质子重离子医学研究中心系列培训·质子重离子中心筹建与运营管理”首届培训班

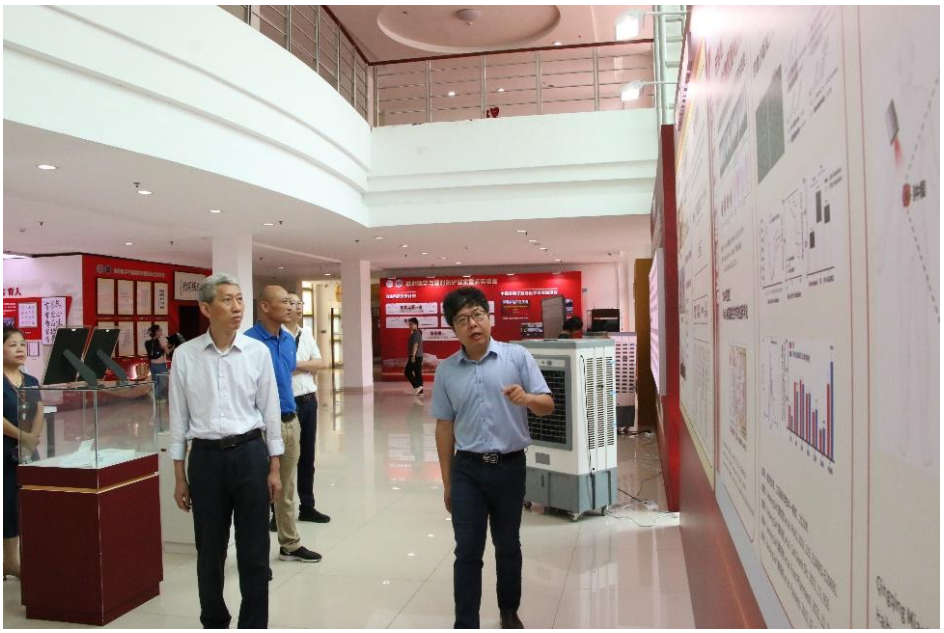
2023 年 4 月 11 日，江苏省政协副主席、民进省委会主委马余强调研

2023 年 6 月 16 日，江苏省副省长徐缨一行调研国重室

2023 年 6 月 29 日，教育部副部长孙尧一行调研

2023 年 7 月 8 日，省部共建放射医学与辐射防护国家重点实验室验收会

2023 年 7 月 8 日，放射医学与辐射防护国家重点实验室重组研讨会



2023 年 7 月 25 日，江苏省科学技术协会调研宣传部部长张红兵调研

2023 年 9 月 5 日，江苏省科协科学技术普及部二级调研员范正银一行指导抽查

2023 年 11 月 6 日-10 日，“质子重离子放射治疗临床技术与应用系列培训”第二期“质子物理技术与实施”培训班

2023 年 11 月 7 日，江苏省副省长赵岩一行调研

2023 年 11 月 22 日，实验室放射性药物 GLP 实验室（筹）揭牌

2023 年 11 月 24 日-25 日，2023 年“放射医学+X”前沿交叉创新论坛

2023 年 11 月 25-27 日，国家自然科学基金重大项目《航天极端环境机体应激与防护策略进展》汇报会暨 2023 特种医学高峰论坛

十六、科普活动

放射医学与辐射防护国家重点实验室作为放射医学领域唯一的国家重点实验室，目前为江苏省和苏州市科普教育基地，拥有院士领衔的科普团队、丰富的科普设施条件和强大的管理运行团队。2020 年以来，各级领导高度重视国重室发展及科普工作情况，苏州市政协主席周伟强、江苏省委书记娄勤俭、国防科工局吴艳华副局长及中国科协科普部钱岩副部长先后参观考察国重室和科普展，国重室科普团队参加全国科普教育基地（江苏）调研座谈，广泛开展与各级科普教育基地交流合作，为科普基地具体工作的落实指明方向。2023 年，实验室获批全国、江苏省科学家精神教育基地；在江苏省科普教育基地终期考核中获评优秀。


2023 年，实验室举办“核你同行”科学家精神展览（获评省科学家精神基地特色展览）、“核星启航”国家重点实验室科学节及研学营活动（获评省科学家精神基地特色活动）、“强核有我，医心为民”科普志愿服务活动(获评长三角科技志愿服务先进典型)、承办 2023 年全国核科普教育基地经验交流会暨核科普讲师培训班等，累计受益 10 万余人次。


“核星启航”国家重点实验室科学节


“核星启航”国家重点实验室研学营

“强核有我，医心为民”科普志愿服务先进典型


2023年全国核科普教育基地经验交流会暨核科普讲师培训班

“核你同行”科学家精神展

2023 年度，柴之芳院士领衔主编，相关专家参与编写的《辐射与健康科普丛书》荣获“典赞·科普苏州”年度优秀科普作品奖；《放射性核素小侦探》科普专辑正式出版。《蛛“锶”马迹，溯源为民》荣获全国“核+X”大赛一等奖。国重室在“魅力之光”讲解员大赛中获得优秀组织奖。原创科普作品、活动获国家及省部级奖项 20 余项。

《辐射与健康科普丛书》

《放射性核素小侦探》科普专辑

原创科普作品获奖

实验室利用国重室网站、公众号及苏州大学网站、公众号等进行宣传展示同时在科普中国网络账户发布了 22 条包含核射、核废水等内容的科普小文章及视频。8 月，实验室紧扣热点如福岛排放核污水积极开展核科学传播，柴之芳院士领衔的科学家团队在中国科协《科学家讲科学》、人民网、央视《新闻调查等节目开展有关核科普。


人民网
people.cn

人民网三评“福岛核污染水处理”之三：科学伦理不该违背

王安芭 刘汉洲 柴之芳

2023年07月20日08:32 | 来源：人民网-国际频道

2023年7月4日，国际原子能机构（下称IAEA）总干事在日本东京正式发布IAEA关于日本福岛核污染水排海问题的综合评估报告，引发了国际社会的关注和质疑。

自从2011年3月日本福岛核事故发生后，累积的核污染水已达130多万吨。由于此次事故污染水直接与堆芯接触，其包含乏燃料中所存在的各种裂变核素、中子活化核素及锕系核素，这使得福

十七、存在问题

1、实现室目前处于重组过渡阶段，今年未获得省科技厅、市科技局的财政经费支持，迫切需要获得上级单位的经费支持从而保障重组工作的顺利进行。

2、根据实验室建设规划，实验场所应集中整体布局。实验室空间紧张，906楼迟迟无法改造，已经严重影响放药平台建设。从长远发展来看，建议学校考虑给重点实验室单独建楼，不仅有利于实验室发展，更是加强放射性管理的必需。

3、重点实验室科研成果原创性和成果转化有待加强。部分选题的科学性不强；实验室各中心发展不平衡；成果转化应按照国家和学校的有关规定进行，加大转化力度。

4、高水平人才培养和引进需要进一步加强。高水平人才对国重实验室的发展至关重要，人才引进永远在路上，要充分利用好国重实验室相对独立的人事权。

5、研究生素质有待提高。建议增加苏州大学本科生推免攻读硕士研究生的比例，增加硕博连读的人数。要求学生做到“五有”：有思想，有品味，有爱心，有担当，有奉献。

6、实验室重器欠缺。中能粒子加速器进展迟缓，将丧失我们在放射医学的优势，后果不堪设想，实验室及苏州大学的优势将不复存在。