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

2019

苏州大学

Soochow University

二零一九年十二月

目　录

前　言

2018 年 9 月 10 日，科学技术部、江苏省人民政府批准建设省部共建放射医学与辐射防护国家重点实验室（国科发基[2018]161 号），这是江苏省首个省部共建国家重点实验室，实现了苏州市和苏州大学国家重点实验室零的突破。

放射医学与辐射防护国家重点实验室依托苏州大学，是为了满足我国人民健康、核安全和核能可持续发展的重大需求而建立的。实验室前身为江苏省放射医学与防护重点实验室和干细胞与生物医用材料重点实验室，经过十多年的建设，实验室现已有一支由院士、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，科研团队专业结构合理，涵盖放射医学、辐射防护、血液学、临床医学、药学、材料学、化学、核科学等多学科领域，苏州大学放射医学是我国该领域中唯一的国家重点学科。

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，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。

2019 年在科学研究、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成绩。实验室现有成员 87 人，其中院士 2 人，杰青 6 人，优青 5 人。周光明教授 2019 年入选国际宇航科学院院士，王殳凹教授入选教育部长江学者。路建美等的“多元催化剂嵌入法富集去除低浓度 V O Cs 增强技术及应用”项目获国家发明二等奖，吴德沛等的“血液系统疾病出凝血异常诊疗新策略的建立及推广应用”项目获国家科学技术进

步二等奖。实验室平台先进，管理规范，一大批仪器高效运行，并对外开放。

在科研方面，2019 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 49 项，总金额 1.4983 亿元。值得指出的是，徐缨、陈新建和李瑞宾分别获国家重点研发计划资助，王殳凹获得教育部长江学者基金资助，杨凯、周如鸿和曹建平同时获得国家自然科学基金委-中核联合创新基金重点项目资助，第五娟获得江苏省杰出青年基金资助。依托重点实验室，共发表 SCI 研究论文 205 篇，其中影响因子大于 10 的 38 篇，大于 5 的 106 篇，论文 2019 被引用 10430 次。获得授权专利 28 项，其中发明专利 25 项，专利转化取得了新的进展，杨林教授领导开发的 CAR-T 新药临床试验申请获 NMPA 正式批准。

今年实验室在研发合作和成果转化方面继续保持良好势头。获得了总装备部、国防科工局、海军医学研究所、中国航天员科研训练中心等军民合作项目；与中广核、好医生医药集团、中陕核、鞍山肿瘤医院、华克、华益等公司的合作稳步向前。其中与中广核集团的合作，在加速器产业园建设和重离子治疗等方面具有重大战略意义。

2019 年国家重点实验室举办了系列会议和科普活动。5 月 17 日，放射医学与辐射防护行业联盟成立，11 月 2 日国家重点实验室第一届学术委员会第二次会议成功举行。策划、举办了“身在辐中，安全为重”—辐射安全文化宣传月等一系列大型科普活动，获得了江苏省以及苏州市的科普教育基地。

同时实验室共有 81 人次被邀请在国际国内学术会议上作报告或者交流；共有 43 人次被邀请来作学术报告。另外，实验室成功举办了 V 世界生物钟联盟会议（4.23-27），第二届太湖国际血栓与止血学术讨论会（10.12）和国家自然科学基金委员会-放射化学学科人才战略研讨会（10.31-11.01）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	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	吴宜灿	教授	中科院合肥物质科学研究院核安全所	核技术
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

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 87 人，其中院士 2 人，杰青 6 人，优青 5 人，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
1	柴之芳	男	194209	放射化学/放射医学	主任（院士、教授）
2	时玉舫	男	196010	肿瘤学	副主任（教授）
3	高明远	男	196703	分子影像与核医学	副主任（教授、杰青）
4	华道本	男	197404	放射化学/辐射防护	副主任（教授、青蓝工程）
5	戴克胜	男	196508	血液学	副主任（教授）
6	朱　力	男	195908	血小板与血管性疾病	副主任（教授）
7	周如鸿	男	196612	定量生物医学	教授
8	张学光	男	195111	免疫学	教授、杰青
9	吴庆宇	男	195710	血液与血管生物学	教授
10	周光明	男	197007	放射医学/特种医学	特聘教授
11	曹建平	男	196205	放射医学/特种医学	教授
12	徐　璎	女	196204	细胞生物学	教授、杰青
13	刘芬菊	女	195412	放射医学/特种医学	教授
14	胡士军	男	198002	细胞生物学	教授
15	杨红英	女	197211	放射医学	教授
16	武　艺	男	196503	血栓与血管生物学	教授
17	何玉龙	男	196701	淋巴管与肿瘤	教授、新世纪人才
18	黄玉辉	男	197212	病理学与病理生理学	教授、省特聘教授

序号	姓　名	性别	出生年月	专　业	技术职务
19	周泉生	男	195505	病理学与病理生理学	教授
20	王建荣	男	196205	细胞生物学	教授
21	杨　林	男	196408	免疫学	教授、省“双创”
22	陈　秋	女	197608	辐射免疫学	教授
23	孙　巧	女	197407	定量生物医学	教授
24	邵常顺	男	196210	遗传学	特聘教授
25	杨再兴	男	198209	定量生物医学	副研究员
26	孟烜宇	女	198306	定量生物医学	副研究员
27	于　冬	男	197008	放射医学	教授
28	王　畅	女	197601	放射医学	副教授
29	阮长耿	男	193908	血液学	院士、教授
30	吴德沛	男	195802	血液学	教授、主任医师
31	钟志远	男	197404	药物化学	特聘教授、杰青
32	陈新建	男	197905	分子影像学	特聘教授
33	陈华兵	男	197811	纳米毒理学	教授、优青
34	李　桢	男	197608	分子影像与核医学	特聘教授、 江苏双创人才
35	史海斌	男	197803	分子影像与核医学	教授
36	许玉杰	男	196311	放射医学与核医学	教授
37	夏利军	男	196203	血液学	教授
38	赵　利	男	198302	放射医学	副教授
39	俞家华	男	198102	放射医学/特种医学	副教授
40	崔凤梅	女	197510	放射毒理学	副教授
41	余自强	男	196311	血液学	主任医师
42	韩　悦	女	197002	血液学	主任医师
43	汪　勇	男	198309	放射医学	副教授
44	焦　旸	女	197711	放射医学	教授

序号	姓　名	性别	出生年月	专　业	技术职务
45	尚增甫	男	198209	放射医学	副教授
46	朱　巍	男	197009	放射医学	副教授
47	朱　然	女	197508	放射医学	副教授
48	朱秀林	男	195510	材料化学	教授
49	路建美	女	196010	材料化学/辐射防护	教授
50	王殳凹	男	198506	放射化学	特聘教授、长江学者、杰青、优青
51	涂　彧	男	196507	放射医学/辐射防护	教授
52	郭正清	男	198105	放射医学	副教授
53	李瑞宾	男	198209	辐射纳米毒理学	特聘教授
54	第五娟	女	198604	放射化学	教授、江苏省杰青
55	张乐帅	男	198002	毒理学	教授
56	刘玉龙	男	196608	放射损伤临床	教授、主任医师
57	葛翠翠	女	198311	辐射纳米毒理学	研究员
58	李永强	男	198210	放射医学	副教授
59	杨　凯	男	198308	放射医学	副教授
60	万　骏	男	196411	放射医学/辐射防护	副教授
61	孙　亮	男	197410	放射医学/辐射防护	副教授
62	胡　亮	男	198402	核科学与技术	特聘副教授
63	刘志勇	男	198101	放射化学	副教授
64	王杨云	女	198610	放射医学	副教授
65	张保国	男	196308	医学物理/辐射防护	研究员
66	白　霞	女	196809	血液学	高级实验师
67	王敬东	男	197004	放射医学	实验师
68	陆启凤	女	199010	实验平台管理	研究实习员
69	吴安庆	男	198706	放射免疫学	实验师
70	商冰雪	女	198612	免疫学	助理研究员

序号	姓　名	性别	出生年月	专　业	技术职务
71	陈永井	男	197712	免疫学	助理研究员
72	聂　晶	女	197304	生物化学	实验师
73	盛道鹏	男	198507	放射化学	助理研究员
74	封　琼	女	198710	放射医学	助理研究员
75	陈兰花	女	198707	放射化学	实验师
76	吴　艳	女	198107	免疫学	高级实验师
77	刘胜堂	男	198702	放射医学	助理实验师
78	闫思齐	女	198905	核物理	实验师
79	畅文娟	女	198704	核物理	助理实验师
80	徐加英	女	197201	肿瘤放射生物	副研究员
81	朱本兴	男	197012	机关管理办公自动化	实验师
82	易　剑	女	196403	机关管理办公自动化	主管技师
83	彭　蓉	女	197704	机关管理办公自动化	科员
84	何伟伟	男	198710	高分子化学与物理	副教授
85	赵　琳	女	198710	放射医学	副教授
86	燕　倩	女	199409	商务管理	财务秘书
87	佟　鑫	女	199108	新闻与传播	行政秘书

二、研究方向

2018 年 6 月 13 日下午，江苏省科技厅会同科技部基础研究司对省部共建放射医学与辐射防护国家重点实验室建设运行实施方案组织专家论证。与会专家从实验室定位、研究方向和研究内容设置等方面提出建设性的意见和建议。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理论基础；

（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。

三、代表性科研成果

（一）放射生物效应及机理

1、发现间充质干细胞调控组织微环境的新机制

射线对组织微环境的影响是当前放射生物学的热点。而间充质干细胞（MSCs）是组织微环境的重要组成成分，其对组织的放射敏感性起到重要的调控作用。因而，我们一直关注 MSCs 调控组织微环境的相关机制。自 1998 年 MSCs 被报道具有免疫抑制功能以来，其对发育、疾病的发生发展和放化疗的抵抗性已成为研究的热点。我们以 MSCs 的免疫抑制作用与其所处的炎症微环境的密切关系为突破口，一方面证明炎症因子赋予 MSCs 免疫抑制功能，另一方面炎症因子的多样性和其水平的动态变化又决定 MSCs 免疫调节能力的可塑性。这些发现对于理解 MSCs 对组织微环境的调控作用和指导 MSCs 的合理应用具有重要意义。而不同微环境条件下 MSCs 的特性优化和免疫调节机制也是当前国际 MSCs 研究领域的热点。胰岛素样生长因子-2（IGF-2）是一个知名的母源遗传印记基因（母源基因关闭，父源基因表达）。肿瘤的放化疗抵抗常常伴随其遗传印记丢失，进而引起 IGF-2 的表达升高，说明高表达 IGF-2 的肿瘤细胞在辐照条件下具有生存优势并可能介导放化疗后的肿瘤复发。通过系统比对不同培养条件下的人源 MSCs 对自身免疫性疾病的治疗作用，我们发现低氧培养条件下 MSCs 中 IGF-2 的表达显著升高且介导了低氧 MSCs 治疗多发性硬化动物模型的良好作用。机制研究发现，IGF-2 通过重编程未成熟的巨噬细胞并赋予其氧化磷酸化的代谢偏向性。处于氧化磷酸化代谢偏向的巨噬细胞高表达 PD-L1, 从而促进 Treg 的分化并执行对于自身免疫性疾病的抑制作用。阻断线粒体电子传递链复合物 V 的活性能够抑制 IGF-2 重编程巨噬细胞上 PD-L1 的高表达和其促进 Treg 分化的能力。 综上所述，低氧条件下 MSCs 产生的 IGF-2 可以赋予成熟过程中巨噬细胞氧化磷酸化的代谢偏向性，诱导抗炎巨噬细胞的形成并促进 Treg 分化，从而有效抑制自身免疫性疾病。相关研究结果发表在 Cell Metabolism （2019, 29, 1363-1375）上。这一研究进一步揭示，在肿瘤治疗中射线诱导的 IGF-2 不仅影响癌细胞的生长和对放化疗的敏感性，也可以诱导肿瘤微环境中的免疫抑制效应，并为放射生物学提出了一个新的研究方向。

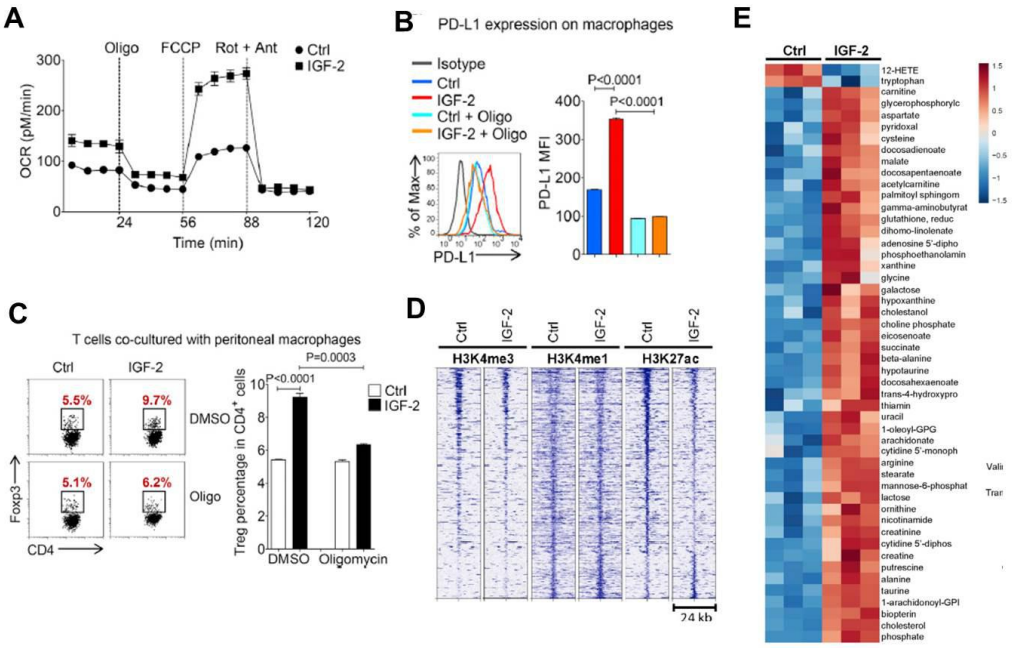

图 1.1 人源 MSCs 分泌 IGF-2 驱动巨噬细胞 M2 极化。

2、在靶向治疗 T 细胞来源的急性淋巴细胞白血病取得新进展

CAR-T 疗法是一种新型肿瘤免疫治疗方法，联合放射治疗和 CAR-T 疗法是目前肿瘤治疗研究的热点，具有良好的应用前景。近几年，嵌合抗原受体（CAR）免疫疗法在 B 细胞恶性肿瘤的临床研究中展现出非常好的临床疗效，但是，针对 T 细胞肿瘤的 CAR-T 疗法仍然面临着很大的挑战，我们很难找到一个针对 T 细胞肿瘤的合适靶点，大部分在 T 细胞肿瘤细胞上高表达的抗原，在正常 T 细胞上也会表达，这会导致 CAR-T 细胞产生自相残杀的现象。CD7 分子在大部分的 T 淋巴细胞白血病细胞中是高表达的，但在一小群正常 T 淋巴细胞中是不表达的，有研究表明 CD7 不会对 T 细胞的发育和功能产生关键的影响。暗示 CD7 分子可能是 T 淋巴细胞白血病的一个理想靶点，但是，由于 CD7 分子在大部分正常 T 细胞上也表达，在制备过程中 CD7-CAR-T 细胞也会产生自杀现象，因此在体外很难制备成功。另外，我们也很难从 T 淋巴细胞白血病患者的体内获得足够的没有被肿瘤细胞污染的正常 T 细胞来制备 CD7-CAR-T 细胞。虽然最近有报道显示,在动物模型中，可以通过同时敲除了 CD7 和 T 细胞受体的异体 CD7-CAR-T 来治疗 T 细胞恶性肿瘤，但异体 CD7-CAR-T 仍然存在移植物抗宿主病（GVHD）的风险。

在本研究中，构建了基于 CD7 纳米抗体序列的 CD7-CAR-NK-92MI 和

dCD7-CAR-NK-92MI 细胞，并通过一些列的实验证明了对 T-ALL 肿瘤细胞的抗肿瘤效果。不仅通过体外实验证实了 CD7-CAR-NK-92MI 细胞对 T-ALL 细胞系和原代肿瘤细胞的特异性细胞毒性，而且还通过动物实验证明了 CD7-CAR-NK-92MI 对 PDX 小鼠模型中的肿瘤细胞具有明显的抑制作用，显著延长了小鼠的生存期。因此，本研究构建的 CD7-CAR-NK-92MI 细胞为靶向治疗 T 淋巴细胞白血病提供了一种新策略和新思路，也可以作为一种快速清除肿瘤负荷，桥接骨髓移植的新手段。相关成果发表在 **American Journal of Cancer Research**, 2019, 9, 64-78。

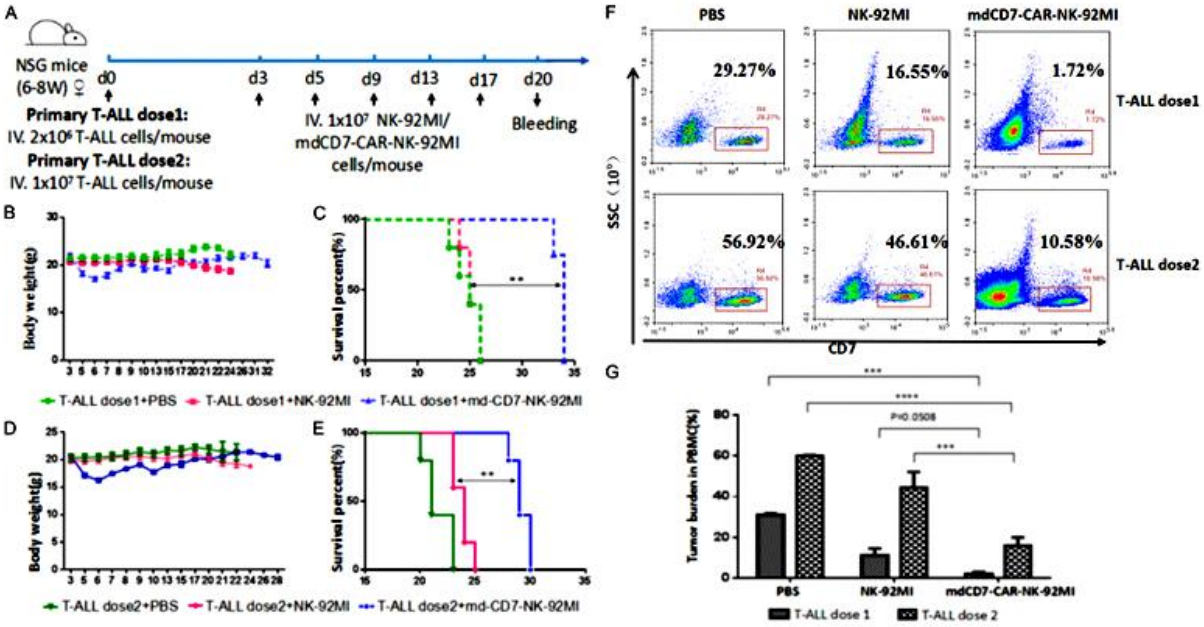

图 1.2 结果显示 CD7-CAR-NK-92MI 细胞具有显著的体内抗肿瘤活性。

（二）先进放射诊断和治疗

1、基于不饱和配位的 Fe3+探针用于增强的磁共振成像和肿瘤治疗

诊疗一体化是目前放射医学及其他生物、医学领域的研究热点之一。外源性铁(III)不仅可用于肿瘤磁共振成像，还可通过铁死亡或光热治疗等方式对抗癌症。要获得理想的成像和治疗效果，高效准确地将 Fe(III)递送到癌组织则是至关重要的，这需要化学反应很好地平衡 Fe3+在肿瘤和正常组织中的释放动力学。该研究报道了一种以上转换发光(UCL)纳米粒子为核心，含有不饱和配位的铁(III)/没食子酸络合物为外壳的新型纳米探针。由于引入了不饱和配位结构，纳米探针中的 Fe(III)只能在微酸性的肿瘤微环境中释放。UCLs 可以被用于定量观察体内 Fe3+的

释放，而释放的 Fe3+也可以作为一种高效的光热材料。得益于这些独特的性能，该纳米探针在体内表现出很好的靶向肿瘤、可激活的磁共振成像以及高效治疗肿瘤的能力。 相关成果发表在 **Angewandte Chemie-International Edition**, 2019, 58, 11088-11096。

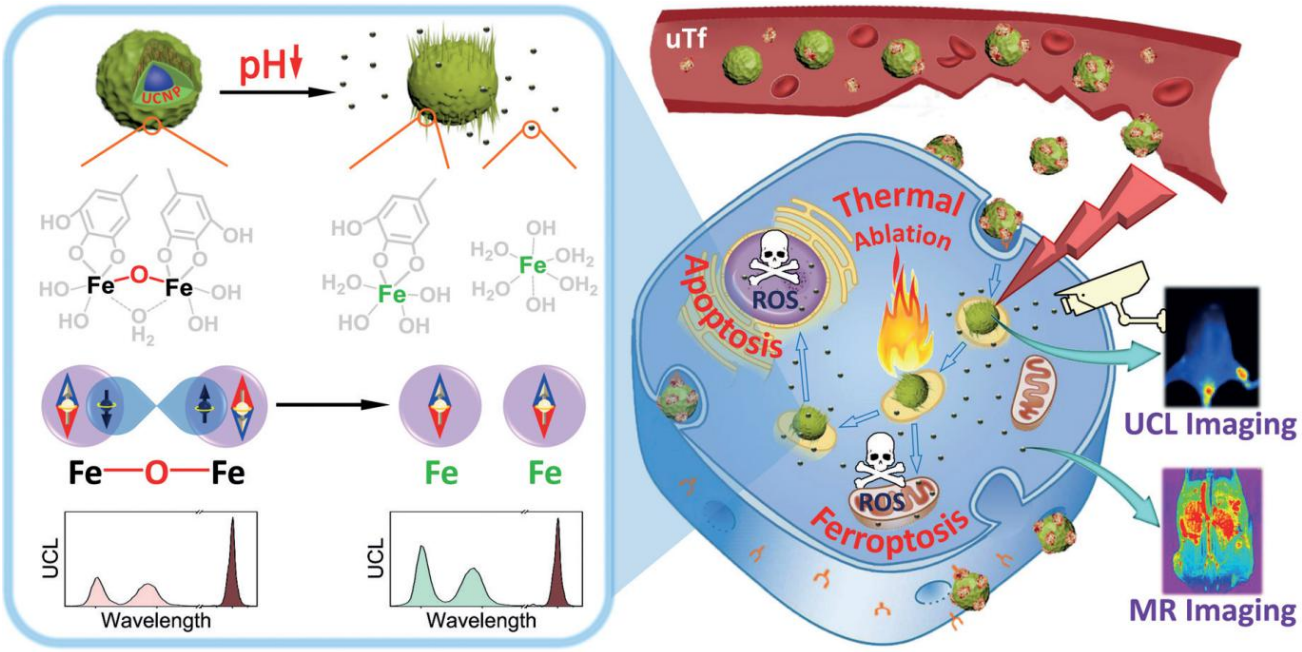

图 2.1 UCNP@GA-FeIII 探针的核磁共振及治疗功能示意图。

2、在比率型光声探针成像研究领域取得新进展

该研究通过构建集光学、光声及放射性单光子发射断层成像于一体的多模态分子影像探针，实现了在体肿瘤的灵敏性诊断及肿瘤恶性程度的无创精准评估。肿瘤微环境相比于正常组织存在弱酸性、乏氧、强氧化还原性以及肿瘤特征酶高表达等特征。基质金属蛋白酶（MMPs）在恶性肿瘤的生长、侵袭、转移和血管生成过程中扮演着非常重要的角色，已经成为一类可靠的、重要的肿瘤生物标志物。因此，在体肿瘤内基质金属蛋白酶活性的无创、准确的定量评价对于肿瘤的诊断、治疗与疗效评价研究意义重大。

在最新进展中，史海斌教授课题组以肿瘤特征酶基质金属蛋白酶 MMP-2 为研究对象，通过将其特异性识别并剪切的多肽底物与近红外荧光染料(Cy5.5)和猝灭剂(QSY21)策略性耦联，构建得到一种激活型荧光/光声（PAI）、单光子发射计算机断层扫描（SPECT）多模态分子探针（图 1）。该探针由于具有两亲性，在缓冲

溶液中能够聚集成尺寸大小均一的纳米颗粒，然而在 MMP-2 酶的剪切下，纳米颗粒的聚集状态被破坏，释放出增强的近红外荧光的同时产生比率型光声信号变化。荷瘤鼠体内实验证明，通过测定$\Delta PAS_{680}/\Delta PAS_{730}$不仅可以对肿瘤进行 PA 成像，更重要的是，结合相应肿瘤的蛋白质免疫印迹（WB）数据，可将比率型光声信号与肿瘤中活性 MMP-2 的表达相关联，建立一种无创、准确的肿瘤特征酶活性定量分析新方法。相关成果发表在 **Journal of the American Chemical Society**, 2019, 141, 3265−3273。

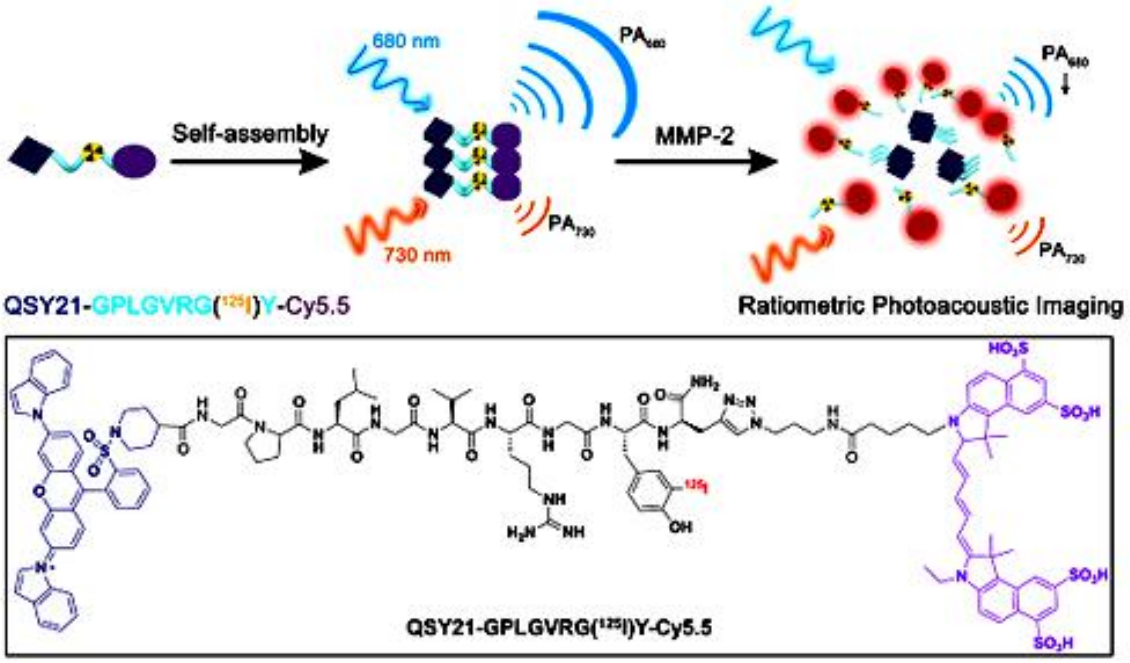

图 2.2 MMP-2 比率型光声探针设计。

（三）辐射防护

1、新型配位聚合物基阳离子交换材料用于选择性去除强放射毒性核素 90Sr

锝-99(^{99}Tc)是核燃料循环中带来问题最多的裂变产物之一，它在用过的核燃料中大量生成并囤积。据最新估计，自 1943 年至 1987 年美国退役核电站——汉福德工厂开始核武器原料生产以来，已有 1990 千克 ^{99}Tc 产生。根据国际原子能机构(IAEA)提供的最新数据，1998 年至 2017 年，^{99}Tc 的估计累积量为 154539 千克。由于核电站的快速发展，这一数字将继续快速增长。此外，^{99}Tc 作为一种典型长寿命（半衰期 2.13×105 年）β 放射源，具有化学毒性和潜在的辐射危害。其主要

物种以水溶性高锝酸根($^{99}TcO_4^-$)阴离子的形式存在，不仅环境迁移率高难以实现玻璃固化，而且其氧化还原活性严重阻碍传统的钚-铀还原萃取过程(PUREX)中其他核素的价态转换。因此，在乏燃料后处理过程中，应在第一阶段去除 $^{99}TcO_4^-$。然而现阶段报道的阴离子交换材料，包括传统的阴离子交换树脂、无机阳离子骨架材料和最近报道的阳离子金属-有机框架材料(MOFs)，在高酸度和强辐射场下难以维持结构稳定。或者它们在存在大量竞争阴离子如 NO_3^-和 SO_4^{2-}的条件下，根据霍夫迈斯特选择性原理(Hofmeister bias selectivity)，对 $^{99}TcO_4^-$选择性较差。因此，找到一种耐酸抗辐照，且具有极快动力学和高选择性的 99Tc 新型吸附剂材料，对解决以上难题具有重大的科学意义。

合成并报道了一例全新的高度共轭的二维阳离子共价有机框架材料(SCU-COF-1)，并首次将这种离子型 COFs 材料应用于放射性 $^{99}TcO_4^-$的去除，且通过分子动力学模拟揭示了其交换原理。该工作不仅在离子型 COFs 材料上的合成上取得了突破，而且证实了 COFs 材料用于高选择性分离 $^{99}TcO_4^-$的优越性。SCU-COF-1 由一种离子化的芳氨基紫罗碱(Viologen-NH2) 和三醛基均苯三酚 (Tp)两种配体通过可逆的席夫碱反应 (Schiff Base Reaction)和不可逆的烯醇式-酮式互变反应而得到。SCU-COF-1 具有超高的酸稳定性 (3 M HNO_3 中仍能维持稳定)、大剂量的耐辐照性 (600 kGy 的 β 或 γ 射线照射后维持稳定)。同时，利用分子动力学模拟研究进一步证明并清楚地显示了阴离子交换过程并解释了其中机理。相关成果发表 **Chemical Science**, 2019, 10, 4293-4305。

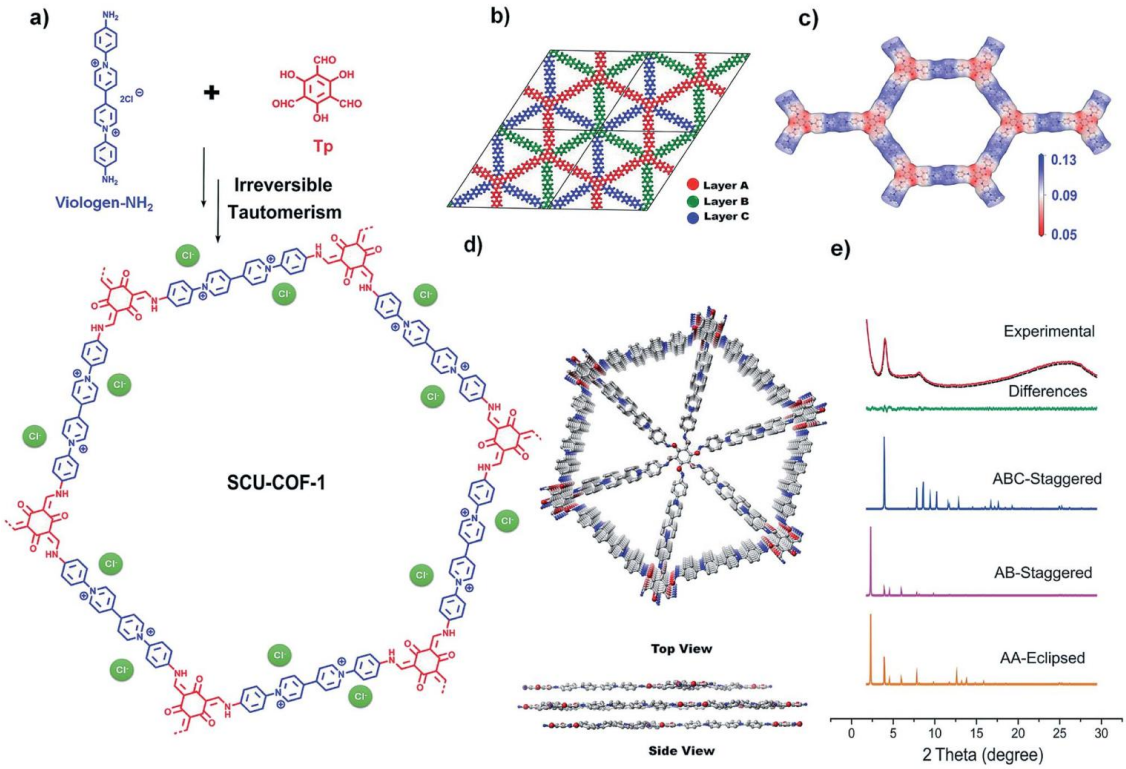

图 3.1 SCU-COF-1 的合成、结构模拟及粉末衍射示意图

2、新型羟基吡啶酮促排剂高效去除骨骼中铀

随着我国核电的高速发展以及近年来国际上核事故和核恐怖袭击事件（核脏弹）的威胁，核安全在全球都得到了高度重视。锕系元素作为核工业及核武器的重要原料，具有极高的化学毒性和放射性，一旦进入人体会沉积在内脏和骨骼等组织难以排出，从而导致严重的器官损伤，如肾衰竭、骨肉瘤等，并极有可能致癌。使用促排剂（络合剂）使锕系元素离子与其结合形成可溶物从而促进其排出体外是处理锕系元素急性体内污染的唯一可行方法。然而，锕系元素促排剂研究近 30 年来进展极为缓慢，未获得十分有效的促排剂来保障公共卫生安全。因此研究低毒、高效的锕系元素促排剂，最大限度降低其内照射产生的辐射损伤是核安全领域最大也是最难的任务之一。

从骨骼中促排锕系元素一直是促排领域内最大的挑战，这是由于锕系元素进入骨骼中，会迅速与成骨材料如羟基磷灰石（HAP）等磷酸配体结合形成极其稳定、溶解度极低的络合物，难以排出。针对该挑战，苏州大学王殳凹课题组从最基础的分子内作用力出发，深入分析了分子内影响络合能力的重要因素，突破了以往

关于促排配体分子设计中氢键对于配体结构刚性和对锕系元素选择性影响的固有认知，创新性地制备出一类新型的 HOPO 配体(5LIO−1−Cm−3, 2−HOPO)，通过电位滴定，DFT 理论计算揭示 5LIO−1−Cm−3, 2−HOPO 对铀酰具有更高的亲和力和更低的结合能，小鼠促排实验发现能够去除肾脏中约 85%的铀以及骨骼中 50%的铀，是首个可以大量去除骨骼中铀的 HOPO 类促排剂。小鼠促排实验发现能够去除肾脏中约 85%的铀以及骨骼中 50%的铀，相比于目前美国报道的最优四齿 HOPO 配体，骨骼促排铀效率提升了近 6 倍，首次在保持肾脏促排率同时可以大量去除骨骼中铀的 HOPO 类促排剂。此外，体外与羟基磷灰石的竞争吸附铀实验也证实了此配体能够高效脱附 HAP（成骨材料）上的铀酰离子，脱附率是此前同类配体的 4 倍以上。进一步研究发现这一配体即使口服给药或者延迟 24 小时给药，仍能够保持很高的促排效率，且对生物体内铀和钍具有很好的广谱促排效果，可以同时去除肝脏中 50%的钍，以及肾脏中近 90%的铀和骨骼中近 55%的铀。可见，该配体是目前世界范围内报道的对铀促排效果最好的四齿羟基吡啶酮的配体，在核应急方面具有极强的可操作性，具有很好的应用前景。相关成果发表 **Nature Communications**, 2019, 10, 2570。

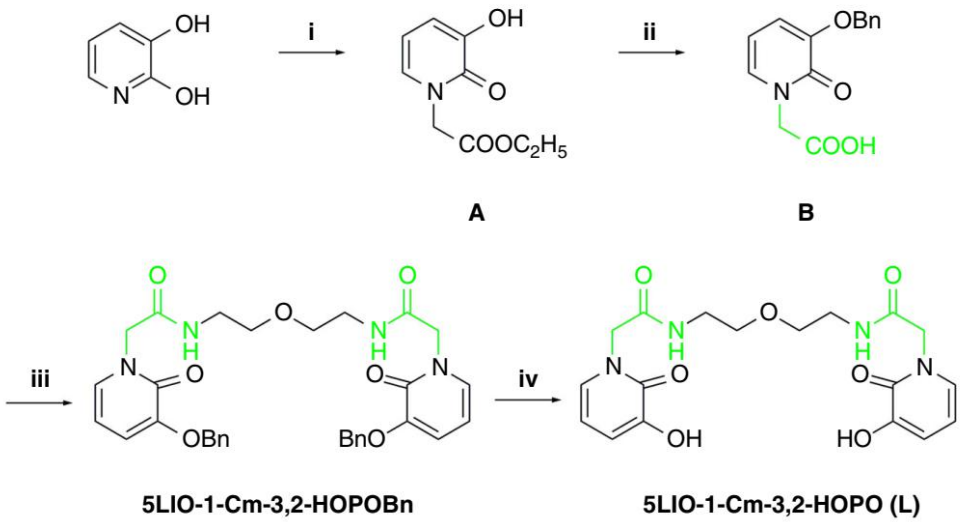

图 3.2 5LIO-1-Cm-3,2-HOPO 合成路线图。

四、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	国家重点实验室	省部共建放射医学与辐射防护国家重点实验室	SS12800119	柴之芳	3000
2	国家重点研发计划	建立小鼠发育代谢表型库	2018YFA0801100	徐璎	4126
3	国家重点研发计划	人工智能元学习新理论与新技术及其在医学影像大数据的示范应用	2018YFA0701700	陈新建	1349
4	国家重点研发计划政府间国际科技创新合作重点专项	金属基纳米颗粒毒理学构效关系探索及其安全设计与合成的研究	2018YFE0120400	李瑞宾	103
5	国家级其他项目	XXX 加固项目研究	41424060204	周光明	400
6	国家自然科学基金	海藻酸钠/咪喹莫特微球在肿瘤重离子免疫联合治疗中应用基础研究	U1932208	杨凯	300
7	国家自然科学基金国际（地区）合作与交流项目	层粘连蛋白调控巨噬细胞和脂肪基质细胞影响肥胖脂肪组织重塑的机制	31961133024	时玉舫	300
8	国家自然科学基金	炎症调控下间充质干细胞的异质性影响肿瘤发生发展的机制研究	81930085	时玉舫	297
9	国家自然科学基金	选择性吸附分离水溶性裂变产物的金属有机框架材料的设计与机理研究	U1967217	周如鸿	269
10	国家自然科学基金	多组学联合的生物辐射敏感分子标志物研究	U1967220	曹建平	267
11	国家自然科学基金	基于比率型光声探针的肿瘤特征分子功能可视化及早期胃癌诊断研究	91959123	史海斌	95.6
12	国家自然科学基金	利用 iPSC 和类器官技术研究线粒体突变在心脏衰老中的作用机制	91949111	胡士军	68

序号	项目类别	项目名称	项目编号	项目负责人	总经费(万元)
13	国家自然科学基金	纳米MOF材料用于体内铀污染促排的研究	21976127	第五娟	66
14	国家自然科学基金	环境污染诱发肺组织炎症中肺部菌群的介导机制研究	21976126	李瑞宾	65
15	国家自然科学基金	体外肝微组织用于铜纳米诊疗剂安全性评价及毒性机制研究	31971319	张乐帅	57
16	国家自然科学基金	血管生成素在静脉内皮细胞命运决定与转分化中的作用机制研究	31970768	何玉龙	57
17	国家自然科学基金	虎杖苷石墨烯水凝胶通过调节肠道细菌Roseburia及其代谢产物5-HIAA救治肠道放射损伤的研究	81973237	崔凤梅	56
18	国家自然科学基金	DNA-PKcs-PIDD信号通路调控电离辐射诱发的有丝分裂期细胞DNA损伤反应和有丝分裂灾变死亡机制研究	81972964	尚增甫	55
19	国家自然科学基金	基于T淋巴细胞活性可视化监测的序贯性肿瘤免疫联合治疗策略	81972877	黄玉辉	55
20	国家自然科学基金	响应型多模态纳米探针用于脑胶质瘤诊疗的研究	81971671	李桢	55
21	国家自然科学基金	阳离子MOFs的构筑及对高锝酸根离子吸附的研究	21906114	盛道鹏	26
22	国家自然科学基金	高稳定高比表面积单晶有机磷酸锆的合成及相关核素的去除研究	21906113	陈兰花	26
23	省协同创新中心	省放射医学协同创新中心	SX12800117	柴之芳	800
24	省优势学科	省特种医学优势学科	YX12800211	柴之芳	590
25	省部级项目	多模态诊疗一体化超小纳米影像探针	BE2019660	李桢	200

序号	项目类别	项目名称	项目编号	项目负责人	总经费(万元)
26	江苏省杰出青年基金项目	针对人体内环境高毒性高放射性锕系元素污染的应急促排剂研究	BK20190044	第五娟	100
27	省部级项目	间充质干细胞与结核感染及耐药性的研究	***	时玉舫	100
28	省部级项目	基于功能纳米探针的活体病原细菌感染靶向诊疗研究	BK20190097	李永强	50
29	省部级项目	纳米酶在放疗联合维生素 C 抗肿瘤治疗中的潜在应用	Q612861519	葛翠翠	30
30	省部级项目	辐射工作人员辐射安全和防护培训机制改革技术支持	K412860419	涂彧	14
31	省部级项目	放射治疗、介入放射从业人员放射防护培训大纲编写	K412860519	涂彧	4
32	苏州市科技创新政策性资助项目	炎症微环境中间充质干细胞对肝肾纤维化的调控作用及干预策略	2018YFA0107503	时玉舫	100
33	苏州市科技创新政策性资助项目	生物钟相关的环境适应基因的筛选与干预研究	1816312ZT00205401	徐璎	20
34	苏州市科技创新政策性资助项目	基于同位素示踪技术的抗肿瘤药物临床评价技术平台的建立-子课题 1（任务 2）	N312861219	许玉杰	40
35	苏州市科技创新政策性资助项目	CFETR 氚工厂系统总体设计技术研究	N312860819	华道本	40
36	苏州市科技创新政策性资助项目	生物相容性氧化铁纳米颗粒的安全性评估	N312860919	柴之芳	40
37	苏州市科技创新政策性资助项目	分子功能影像与生命组学引导肿瘤多线束放疗敏感性预测	N312861419	曹建平	40
38	苏州市科技创新政策性资助项目	高质量磁性氧化铁纳米颗粒稳定宏量制备	N312861019	李桢	40
39	苏州市科技创新政策性资助项目	乏氧肿瘤多线束放疗的生物效应和分子机制研究	N312861119	周光明	40
40	国家重点研发计划子课题	空间带电粒子微探测器研制	2016YFB0501303	胡亮	10

序号	项目类别	项目名称	项目编号	项目负责人	总经费(万元)
41	横向项目	放射性药物制剂创新技术	H190751	钟志远	1000
42	横向项目	苏州大学-北京耀中堂非医疗健康干预研究中心	H190443	王建荣	500
43	横向项目	XXX	XXX	第五娟	65.2
44	横向项目	XXX	XXX	第五娟	26.5
45	横向项目	核与辐射医学应急标准体系研究	ISNI-KY-102-2019	刘玉龙	15
46	横向项目	辐射损伤防治药效检测	JH04-2019-03	李瑞宾	9.85
47	横向项目	修订国家职业卫生标准《核电厂操纵员的健康要求和医学监督规定》	20192104	刘玉龙	8
48	横向项目	上海仁机研究生工作站专项	7112800119	涂彧	5
49	横向项目	岩棉纤维材料对大鼠危害性的测试研究	2019-7-5	李瑞宾	3.286
合计					14983.436

五、国内外学术交流

1、主办、承办会议

序号	会议名称	会议类型	会议日期	会议地址	参加人数
1	V 世界生物钟联盟会议	全球性	2019-04-23	苏州	300
2	第二届太湖国际血栓与止血学术讨论会	全球性	2019-10-12	苏州	200
3	2019 年无锡国际生物医药论坛暨第九届 Cell Death & Disease 国际研讨会—新药研发	全球性	2019-11-04	无锡	260
4	亚洲核合作论坛（Forum for Nuclear Cooperation in Asia，FNCA）“2019 年 FNCA 肿瘤放疗研讨会”	全球性	2019-10-27	苏州	55
5	首届放射生物学研讨会	全国性	2019-05-17	苏州	58
6	国家自然科学基金委员会-放射化学学科人才战略研讨会	全国性	2019-10-31	苏州	260
7	2019 年国家级继续教育项目[2019-12-01-005(国)]《核与辐射损伤医学应急演练与临床处理》培训班	全国性	2019-11-25	苏州	110
8	第三届中国氚科学与技术学术交流会	全国性	2019-10-16	苏州	150
9	第六届医学图像计算青年研讨会	全国性	2019-07-13	苏州	1500
10	东吴心血管病基础论坛	全国性	2019-12-27	苏州	200
11	耀中堂科学辟谷苏州集训班	全国性	2019-11-13	苏州	70
12	放射卫生与监督进展学术报告会	区域性	2019-11-03	苏州	60
13	放射防护领域新进展述评	区域性	2019-10-14	苏州	80
14	移植出凝血学习班		2019-07-28	苏州	150

2、专家来访

序号	时间	报告人	主题	单位
1	2019-07-10	Prof. Chen Bin	Harness open genomic data and artificial intelligence to discover new cancer therapeutics	密西根州立大学
2	2019-06-08	唐晓英教授	动态图论特征在脑部神经疾病中的应用	北京理工大学
3	2019-06-08	王德平处长	科技计划布局与部署	科技部中国生物技术中心前沿生物技术处
4	2019-06-08	马国林主任	面神经麻痹的静息态脑功能和脑网络磁共振成像研究	北京中日友好医院
5	2019-03-23	唐建斌教授	抗癌纳米药物：肿瘤靶向输送与特异性释放	浙江大学
6	2019-03-23	范曲立教授	半导体高分子在近红外二区荧光成像中的应用	南京邮电大学
7	2019-03-23	梁高林教授	自组装在分子影像中的应用	中国科技大学
8	2019-10-14	Prof. Joseph S. Francisco	Catalytic & Autocatalytic Chemical Processes in the Atmosphere	美国宾夕法尼亚大学
9	2019-06-18	苏宝连院士	—等级定律：等级孔纳米材料的设计理论及等级孔材料的发展历程	比利时那慕尔大学
10	2019-10-24	Yang Ba 博士	Strategies toward Stable and Efficient Perovskite Photovoltaics and Integrated Energy System	澳大利亚昆士兰大学的
11	2019-10-25	袁荃教授	基于分子识别的诊疗探针的设计与应用	湖南大学
12	2019-10-22	刘健研究员	—走进纳米反应器：微纳空间中的催化反应过程	大连化物所
13	2019-10-12	姚立研究员	超低场纳米磁材料的设计合成与性能研究	中国科学院化学所
14	2019-09-27	李峰研究员	病毒纳米生物技术	武汉病毒研究所
15	2019-04-18	胡玉正教授	Neural Circuits Associated with Compulsive Behavior of Drug Addiction	浙江大学
16	2019-05-09	Jim Xiang 教授	Novel EXO-T vaccine for HIV and cancer	加拿大萨斯卡彻温大学药学院
17	2019-04-10	郭海洋博士	前列腺癌精准医学与器官衰老	加拿大多伦多大学
18	2019-04-10	石国军博士	细胞代谢	美国密西根大学医学院

序号	时间	报告人	主题	单位
19	2019-04-29	蒋红柳	HWQ 效应及其防护	火箭军研究院
20	2019-04-30	Francis A. Cucinotta	Cognitive Detriments after Proton and Heavy ion Exposures in Spaceflight and Hadron Therapy	内华达大学
21	2019-05-16	李川源	Unexpected role of apoptotic caspases and DNA repair in carcinogenesis and cancer therapy	Duke University Medical Center
22	2019-09-23	Lembit Sihver	Radiation and Radiation Protection at Aviation Altitudes and in Deep Space	Vienna University of Technol
23	2019-09-24	Guenther Reitz	Moon to Mars	德国宇航员中心航天医学研究所辐射生物研究室
24	2019-09-24	Lembit Sihver	History and Physics of Particle and Ion Therapy	Vienna University of Technol
25	2019-09-27	Francis A. Cucinotta	Nasa Space Cancer Risk Model 2020: in memory of GioacchinoFailla	内华达大学
26	2019-09-26	陆嘉德	Carbon ion radiation therapy in the management of head and neck malignancies	上海市质子重离子医院（复旦大学附属肿瘤医院质子重离子中心
27	2019-09-26	Lembit Sihver	From Radiotherapy to Space Dosimetry	Vienna University of Technol
28	2019-09-27	Lembit Sihver	Causes and Radiological Consequences of the Three Mile Island, Chernobyl and Fukushima Nuclear Accidents	Vienna University of Technol
29	2019-12-01	Oleg Belyakov	Overview of NAHU/ARBR Radiation Biology Coordinated Research Projects	IAEA
30	2019-12-02	Satoshi Tashiro	Clinical Applications of Biological Dosimetry	日本广岛大学原爆放射线医科学研究所
31	2019-12-02	Shinya Matsuura	Analysis of Individual Differences in Radiation Sensitivity	日本广岛大学原爆放射线医科学研究所
32	2019-12-02	Yukihito Higashi	Regenerative Medicine for Radiation Emergency	日本广岛大学原爆放射线医科学研究所
33	2019-11-06	Prof.Ilia Droujinine	Characterization of protein communication networks between organs and organisms	美国 Scripps 研究中心
34	2019-03-18	朱广山教授	Porous aromatic frameworks using in adsorption and catalysis	东北师范大学
35	2019-04-29	蒋红柳研究员	核武器及其效应简介(公开)	火箭军研究院

序号	时间	报告人	主题	单位
36	2019-06-05	王浩副教授	Tailor-made metal-organic frameworks for targeted molecular capture and separation	深圳职业技术学院霍夫曼先进材料研究院
37	2019-06-05	刘威副教授	卤化亚铜类无机-有机半导体荧光粉材料	深圳职业技术学院霍夫曼先进材料研究院
38	2019-06-18	苏宝连教授	等级定律：等级孔纳米材料的设计理论及等级孔材料的发展历程	武汉理工大学
39	2019-06-28	郭啸峰教授	Experimental Thermodynamics on Nuclear Fuel and Waste Materials	华盛顿州立大学
40	2019-07-23	孙俊良研究员	粉末晶态样品的解析	北京大学
41	2019-07-23	孙学谦研究员	UnderstandingSurface and Interfacial Chemistry in Functional Materials by Solid-state NMR	浙江大学
42	2019-07-27	胡淑贤博士	锕酰离子成键规律的理论研究	北京计算科学研究中心
43	2019-11-13	Dr. Robert D. Eagling	Publishing in Chem	CellPress Publication

3、外出参加交流

序号	会议名称	会议时间	举办地点	参加人员	类别
1	ACS Fall 2019 National Meeting & Exposition	2019-08-25	San Diego, USA	钟志远	国外
2	ACS Fall 2020 National Meeting & Exposition	2019-08-25	San Diego, USA	钟志远	国外
3	Spring ACS National Meeting	2019-03-31	奥兰多（美）	周如鸿	国外
4	2019 Fall ACS National Meeting	2019-08-26	圣地亚哥（美）	周如鸿	国外
5	The 16th International Congress of Radiation Research （ICRR2019）	2019-08-25	英国.曼彻斯特	焦旸	国外
6	American Society of Biochemistry and Molecular Biology (ASBMB), Special Symposium on Serine Proteases in Pericellular Proteolysis and Signaling	2019-09-12	Protomac, Maryland, USA	吴庆宇	国外
7	American Society of Biochemistry and Molecular Biology (ASBMB), Special Symposium on Serine Proteases in Pericellular Proteolysis and Signaling	2019-09-12	Protomac, Maryland, USA	吴庆宇（贺美玲）	国外
8	American Society of Biochemistry and Molecular Biology (ASBMB), Special Symposium on Serine Proteases in Pericellular Proteolysis and Signaling	2019-09-12	Protomac, Maryland, USA	吴庆宇（牛亚燕）	国外
9	American Society of Biochemistry and Molecular Biology (ASBMB), Special Symposium on Serine Proteases in Pericellular Proteolysis and Signaling	2019-09-12	Protomac, Maryland, USA	吴庆宇（王志婷）	国外
10	2019ACS 春季会议	2019-03-30	美国奥兰多	王殳凹	国外
11	ISCT 第 25 届年会	43617	墨尔本	时玉舫	国外
12	2019 Camberidge 10th CDD Conference"Cancer,Inflammation&Immunity"	2019-09-01	英国剑桥	时玉舫	国外
13	The 16th International Congress of Radiation Research. .	2019-08-25	Manchester, 英国	涂彧、孙亮、崔凤梅	国外
14	2019 年纳米机器会议	2019-12-14	东京	陈华兵	国外
15	国际未来材料论坛	2019-01-28	澳大利亚卧龙岗	孙巧	国外
16	第一届生物物理标定会议	2019-05-19	德国达姆施塔特	周光明	国外

序号	会议名称	会议时间	举办地点	参加人员	类别
17	22nd IAA Humans in Space Symposium	2019-11-10	迪拜	周光明	国外
18	5th INTERNATIONAL SYMPOSIUM ON THE SYSTEM OF RADIOLOGICAL PROTECTION	2019-11-16	澳大利亚	周光明	国外
19	The 30th Great Wall International Congress of Cardiology	2019-10-10	北京	吴庆宇	国内
20	The Third International Symposium on Radiation Therapeutics and Biology	2019-11-29	苏州	杨红英	国内
21	第三届先进凝胶材料与软物质国际学术讨论会	2019-06-14	西安	胡亮	国内
22	第四届分子影像与纳米医学国际研讨会	2018-11-04	苏州	汪勇	国内
23	Cell & Gene therapy Asia summit 2019 Beijing China	2019-06-11	北京	时玉舫	国内
24	2019 无锡国际生物医药论坛	2019-11-04	无锡	时玉舫	国内
25	第六届东吴国际介入论坛	2019-10-25	苏州	黄玉辉	国内
26	第十届全国环境化学大会	2019-8-15	天津	华道本	国内
27	第二届核应急与放射医疗高峰论坛	2019-11-07	成都	华道本	国内
28	海水提铀联盟成立大会	2019-11-08	北京	华道本	国内
29	第六届长三角肿瘤消融论坛	2019-11-23	苏州	史海斌	国内
30	第三届荧光探针与成像青年学者研讨会	2019-04-14	西安	史海斌	国内
31	化学生物学东湖论坛	2019-03-30	武汉	史海斌	国内
32	2019 年中国生物医学工程学会大连青年论坛	2019-08-20	大连	李桢	国内
33	2019 中国生物材料大会暨国际先进生物材料大会	2019-08-22	大连	李桢	国内
34	Chinanano 2019	2019-07-17	北京	李桢	国内
35	中国（上海）国际辐射科技产业大会	2019-11-12	上海	李桢	国内
36	中国材料大会	2019-07-11	成都	李桢	国内
37	2019 侨界精英创新创业(中国·杭州）峰会	2019-10-30	杭州	李桢	国内
38	中国化学会第十七届胶体与界面术议	2019-07-28	无锡	李桢	国内
39	2019 新材料国际发展趋势高层论坛	2019-09-24	武汉	李桢	国内
40	第二届核应急救援与放射医疗高峰论坛	43776	成都	李桢	国内

序号	会议名称	会议时间	举办地点	参加人员	类别
41	2019 年纳米肿瘤学年会	2019-10-10	太原	李桢	国内
42	近红外二区光学分子影像学术研讨会	2019-12-06	西安	李桢	国内
43	中国颗粒学会 2019 功能材料与界面 科学研讨会	2019-12-13	长沙	李桢	国内
44	第十届全国环境化学大会	2019-08-15	天津	周如鸿	国内
45	China Nano 2019, IOP Symposium	2019-08-19	北京	周如鸿	国内
46	第十届中华医学会放射医学与防护会议	2019-11-14	温州	焦旸	国内
47	首届放射医学博士（后）创新发展学术研讨会	2019-09-25	天津	焦旸	国内
48	Interdisciplinary Workshop on Thin Films & Photonics and Organic Electronics (TF-POE2019)	2019-11-20	济南	李永强	国内
49	大河三角洲与大湾区学术研讨会	2019-11-20	南京	刘志勇	国内
50	2019 江南分析化学论坛	2019-04-18	无锡	汪勇	国内
51	2019 中国生物材料大会	2019-08-22	大连	汪勇	国内
52	第十届东吴医学影像论坛	2019-11-01	苏州	汪勇	国内
53	国家重点研发计划“纳米科技”重点专项—“新型纳米氧化铁磁共振造影剂的宏量制备及临床转 化研究”2019 年项目进展暨学术交流会	2019-11-16	苏州	汪勇	国内
54	香山科学会议“放射生物学关键科学问题与多组织器官损伤救治前沿技术”学术讨论会	2019-10-23	北京	杨红英	国内
55	第二届核应急救援与放射医疗高峰论坛暨核应急医学研讨会	2019-11-07	成都	杨红英	国内
56	临床放射生物学新进展研讨会	2019-12-07	福州	杨红英	国内
57	第五届辐射与环境专题研讨会	2019-04-20	湖南衡阳	周光明、刘宁昂	国内
58	the 4th International Conference on Nanoenergy and Nanosystems 2019 (NENS2019)	2019-06-15	北京	胡文涛	国内
59	“聚焦创新，合新合力”交流会暨全国首届放射医学博士生（后）创新发展学术交流会	2019-09-05	天津	周光明	国内
60	中国毒理学会第九次全国毒理学大会	2019-09-17	山西太原	裴炜炜	国内

序号	会议名称	会议时间	举办地点	参加人员	类别
61	国家重点研发计划“分子影像引导的乏氧肿瘤多线束精准放射治疗计划技术研发及临床实现”2019 年度项目中期进展讨论会	2019-09-22	兰州	胡文涛 李冰燕	国内
62	7th International Systems Radiation Biology Workshop	2019-09-28	大连	周光明、 黄皓	国内
63	特种医学学科发展战略研讨会	2019-10-09	北京	周光明、 裴海龙	国内
64	黄埭高新区生物医药产业创新发展论坛	2019-10-26	苏州	周光明	国内
65	医用融合科技发展国际学术高峰论坛	2019-11-02	北京	周光明	国内
66	3rd International Symposium on Radiation Therapeutics & Biology	2019-11-29	苏州	周光明	国内
67	广东省中西医结合学会核医学专业委员会 2018 年会	2018-11-15-18	广州	朱然	国内
68	江苏省核医学发展高峰论坛	2018-06-10	南京	朱然	国内
69	环境化学青年学者研讨会	2019-03-24	武汉	葛翠翠	国内
70	第十七次中国暨国际生物物理大会	2019-08-03	天津	葛翠翠	国内
71	第十届全国环境化学大会	2019-08-15	天津	葛翠翠	国内
72	第 22 届全国色谱会议	43576	上海	李瑞宾	国内
73	2019 环境与健康学术会议	43767	天津	李瑞宾	国内
74	2019 全国环境化学大会	43698	天津	李瑞宾	国内
75	放射化学学科战略研讨会	2019-10-30	苏州	王殳凹	国内
76	中国干细胞第九届年会	2019-09-19	天津	时玉舫	国内
77	2019 年国家级继续医学教育项目“肿瘤微环境与免疫治疗的基础/临床研究进展”	2019-11-09	苏州	黄玉辉	国内
78	第二十二届全国临床肿瘤学大会暨 2019 年 CSCO 学术年会	2019-09-18	厦门	黄玉辉	国内
79	2019 年粤港澳大湾区临床免疫大会	2019-11-01	深圳	时玉舫	国内
80	2019 年金陵淋巴肿瘤论坛	2019-05-17	南京	黄玉辉	国内
81	2019 年信达浙闽赣免疫肿瘤论坛	2019-05-12	杭州	黄玉辉	国内

六、授权专利目录

序号	专利号	专利名称	类别	授权公告日	国家	完成人(固定人员)
1	US 10,336, 720 B2	Cyclic carbonate monomer containing double iodine, biodegradable polymer prepared thereby and use	发明专利	2019-07-02	美国	钟志远
2	ZL 2016 10501766.7	具有不对称膜结构的可逆交联生物可降解聚合物囊泡及其制备方法与在核酸药物中的应用	发明专利	2019-01-18	中国	钟志远
3	ZL 2016 10559279.6	一种基于交联生物可降解聚合物囊泡的抗肿瘤纳米药物及其制备方法	发明专利	2019-04-05	中国	钟志远
4	ZL 2016 10558116.6	内膜具有正电的可逆交联生物可降解聚合物囊泡及其制备方法与在制备抗肿瘤药物中的应用	发明专利	2019-03-01	中国	钟志远
5	ZL 2016 10613021.X	透明质酸衍生化的美登素前药、其制备方法与在制备肿瘤靶向治疗药物中的应用专利号	发明专利	2019-02-19	中国	钟志远
6	ZL 2015 10973770.9	生物可降解双亲性聚合物、由其制备的聚合物囊泡及在制备肺癌靶向治疗药物中的应用	发明专利	2019-07-12	中国	钟志远
7	ZL 2016 10536475.1	一种自发荧光纳米凝胶及其制备方法与应用	发明专利	2019-02-26	中国	钟志远
8	ZL 2016 1 0536411.1	一种抗肿瘤药物的制备方法	发明专利	2019-05-10	中国	钟志远
9	ZL 2016 10292665.3	一种利用流式细胞术检测人气道胰蛋白酶样蛋白酶 4 的方法	发明专利	2019-07-26	中国	吴庆宇
10	ZL 2015 10211769.2	一种叶酸修饰的磺酸甜菜碱-壳聚糖纳米颗粒及其制备方法和应用	发明专利	2019-08-13	中国	刘芬菊, 俞家华, 华道本
11	ZL 2017 10670861.42	吸氡抗辐射涂料及其制备方法和应用	发明专利	2019-11-15	中国	朱巍
12	ZL 2017 10670859.73	炫彩石墨烯量子点涂料及其制备方法和应用	发明专利	2019-11-15	中国	朱巍
13	ZL 2017 10890769.9	抗腐蚀石墨烯工业涂料及其制备方法和应用	发明专利	2019-11-15	中国	朱巍

序号	专利号	专利名称	类别	授权公告日	国家	完成人(固定人员)
14	ZL 2016 10668501.6	一种共载化疗药物和放疗药物的蛋白及其应用	发明专利	2019-08-23	中国	杨凯
15	ZL 2017 10016465.X	一种高锝酸根吸附剂及其合成方法与在处理放射性废水中的应用	发明专利	2019-04-05	中国	王殳凹
16	2017104566159	去除稀土矿物中放射性钍元素的方法	发明专利	2019-07-04	中国	王殳凹
17	ZL2016 10723117.1	紫外光介导的纳米颗粒自组装聚集体、其制备方法和应用	发明专利	2019-06-25	中国	史海斌, 高明远
18	ZL 2016 10575997.2	双金属硫族三元半导体纳米颗粒及其制备方法	发明专利	2019-01-29	中国	李桢
19	ZL 2016 10839718.9	用于体内细菌感染的诊疗一体化纳米探针及其制备方法	发明专利	2019-09-03	中国	李永强
20	ZL 2016 11022142.3	去除血液中铯离子的方法	发明专利	2019-09-27	中国	华道本
21	ZL 2016 10034539.8	三维图割算法结合随机游走算法的 PET-CT 肺肿瘤分割方法	发明专利	2019-02-26	中国	陈新建
22	ZL 2015 10097720.9	视网膜细胞荧光显微图像的自动分割和计数方法	发明专利	2019-03-01	中国	陈新建
23	ZL 2016 10846899.8	一种铂基化氟硼二吡咯类化合物及制备方法和应用	发明专利	2019-01-01	中国	陈华兵
24	ZL 2016 10453656.8	矿化三维多孔石墨烯材料在制备骨缺损填充物中的应用	发明专利	2019-02-19	中国	曹建平
25	ZL 2017107907653	有核定位能力的透皮短肽及其应用	发明专利	2019-11-12	中国	曹建平
26	2019210256722	细菌纤维素培养装置	实用新型	2019-12-13	中国	杨凯
27	ZL 201821830677.8	一种含有机氚碳 14 的废弃物处理装置	实用新型	2019-08-13	中国	王敬东, 许玉杰
28	201920276309.1	生物组织活细胞分离器	实用新型	2019-11-06	中国	李瑞宾

七、论文目录

序号	论文名称	刊物/出版社名称	卷、期、页	作者
1	CD44-Specific A6 Short Peptide Boosts Targetability and Anticancer Efficacy of Polymersomal Epirubicin to Orthotopic Human Multiple Myeloma	Advanced Materials	2019, 1904742	Wenxing Gu, Jingnan An, Hao Meng, Na Yu, Yinan Zhong, Fenghua Meng*, Yang Xu*, Jeroen J.L.M. Cornelissen, and Zhiyuan Zhong*
2	IGF-2 Preprograms Maturing Macrophages to Acquire Oxidative Phosphorylation-Dependent Anti-inflammatory Properties	Cell Metabolism	2019, 29,1363-1375.e8	Liming Du, Liangyu Lin, Qing Li, Keli Liu,Yin Huang,Xuefeng Wang, Kai Cao,Xiaodong Chen,Wei Cao, Fengying Li, Changshun Shao, Ying Wang* and Yufang Shi*
3	FOXO3, a Molecular Search for the Fountain of Youth	Cell Stem Cell	2019, 24, 351-352	Willem E. Fibbe,* and Yufang Shi*
4	Distinctive Two-Step Intercalation of Sr2+ into a Coordination Polymer with Record High 90Sr Uptake Capabilities	Chem	2019, 5, 977-994	Jiarong Zhang‡, Lanhua Chen‡, Xing Dai‡, Lin Zhu, Chengxiang Xiao, Lin Xu, Zhengyi Zhang, Evgeny V. Alekseev, Yaxing Wang, Chao Zhang, Haowen Zhang, Yanlong Wang, Juan Diwu*, Zhifang Chai, Shuao Wang*
5	[Ln6O8] Cluster-Encapsulating Polyplumbites as New Polyoxometalate Members and Record Inorganic Anion-Exchange Materials for ReO4- Sequestration	Advanced Science	2019, 6, 1900381	Jian Lin, Lin Zhu, Zenghui Yue, Chuang Yang, Wei Liu, Thomas E. Albrecht-Schmitt, Jianqiang Wang,* and Shuao Wang*
6	Textile-based Wireless Pressure Sensor Array for Human-interactive Sensing	Advanced Functional Materials	2019, 29, 1808786	Baoqing Nie, Rong Huang, Ting Yao, Yiqiu Zhang, Yihui Miao, Changrong Liu, Jian Liu, Xinjian Chen
7	Boosting H2O2-Guided Chemodynamic Therapy of Cancer by Enhancing Reaction Kinetics through Versatile Biomimetic Fenton Nanocatalysts and the Second Near-Infrared Light Irradiation,	Advanced Functional Materials	2019, DOI: 10.1002/adfm.201906128	Tingting Wang, Hao Zhang, Hanghang Liu, Qiang Yuan, Feng Ren, Yaobao Han, Qiao Sun, Zhen Li,* and Mingyuan Gao

序号	论文名称	刊物/出版社名称	卷、期、页	作者
8	3D superelastic scaffolds constructed from flexible inorganic nanofibers with self-fitting capability and tailorable gradient for bone regeneration	Advanced Functional Materials	2019, 29, 1901407	Lihuan Wang, Yuyou Qiu, Haijun Lv, Yang Si, Lifang Liu, Qi Zhang, Jianping Cao, Jianyong Yu, Xiaoran Li*, Bin Ding*
9	Enhancing proliferation and migration of fibroblast cells by electric stimulation based on triboelectric nanogenerator	Nano Energy	2019, 57, 600-607	Wentao Hu, Xuelian Wei, Lin Zhu, Dong Yin, Aimin Wei, Xiangyu Bi, Tao Liu, Guangming Zhou, Yinghuai Qiang, Xuhui Sun, Zhen Wen*, Yue Pan*
10	Direct Radiation Detection by a Semiconductive Metal-Organic Framework	Journal of the American Chemical Society	2019, 141, 8030-8034	YaxingWang, Xin Liu, Xiaoyan Li, Fuwan Zhai, Siqi Yan, Ning Liu, Zhifang Chai, Yadong Xu*, Xiaoping Ouyang*, Shuao Wang*
11	Quantitatively Visualizing Tumor-Related Protease Activity in Vivo Using a Ratiometric Photoacoustic Probe	Journal of the American Chemical Society	2019, 141, 3265–3273	Ling Yin, Hao Sun, Hao Zhang, Lei He, Ling Qiu, Jianguo Lin, Huawei Xia, Yuqi Zhang, Shun-jun Ji,* Shi, H,* Mingyuan Gao*
12	Powerful uranium extraction strategy with combined ligand complexation and photocatalytic reduction by postsynthetically modified photoactive metal-organic frameworks	Applied Catalysis B: Environmental	2019, 254, 47–54	Hui Li, Fuwan Zhai, Daxiang Gui, Xiangxiang Wang, Chunfang Wu, Duo Zhang, Xing Dai, Hong Deng, Xintai Su, Juan Diwu, Zhang Lin , Zhifang Chai, Shuao Wang,
13	Spatiotemporally Light-Activatable Platinum Nanocomplexes for Selective and Cooperative Cancer Therapy	ACS Nano	2019, 13, 6647-6661	Hao Zhao. Jiabao Xu. Wenjing Huang. Guiting Zhan. Yanbing Zhao*. Huabing Chen*. Xiangliang Yang*
14	Engineered Graphene Oxide Nanocomposite Capable of Preventing the Evolution of Antimicrobial Resistance	ACS nano	2019, 13, 11488-11499	Zheng, Huizhen#; Ji, Zhaoxia#; Roy, Kevin R; Gao, Meng; Pan, Yanxia; Cai, Xiaoming; Wang, Liming; Li, Wei; Chang, Chong Hyun; Kaweeteerawat, Chitrada; Chen, Chunying; Xia, Tian; Zhao, Yuliang; Li, Ruibin*

序号	论文名称	刊物/出版社名称	卷、期、页	作者
15	Optimization of Antibacterial Efficacy of Noble-Metal-Based Core-Shell Nanostructures and Effect of Natural Organic Matter	ACS Nano	2019, doi: 10.1021/acsnano.9b04366	Tingting Cai, Ge Fang, Xin Tian, Jun-Jie Yin, Chunying Chen and Cuicui Ge*
16	Boosting the Radiosensitizing and Photothermal Performance of Cu2-xSe Nanocrystals for Synergetic Radiophotothermal Therapy of Orthotopic Breast Cancer	Acs Nano	2019, 13, 1342-1353	Qian Huang, Shaohua Zhang, Hao Zhang, Yaobao Han, Hanghang Liu, Feng Ren, Qiao Sun, Zhen Li,* and Mingyuan Gao
17	pH-Switchable Antimicrobial Nanofiber Networks of Hydrogel Eradicate Biofilm and Rescue Stalled Healing in Chronic Wounds	ACS Nano	2019,13,11686-11697	Jianhao Wang, Xiaoyi Chen, Yuan Zhao, Yanmei Yang, Weijie Wang, Chun Wu, Baozhu Yang, Zhaotian Zhang, Leshuai Zhang, Yun Liu, Xuancheng Du, Weifeng Li, Lin Qiu, Pengju Jiang,* XiaozZhou Mou,* Yongqiang Li*
18	Optimization of Antibacterial Efficacy of Noble-Metal-Based Core−Shell Nanostructures and Effect of Natural Organic Matter	ACS Nano	2019, 13, 12694-12702	Tingting Cai,# Ge Fang,#Xin Tian, Jun-Jie Yin, Chunying Chen and Cuicui Ge*
19	Smart, elastic, and nanofiber-based 3D scaffolds with self-deploying capability for osteoporotic bone regeneration	Nano Lett.	2019, 19, 9112-9120	Lihuan Wang, Yuyou Qiu, Yuxia Guo, Yang Si, Lifang Liu, Jianping Cao, Jianyong Yu, Xiaoran Li*, Qi Zhang*, Bin Ding*
20	Successful Decontamination of 99TcO4− in Groundwater at Legacy Nuclear Sites by a Cationic Metal‐Organic Framework with Hydrophobic Pockets	Angewandte Chemie-International Edition	2019, 58, 4968-4972	Daopeng Sheng, Lin Zhu, Xing Dai, Chao Xu, Peng Li, Carolyn I. Pearce, Chengliang Xiao,* Jing Chen, Ruhong Zhou, Tao Duan, Omar K. Farha, Zhifang Chai, and Shuao Wang*
21	Three Mechanisms in One Material: Uranium Capture by a Polyoxometalate–Organic Framework through Combined Complexation, Chemical Reduction, and Photocatalytic Reduction	Angewandte Chemie-International Edition	2019, 58, 16110-16114	Hailong Zhang, Wei Liu, Ao Li, Duo Zhang, Xiaoyan Li, Fuwan Zhai, Lanhua Chen, Long Chen, Yanlong Wang, and Shuao Wang*

序号	论文名称	刊物/出版社名称	卷、期、页	作者
22	Coordinatively Unsaturated Fe3+ Based Activatable Probes for Enhanced MRI and Therapy of Tumors	Angewandte Chemie-International Edition	2019, 58, 11088-11096	Peisen Zhang, Yi Hou,* Jianfeng Zeng, Yingying Li, Zihua Wang, Ran Zhu, Tiancong Ma, and Mingyuan Gao*
23	Optimizing Radionuclide Sequestration in Anion Nanotraps with Record Pertechnetate Sorption	Nature Communications	2019, 10, 1646	Q. Sun, L. Zhu, Briana Aguila, Praveen K. Thallapally, C. Xu, J. Chen, S. Wang*, David Rogers, S. Ma*
24	A 3,2-Hydroxypyridinone-Bsed Decorporation Agent that Removes Uranium from Bones in vivo	Nature Communications	2019, 10, 2570	Xiaomei Wang, Xing Dai, Cen Shi, Jianmei Wan, Mark A. Silver, Linjuan Zhang, Lanhua Chen1, Xuan Yi, Bizheng Chen, Duo Zhang, Kai Yang, Juan Diwu, Jianqiang Wang, Yujie Xu, Ruhong Zhou, Zhifang Chai & Shuao Wang
25	Multispectral Optoacoustic Imaging of Dynamic Redox Correlation and Pathophysiological Progression Utilizing Upconversion Nanoprobes	Nature Communications	2019, 10, 1087	Xiangzhao Ai, Zhimin Wang, Haolun Cheong, Yong Wang, Ruochong Zhang, Jun Lin, Yuanjin Zheng, Mingyuan Gao & Bengang Xing
26	Tumor Vasculatures: A New Target for Cancer Immunotherapy	Trends in Pharmacological Sciences	2019, 40(9)	Zhigang Liu, Yifan Wang, Yuhui Huang, Betty Y.S. Kim, Hong Shan,* Depei Wu* and Wen Jiang,*
27	Core 1-derived mucin-type O-glycosylation protects against spontaneous gastritis and gastric cancer.	Journal of Experimental Medicine	2019, doi: 10.1084/jem.20182325. PMID: 31645367	Fei Liu, Jianxin Fu, Kirk Bergstrom, Xindi Shan, J. Michael McDaniel, Samuel McGee, Xia Bai, Weichang Chen, and Lijun Xia
28	Nano-Agents Based on Poly(ethylene glycol)-b-Poly(L-thyroxine) Block Copolypeptide for Enhanced Dual-Modality Imaging and Targeted Tumor Radiotherapy	Small	2019, 15, 1902577	Xiaolei Gu, Zhehong Zhu, Qianyi Fan, Yaohua Wei, Guanglin Wang, Fenghua Meng,Zhiyuan Zhong,* and Chao Deng*

序号	论文名称	刊物/出版社名称	卷、期、页	作者
29	Preferential Tumor Accumulation of Polyglycerol Functionalized Nanodiamond Conjugated with Cyanine Dye Leading to Near-Infrared Fluorescence In Vivo Tumor Imaging	Small	2019, 1901930	Fumi Yoshino, Tsukuru Amano, Yajuan Zou, Jian Xu, Fuminori Kimura, Yoshio Furusho, RO Tokuhiro Chano, Takashi Murakami, Li Zhao,* and Naoki Komatsu*
30	Holo-Lactoferrin Modifed Liposome for Relieving Tumor Hypoxia and Enhancing Radiochemotherapy of Cancer	Small	2019, 1803703	Zheng Zhang, Jingrong Yang, Qingqing Min, Chenjie Ling, Debabrata Maiti, Jiaying Xu,* Liqiang Qin,* and Kai Yang*
31	Emitting/Sensitizing Ions Spatially Separated Lanthanide Nanocrystals for Visualizing Tumors Simultaneously through Up- and Down-conversion Near-infrared II Luminescence in Vivo	Small	2019, DOI: 10.1002/smll.201905344	Yingying Li, Peisen Zhang, Haoran Ning, Jianfeng Zeng, Yi Hou, Lihong Jing, Chunyan Liu, Mingyuan Gao*
32	Highly fluorescent conjugated microporous polymers for concurrent adsorption and detection of uranium	Journal of Materials Chemistry A	2019, 7, 11214-11222	Xu, Meiyun; Wang, Tao; Gao, Peng; Zhao, Li; Zhou, Lei; Hua, Daoben*
33	Fluorescent conjugated mesoporous polymers with N, N-diethylpropylamine for efficient capture and real-time detection of volatile iodine	Journal of Materials Chemistry A	2019, DOI:10.1039/C9TA11446G	Xu, Meiyun; Wang, Tao; Zhou, Lei; Hua, Daoben*
34	Harnessing tumor-associated macrophages as aids for cancer immunotherapy	Molecular Cancer	2019, 18, 177	Xiaolei Li; Rui Liu, Xiao Su, Yongsha Pan, Xiaofen Han*, Changshun Shao*,Yufang Shi*
35	Boosting Often Overlooked Long Wavelength Emissions of Rare-Earth Nanoparticles for NIR-II Fluorescence Imaging of Orthotopic Brain Tumor	Biomaterials	2019, 219, 119364	Zheng Liu, Feng Ren, Hao Zhang, Qiang Yuan, Zhilin Jiang, Hhanghang Liu, Qiao Sun, Zhen Li
36	Radiolabeling nanomaterials for multimodality imaging: New insights into nuclear medicine and cancer diagnosis	Biomaterials	2020, 228, 119553	Jianxian Ge, Qianyi Zhang, Jianfeng Zeng*, Zi Gu*, Mingyuan Gao
37	Separation and Remediation of TcO4- from Aqueous Solutions	Chemistry of Materials	2019, 31, 3863-3877	Chengliang Xiao, Afshin Khayambashi, Shuao Wang*

序号	论文名称	刊物/出版社名称	卷、期、页	作者
38	Introducing Uranium as the Activator toward Highly Stable Narrow- Band Green Emitters with Near- Unity Quantum Efficiency	Chemistry of Materials	2019, DOI: 10.1021/acs.chemmater.9b03130	Wei Liu, Enhai Song, Liwei Cheng, Liping Song, Jian Xie, Guodong Li, Yugang Zhang, Yanlong Wang, Yaxing Wang, Zhiguo Xia,*, Zhifang Chai, and Shuao Wang*
39	Mo-based 2D MOF as a highly efficient electrocatalyst for reduction of N2 to NH3: a density functional theory study,	Journal of Materials Chemistry A	2019, 7, 14510-14518	Qianyi Cui, Gangqiang Qin, Weihua Wang, Geethalakshmi K Rangaswamy, Aijun Du, Qiao Sun
40	Mechanism Unravelling for Ultrafast and Selective 99TcO4- Uptake by a Radiation-Resistant Cationic Covalent organic Framework: A Combined Radiological Experiment and Molecular Dynamics Simulation Study	Chemical Science	2019, 10, 4293-4305	Linwei He‡, Shengtang Liu‡, Long Chen‡, Xing Dai, Jie Li, Mingxing Zhang, Fuyin Ma, Chao Zhang, Zaixing Yang*, Ruhong Zhou, Zhifang Chai, Shuao Wang*
41	Polyoxomolybdate (POM) nanoclusters with radiosensitizing and scintillating properties for low dose X-ray inducible radiation-radiodynamic therapy	Nanoscale Horizons	2019, DOI: 10.1039/c9nh00374f	Debabrata Maiti, Jing Zhong, Zheng Zhang, Hailin Zhou, Saisai Xion, Ziliang Dong, Sarvendra Kumar, Zhuang Liu and Kai Yang *
42	Small, Traceable, Endosome-Disrupting and Bioresponsive Click Nanogels Fabricated via Microfluidics for CD44-Targeted Cytoplasmic Delivery of Therapeutic Proteins	Acs Applied Materials & Interfaces	2019, 11, 22171-22180	Ke Huang, Yahui He, Zhehong Zhu, Jiakun Guo, Guanglin Wang, Chao Deng,* and Zhiyuan Zhong*
43	Iodine-rich polymersomes enable versatile SPECT/CT imaging and potent radioisotope therapy for tumor in vivo	Acs Applied Materials & Interfaces	2019, 11, 18953-18959	Jinsong Cao, Yaohua Wei, Yanxiang Zhang, Guanglin Wang, Xiang Ji, and Zhiyuan Zhong*
44	Enhanced Lysosomal Escape of pH-Responsive Polyethylenimine−Betaine Functionalized Carbon Nanotube for the Codelivery of Survivin Small Interfering RNA and Doxorubicin	Acs Applied Materials & Interfaces	11(10):9763-9776	Yue Cao, Haoyan Huang, Liqing Chen,Huanhuan Du, Jinghao Cui, Leshuai W. Zhang,* Beom-Jin Lee, and Qingri Cao*

序号	论文名称	刊物/出版社名称	卷、期、页	作者
45	Bioactive Polysaccharide Nanoparticles Improve Radiation-Induced Abscopal Effect through Manipulation of Dendritic Cells.	Acs Applied Materials & Interfaces	2019, doi: 10.1021/acsami.9b16814	Guibin Pang, Chao Chen, Yun Liu, Tianyan Jiang, Huan Yu, Yanxian Wu, Yangyun Wang, Fu-Jun Wang*, Zhiyong Liu*, Leshuai Zhang*
46	Effective Radiotherapy in Tumor Assisted by Ganoderma lucidum Polysaccharide-Conjugated Bismuth Sulfide Nanoparticles through Radiosensitization and Dendritic Cell Activation.	Acs Applied Materials & Interfaces	2019, 11, 27536-27547	Huan Yu, Yang Yang, Tianyan Jiang, Xihui Zhang, Yuhao Zhao, Guibin Pang, Yahui Feng, Shulei Zhang, Fujun Wang, Yong Wang, Yangyun Wang*, Leshuai W. Zhang*
47	Photogenerated Charge Carriers in Molybdenum Disulfide Quantum Dots with Enhanced Antibacterial Activity.	Acs Applied Materials & Interfaces	2019, 11, 4858−4866	Xin Tian; Sun Yurong; Fan Sanhong; Boudreau Mary D.; Chen Chunying; Ge Cuicui*; Yin Jun-Jie
48	Cytotoxicity of C2N Originating from Oxidative Stress Instead of Membrane Stress	Acs Applied Materials & Interfaces	2019, 11, 34575-34585.	Shitong Zhang, Lu Liu, Guangxin Duan, Lin Zhao, Shengtang Liu, Bo Zhou, Zaixing Yang*
49	Nano-MOF+ Technique for Efficient Uranyl Remediation	Acs Applied Materials & Interfaces	2019, 11, 21619-21626	Lin Xu, Duo Zhang, Fuyin Ma, Jiarong Zhang, Afshin Khayambashi, Yawen Cai, Lanhua Chen, Chengliang Xiao*, ShuaoWang*
50	Cholesterol-Modified Black Phosphorus Nanospheres for the First NIR-II Fluorescence Bioimaging	Acs Applied Materials & Interfaces	2019, 11, 21399-21407	Yifan Xu, Feng Ren, Hanghang Liu, Hao Zhang, Yaobao Han, Zheng Liu, Wenliang Wang‡ Qiao Sun, Chongjun Zhao* and Zhen Li*,
51	Light-enhanced O2-evolving Nanoparticles Boost Photodynamic Therapy to Elicit Anti-tumor Immunity	Acs Applied Materials & Interfaces	2019, 11, 16367-16379	Tingting Wang, Hao Zhang, Yaobao Han, Hanghang Liu, Feng Ren, Jianfeng Zeng, Qiao Sun, Zhen Li,* and Mingyuan Gao
52	Bacteria-Instructed Click Chemistry between Functionalized Gold Nanoparticles for Point-of-Care Microbial Detection	Acs Applied Materials & Interfaces	2019,11,23093-23101	Xiaozhou Mou, Xiaoyi Chen, Jianhao Wang, Zhaotian Zhang, Yanmei Yang,* Zhangxuan Shou, Yuexing Tu, Xuancheng Du, Chun Wu, Yuan Zhao, Lin Qiu, Pengju Jiang, Chunying Chen, Dongsheng Huang,* Yongqiang Li*

序号	论文名称	刊物/出版社名称	卷、期、页	作者
53	Donor-Acceptor-Type Conjugated Polymer-Based Multicolored Drug Carriers with Tunable Aggregation-Induced Emission Behavior for Self-Illuminating Cancer Therapy	Acs Applied Materials & Interfaces	2019, DOI: 10.1021/acsami.9b11237	Wang, Ziyu; Wang, Cheng; Gan, Quan; Cao, Yu; Yuan, Hong*; Hua, Daoben*
54	Cyclic RGD-Functionalized and Disulfide-Crosslinked Iodine-Rich Polymersomes as a Robust and Smart Theranostic Agent for Targeted CT Imaging and Chemotherapy of Melanoma	Theranostics	2019, 9, 8061-8072	Y. Zou, Y.H. Wei, J. Bao, F.R. Yao, Z.K. Li, Y.P. Sun, F.H. Meng*, C.H. Hu, G. Storm, and Z.Y. Zhong*
55	LncRNA-Safe contributes to cardiac fibrosis through Safe-Sfrp2-HuR complex in mouse myocardial infarction	Theranostics	2019, 9, 7282-7297	Kaili Hao, Wei Lei, Hongchun Wu, Jie Wu, Zhuangzhuang Yang, Shiping Yan, Xing-Ai Lu, Jingjing Li, Xue Xia, Xinglong Han, Wenbo Deng, Guisheng Zhong, Zhen-Ao Zhao, Shijun Hu
56	Luminescent ruthenium(II) polypyridyl complexes acted as radiosensitizer for pancreatic cancer by enhancing radiation-induced DNA damage	Theranostics	2019, 9, 6665-6675	Yuyang Zhou*, Ying Xu, Lunjie Lu, Jingyang Ni, Jihua Nie, Jianping Cao, Yang Jiao*, Qi Zhang*
57	Luminescent ruthenium(II) polypyridyl complexes acted as radiosensitizer for pancreatic cancer by enhancing radiation-induced DNA damage	Theranostics	2019, 9, 6665-6675	Yuyang Zhou*, Ying Xu, Lunjie Lu, Jingyang Ni, Jihua Nie, Jianping Cao, Yang Jiao*, Qi Zhang*
58	The Fifth Symposium on Innovative Polymers for Controlled Delivery	Journal of Controlled Release	2019, 307, 410-412	Huanlin Sun, Z.Y. Zhong*, and Jan Feijen
59	cRGD-decorated biodegradable polytyrosine nanoparticles for robust encapsulation and targeted delivery of doxorubicin to colorectal cancer in vivo	Journal of Controlled Release	2019, 301, 110-118	Xiaolei Gu, Yaohua Wei, Qianyi Fan, Huanli Sun, Ru Cheng, Zhiyuan Zhong , Chao Deng
60	Automatic Pathological Lung Segmentation in Low-Dose CT Image Using Eigenspace Sparse Shape Composition	IEEE Transactions on Medical Imaging	2019, 38, 7 , 1736-1749	Geng Chen, Dehui Xiang, Bin Zhang, Haihong Tian, Xiaoling Yang, Fei Shi, Weifang Zhu, Bei Tian, Xinjian Chen

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62	3,4-Hydroxypyridinone-Modified Carbon Quantum Dot as a Highly Sensitive and Selective Fluorescent Probe for the Rapid Detection of Uranyl Ions	Environmental Science-Nano	2019, 6, 1457-1465	Zhao Zhang, Duo Zhang, Cen Shi, Wei Liu, Lanhua Chen, Yu Miao, Juan Diwu*, Jianli Li*, Shuao Wang*
63	Petroleum pitch-based porous aromatic frameworks with phosphonate ligand for efficient separation of uranium from radioactive effluents	Journal of Hazardous Materials	2019, 368, 214-220	Wang, Tao; Xu, Meiyun; Han, Xiaoli; Yang, Sen; Hua, Daoben*
64	Protein ww domain denaturation on defected graphene reveals the significance of nanomaterial defects in nanotoxicity	Carbon	2019, 146, 257-264	Baoyu Li, David R Bell, Zonglin Gu, Weifeng Li, Ruhong Zhou*
65	Multifunctional nano-graphene based nanocomposites for multimodal imaging guided combined radioisotope therapy and chemotherapy	Carbon	2019, 149, 55-62	Rui Qian , Debabrata Maiti, Jing Zhong, SaiSai Xiong, Hailin Zhou, Ran Zhu, Jianmei Wan*, Kai Yang*
66	Ratiometric Monitoring of Thorium Contamination in Natural Water Using a Dual-Emission Luminescent Europium organic Framework	Environmental Science & Technology	2019, 53, 332-341	Wei Liu‡, Xing Dai‡, Y.anlong Wang, Liping Song, Linjuan Zhang, Duo Zhang, Jian Xie, Long Chen, Juan Diwu, Jianqiang Wang, Zhifang Chai, Shuao Wang*
67	Different platinum crystal surfaces show very distinct protein denaturation capabilities	Nanoscale	2019, 11, 19352-19361	Shengtang Liu, Xiuhua Yin, Hong Zhou, Bo Zhou, Qiwen Shao, Zaixing Yang*, Ruhong Zhou*
68	Facet-regulated adhesion of double-stranded DNA on palladium surfaces	Nanoscale	2019, 11, 1827-1836	Zonglin Gu, Lin Zhao, Cuicui Ge, Shengtang Liu, Ge Fang, Serena S Chen, Zaixing Yang*, Ruhong Zhou*

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70	Plant-derived chlorophyll derivative loaded liposomes for tri-model imaging guided photodynamic therapy	Nanoscale	2019, 11, 19823	Hailin Zhou,‡,b Lu Xia,‡ Jing Zhong, Saisai Xiong, Xuan Yi, Lei Chen, Ran Zhu,* Quanliang Shi* and Kai Yang *
71	Rational Synthesis of Novel Phosphorylated Chitosan-Carboxymethyl Cellulose Composite for Highly Effective Decontamination of U(VI)	ACS Sustainable Chemistry & Engineering	2019, 7, 5393-5403	Yawen Cai, Lei Chen, Shitong Yang, Lin Xu, Haibo Qin, Zhiyong Liu, Lanhua Chen, Xiangke Wang*, Shuao Wang*
72	The Release and Detection of Copper Ions from Ultrasmall Theranostic Cu2-xSe Nanoparticles	Nanoscale	2019, 11, 11819-11829	Yaobao Han, Tingting Wang, Hanghang Liu, Shaohua Zhang, Hao Zhang, Mengting Li, Qiao Sun and Zhen Li
73	Second Near-Infrared Photodynamic Therapy and Chemotherapy of Orthotopic Malignant glioblastoma with Ultra-small Cu2-xSe Nanoparticles	Nanoscale	2019, 11, 7600-7608	Hao Zhang, Tingting Wang, Hanghang Liu, Feng Ren, Weibao Qiu, Qiao Sun, Fei Yan, Hairong Zheng, Zhen Li * and Mingyuan Gao
74	NCR group 3 innate lymphoid cells orchestrate IL-23/IL-17 axis to promote hepatocellular carcinoma development	EBioMedicine	2019, 333-344	Yonghao Liu, Yuan Song, Dandan Lin, Lei Lei, Yu Mei, Ziqi Jin, Huanle Gong, Ying Zhu, Bo Hu, Yinsheng Zhang, Lixiang Zhao, Huey Yee Teo, Ju Qiu, Wen Jiang, Chen Dong, Depei Wu, Yuhui Huang, Haiyan Liu
75	Low-toxicity Transferrin-Guided Polymersomal Doxorubicin for Potent Chemotherapy of Orthotopic Hepatocellular Carcinoma in Vivo	Acta Biomaterialia	2019, 92, 196-204	Yaohua Wei, Xiaolei Gu, Liang Cheng*, Fenghua Meng*, Gert Storm, and Z.Y. Zhong*
76	Doxorubicin-polyglycerol-nanodiamond composites stimulate glioblastoma cell immunogenicity through activation of autophagy	Acta Biomaterialia	2019, 86, 381-394	Tongfei Li, Yonghong Xu, Ke Li, Chao Wang, Xin Liu, Yuan Yue, Zhuo Chen, Shen-Jun Yuan, Yu Wen , Quan Zhang, Min Han, Naoki Komatsu, Li Zhao*, Xiao Chen

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78	Upregulation of IL-6 in CUL4B-deficient myeloid-derived suppressive cells increases the aggressiveness of cancer cells.	Oncogene	2019 , 38, 5860-5872	Zhiliang Xu, Linchuan Li,Yanyan Qian, Yu Song, Liping Qin, Yuyao Duan, Molin Wang, Peishan Li, Baichun Jiang, Chunhong Ma, Changshun Shao, Yaoqin Gong
79	MHC class I dysfunction of glioma stem cells escapes from CTL-mediated immune response via activation of Wnt/β-catenin signaling pathway	Oncogene	2019, doi: 10.1038/s41388-019-1045-6	Wei Yang, Yanyan Li, Ruoling Gao, Zenghe Xiu, Ting Sun
80	H22954, a novel long non-coding RNA down-regulated in AML patients, inhibits cancer cell growth *in vitro* and *in vivo*.	Cancer Letters	2019, 454, 26-36	Xiaofei Qia, Yang Jiao, Chao Cheng, Feng Qiang, Zixing Chen, Qingyu Wu
81	In Vivo Photoacoustic/Single-Photon Emission Computed Tomography Imaging for Dynamic Monitoring of Aggregation-Enhanced Photothermal Nanoagents	Analytical Chemistry	2019, 91, 2128-2134	Yangyun Wang, Ziling Sun, Zhizhong Chen, Yanxian Wu, Yuan Gu, Subin Lin, Yong Wang*
82	Ultra-Sensitive Detection and Inhibition of the Metastasis of Breast Cancer Cells to Adjacent Lymph Nodes and Distant Organs by Using Long Persistent Luminescence Nanoparticles	Analytical Chemistry	2019, DOI: 10.1021/acs.analchem.9b03739	anghang Liu, Feng Ren, Xingguo Zhou, Changqiu Ma, Tingting Wang, Hao Zhang, Qiao Sun,* and Zhen Li*
83	A nanogel sensor for colorimetric fluorescence measurement of ionizing radiation doses	Chemical Communications	2019, 55, 9614-9617	Wenxiang Li, Jing Nie, Rui Hu, Rui Zhao, Weifang Zhu, Xinjian Chen, Dan Li,* Lei Wang and Liang Hu*
84	Color-Tunable X-ray Scintillation Based on a Series of Isotypic Lanthanide-Organic Frameworks	Chemical Communications	2019, DOI: 10.1039/c9cc08114c	Xia Wang,‡ Yaxing Wang,‡ Yanlong Wang, Hanzhou Liu, Yugang Zhang,a Wei Liu, Xiangxiang Wang and Shuao Wang*

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86	Effective cancer immunotherapy by Ganoderma lucidum polysaccharide-gold nanocomposites through dendritic cell activation and memory T cell response.	Carbohydrate Polymers	2019, 205:192-202	Shulei Zhang, GuibinPang, Chao Chen, Jianzhong Qin, HuanYu, Yongming Liu, Xihui Zhang, Zhentao Song, Jian Zhao, Fujun Wang*, Yangyun Wang*, Leshuai W.Zhang*
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88	Fibrotic liver microenvironment promotes Dll4 and SDF-1-dependent T-cell lineage development.	Cell Death Disease	2019, 10, 440	Zheng Gong, Bingxue Shang, Yunpeng Chu, Xiaodong Chen, Qing Li, Keli Liu, Yongjing Chen, Yin Huang , Yanyan Han, Qianwen Shang, Zhiyuan Zheng, Lin Song, Yanan Li, Rui Liu, Chenchang Xu, Xiaoren Zhang, Baochi Liu, Luowei Wang*, Changshun Shao* , Ying Wang* and Yufang Shi*.
89	Inhibition of DYRK1A-EGFR axis by p53-MDM2 cascade mediates the induction of cellular senescence.	Cell Death Disease	2019, 10, 282	Xu X, Liu Q, Zhang C, Ren S, Xu L, Zhao Z, Dou H, Li P, Zhang X, Gong Y, Shao C*.
90	Berberine downregulates CDC6 and inhibits proliferation via targeting JAK-STAT3 signaling in keratinocytes.	Cell Death Disease	2019, 10, 274	Sun S, Zhang X, Xu M, Zhang F, Tian F, Cui J, Xia Y, Liang C, Zhou S, Wei H, Zhao H, Wu G, Xu B, Liu X, Yang G, Wang Q, Zhang L, Gong Y, Shao C, Zou Y*.
91	Cul4a promotes zebrafish primitive erythropoiesis via upregulating scl and gata1 expression.	Cell Death Disease	2019, 10, 388	Fan Yang, Huili Hu, Yuanyuan Liu, Ming Shao, Changshun Shao and Yaoqin Gong

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93	Cancer Nanomedicines Based on Synthetic Polypeptides	Biomacromolecules	2019, 20, 4299-4311	Huanli Sun, Xiaolei Gu, Qiang Zhang, Hao Xu, Zhiyuan Zhong,* and Chao Deng*
94	CD44-Targeted Multifunctional Nanomedicines Based on a Single-Component Hyaluronic Acid Conjugate with All-Natural Precursors: Construction and Treatment of Metastatic Breast Tumors in Vivo	Biomacromolecules	2019, DOI: 10.1021/acs.biomac.9b01012	H.M. Fang, X.F. Zhao, X.L. Gu, H.L. Sun, R. Cheng, Z.Y. Zhong*, and C. Deng
95	HER2-Specific Reduction-Sensitive Immunopolymersomes with High Loading of Epirubicin for Targeted Treatment of Ovarian Tumor	Biomacromolecules	https://doi.org/10.1021/acs.biomac.9b00947.	Lin Ding, Wenxing Gu, Yifan Zhang, Shujing Yue, Huanli Sun, Jeroen J. L. M. Cornelissen, and Zhiyuan Zhong*
96	Biomacromolecules for Emerging Biological and Medical Science and Technology	Biomacromolecules	2019, 20, 4241-4242	Huanli Sun, Zhiyuan Zhong*
97	The vanillin derivative VND3207 protects intestine against radiation injury by modulating p53/NOXA signaling pathway and restoring the balance of gut microbiota	Free Radical Biology and Medicine	2019, 145, 223-236	Ming Li, Meng-Meng Gu, Yue Lang, Jianming Shi, Benjamin P.C. Chen, Hua Guan,Lan Yu, Ping-Kun Zhou, Zengfu Shang
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99	Pregnancy-associated cardiac hypertrophy in corin-deficient mice: observations in a transgenic model of preeclampsia	Canadian Journal Cardiology	2019, 35, 68-76	Rachael C. Baird, Shuo Li, Hao Wang, Sathyamangla V. Naga Prasad, David Majdalany, Uma Perni, and Qingyu Wu

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101	Bactericidal Effects and Accelerated Wound Healing using Tb_4O_7 Nanoparticles with Intrinsic Oxidase-Like Activity	Journal of Nanobiotechnology	2019, 17, 54	Chen Li#, Yurong Sun#, Xiaoping Li#, Sanhong Fan*, Yiming Liu, Xiumei Jiang, Mary D. Boudreau, Yue Pan*, Xin Tian*, Jun-Jie Yin
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103	Novel two-dimensional MOF as a promising single-atom electrocatalyst for CO2 reduction: A theoretical study,	Applied Surface Science	2020, 500, 143993.	Qianyi Cui, Gangqiang Qin, Weihua Wang, K. R. Geethalakshmi, Aijun Du and Qiao Sun
104	Self-illuminating agents for deep-tissue optical imaging	Frontiers in Bioengineering and Biotechnology	2019,7, 326	Qing Li, Jianfeng Zeng, Qingqing Miao* and Mingyuan Gao
105	MIR148A family regulates cardiomyocyte differentiation of human embryonic stem cells by inhibiting the DLL1-mediated NOTCH signaling pathway	Journal of Molecular and Cellular Cardiology	2019, 134, 1-12.	Xing Fang, Shumei Miao, You Yua, Fengyue Ding, Xinglong Han, Hongchun Wu, Zhen-Ao Zhao, Yongming Wang, Shijun Hu , Wei Leia
106	Nanowire-integrated thermoresponsive microfluidic platform for on-demand enrichment and colorimetric detection of pathogenic bacteria	Journal of Materials Chemistry B	2019, DOI: 10.1039/C9TB01923E	Xuancheng Du, Chun Wu, Weijie Wang, Lin Qiu, Pengju Jiang, Jianhao Wang,* Yongqiang Li*
107	Efficient and Selective Sensing of Cu2+ And UO22+ by a Europium Metal-Organic Framework	Talanta	2019, 196, 515-522	Wei Liu, Yanlong Wang, Liping Song, Mark A. Silver, Jian Xie, Linmeng Zhang, Lanhua Chen, Juan Diwu, Zhifang Chai, Shuao Wang
108	Spectrographic sensors for uranyl detection in the environment	Talanta	2019, 201, 317-329	He, Weiwei; Hua, Daoben*

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110	Inorganic X-Ray Scintillators Based on a Previously Unnoticed but Intrinsically Advantageous Metal Center	Inorganic Chemistry	2019, 58, 2807-2812	Yaxing Wang‡, Yumin Wang‡, Xing Dai‡, Wei Liu, Xuemiao Yin, Long Chen, Fuwan Zhai, Juan Diwu, Chao Zhang, Ruhong Zhou, Zhifang Chai, Ning Liu*, Shuao Wang*
111	3-Hydroxy-2-Pyrrolidinone as a Potential Bidentate Ligand for in vivo Chelation of Uranyl with Low Cytotoxicity and Moderate “Decorporation Efficacy: A Solution Thermodynamics, Structural Chemistry, and in vivo Uranyl Removal Survey	Inorganic Chemistry	2019, 58, 3349-3354 .	Xiaomei Wang‡, Suqiang Wu‡, Jinwen Guan, Lanhua Chen, Cen Shi, Jianmei Wan, Yong Liu, Juan Diwu*, Jianqiang Wang*, Shuao Wang*
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113	A novel CD7 chimeric antigen receptor-modified NK-92MI cell line targeting T-cell acute lymphoblastic leukemia.	American Journal of Cancer Research	2019, 9, 64-78	Fengtao You；Yinyan Wang；Licui Jiang； Xuejun Zhu；Dan Chen；Lei Yuan；Gangli An；Huimin Meng；Lin Yang*
114	Immunoactive polysaccharide functionalized gold nanocomposites promote dendritic cell stimulation and antitumor effects.	Nanomedicine	2019, 14, 1291-1306	Guibin Pang, Shulei Zhang, Xiapeng Zhou, Huan Yu, Yanxian Wu, Tianyan Jiang, Xihui Zhang, Fujun Wang*, Yangyun Wang*, Leshuai W.Zhang*
115	Exploring the interactions between engineered nanomaterials and immune cells at 3D nano-bio interfaces to discover potent nano-adjuvants	Nanomedicine	2019, 21, 102037	Ronglin Ma#, Huizhen Zheng#, Qi Liu, Di Wu, Wei Li, Shujuan Xu, Xiaoming Cai, Ruibin Li*

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117	Light-triggered Crosslinking of Gold Nanoparticles for Remarkably Improved Radiation Therapy and CT Imaging of Tumors	Nanomedicine	2019, DOI: 10.2217/nnm-2019-0015	Xiaju Cheng, Rui Sun, Huawei Xia, Jianan Ding, Ling Yin, Zhifang Chai, Haibin Shi* and Mingyuan Gao*
118	Serum semaphorin 7A is associated with the risk of acute atherothrombotic stroke	Journal of Cellular And Molecular Medicine	2019, 00, 1–6	You T, Zhu Z, Zheng X, Zeng N, Hu S, Liu Y, Ren L, Lu Q, Tang S, Ruan C, Zhang Y* and Zhu L*
119	IFNγ and TNFα synergistically induce apoptosis of mesenchymal stem/stromal cells via the induction of nitric oxide	Stem Cell Research & Therapy	2019, 10, 18	Xiaolei Li#; Bingxue Shang#; Ya-nan Li; Yufang Shi*; Changshun Shao*
120	Human embryonic stem cell-derived cardiomyocyte therapy in mouse permanent ischemia and ischemia-reperfusion models	Stem Cell Research & Therapy	2019, 10, 167	You Yu, Nianci Qin, Xing-Ai Lu, Jingjing Li, Xinglong Han, Xuan Ni, Lingqun Ye, Zhenya Shen, Weiqian Chen, Zhen-Ao Zhao, Wei Lei and Shijun Hu*
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123	Fabrication of Hybrid Hydrogels from Silk Fibroin and Tannic Acid with Enhanced Gelation and Antibacterial Activities	ACS Biomaterials Science & Engineering	2019, 5, 4601−4611	Juan Jing#, Shufeng Liang#, Yufei Yan, Xin Tian*, Xinming Li*.

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125	Lowering iron level protects against bone loss in focally irradiated and contralateral femurs through distinct mechanisms	Bone	2019, 120, 50-60	Jian Zhang#, Lijun Zheng#, Ziyang Wang, Hailong Pei, Wentao Hu, Jing Nie, Peng Shang, Bingyan Li, Tom K Hei*, Guangming Zhou*
126	Size-Dependent Photothermal Conversion and Photoluminescence of Theranostic NaNdF4 Nanoparticles under Excitation of Different-Wavelength Lasers	Bioconjugate Chemistry	2019, DOI: 10.1021/acs.bioconjchem.9b00700	Lihua Ding, Feng Ren, Zheng Liu, Zhilin Jiang, Baofeng Yun, Qiao Sun, and Zhen Li
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132	Segmentation of Lung in Chest Radiographs Using Hull and Closed Polygonal Line Method	IEEE Access	2019, 7, 137794-137810	Tao Peng, Yihuai Wang, Thomas Canhao Xu, Xinjian Chen
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136	Assembly of Porphyrin-based Uranium organic Frameworks with (3,4)-connected pto and tbo Topologies	Dalton Transactions	2019, 48, 1595-1598	Lang Shao, Fuwan Zhai, Yanlong Wang, Guozong Yue, Yingru Li, Mingfu Chu* and Shuao Wang *
137	A unique uranyl framework containing uranyl pentamers as secondary building units: synthesis, structure, and spectroscopic properties	Dalton Transactions	2019, DOI:10.1039/C9DT03871J	Yugang Zhang,‡ Lanhua Chen,‡ Jingwen Guan, Xia Wang, Shuao Wang Juan Diwu*
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八、代表性论文首页

COMMUNICATION

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CD44-Specific A6 Short Peptide Boosts Targetability and Anticancer Efficacy of Polymersomal Epirubicin to Orthotopic Human Multiple Myeloma

Wenxing Gu, Jingnan An, Hao Meng, Na Yu, Yinan Zhong, Fenghua Meng, Yang Xu,* Jeroen J. L. M. Cornelissen, and Zhiyuan Zhong**

Chemotherapy is widely used in the clinic though its benefits are controversial owing to low cancer specificity. Nanovehicles capable of selectively transporting drugs to cancer cells have been energetically pursued to remodel cancer treatment. However, no active targeting nanomedicines have succeeded in clinical translation to date, partly due to either modest targetability or complex fabrication. CD44-specific A6 short peptide (KPSSPPEE) functionalized polymersomal epirubicin (A6-PS-EPI), which boosts targetability and anticancer efficacy toward human multiple myeloma (MM) in vivo, is described. A6-PS-EPI encapsulating 11 wt% EPI is small (≈55 nm), robust, reduction-responsive, and easy to fabricate. Of note, A6 decoration markedly augments the uptake and anticancer activity of PS-EPI in CD44-overexpressing LP-1 MM cells. A6-PS-EPI displays remarkable targeting ability to orthotopic LP-1 MM, causing depleted bone damage and striking survival benefits compared to nontargeted PS-EPI. Overall, A6-PS-EPI, as a simple and intelligent nanotherapeutic, demonstrates high potential for clinical translation.

Chemotherapy based on toxic compounds that primarily inhibit the fast proliferation of the cancer cells is widely used in the clinics though its benefits are controversial owing to a low cancer-specificity and concomitant treatment-related toxic effects.[1] Nanovehicles capable of selectively transporting drugs to cancer cells have been energetically pursued to provide effective solutions for this dilemma.[2] Specific (or active) targeting relies on functionalizing the surface of nanovehicles with ligands that are complementary to the target sites.[3] However, in spite of promise and progress, no actively targeted nanomedicines have succeeded in clinical translation to date, partly due to modest targetability or complex fabrication.[4] The balance of simplicity and functionality is a key to the success of targeted nanomedicines.[2a]

Multiple myeloma (MM) is the second most frequent hematologic malignancy that is characterized by clonal proliferation of malignant plasma cells in the bone marrow microenvironment.[5] Despite increasingly new methods and agents have been validated,[6] including immunomodulatory drugs,[7] proteasome inhibitors,[8] monoclonal antibodies,[9] and CAR-T cell therapy,[10] MM remains incurable for a majority of patients. Liposomal nanomedicines such as Doxil and Oncocort IV are also used for the treatment of MM patients,[11] though their therapeutic benefits are limited as a result of poor MM selectivity. For effective management of MM, targeted formulations are desired.[12] Interestingly, hematologic cancers including MM are found overexpressing adhesion molecule CD44.[13] Various CD44 targeting ligands including hyaluronic acid, aptamer, and anti-CD44 antibody[14] have shown to enhance anti-MM efficacy in vitro and in vivo.[9a,13c] However, these ligands are big, which complicates fabrication of nanomedicines.

Here, we report for the first time that CD44-specific A6 short peptide (KPSSPPEE) functionalized polymersomal epirubicin (A6-PS-EPI) boosts targetability and anticancer efficacy toward human MM in vivo (**Scheme 1**). A6 is a urokinase-derived peptide that shows a strong binding to CD44 and thereby effective metastasis inhibition of CD44-overexpressing tumors.[15] Notably, phase I and II human clinical trials displayed that

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DOI: 10.1002/adma.201904742

Please cite this article in press as: Du et al., IGF-2 Preprograms Maturing Macrophages to Acquire Oxidative Phosphorylation-Dependent Anti-inflammatory Properties, Cell Metabolism (2019), https://doi.org/10.1016/j.cmet.2019.01.006

Cell Metabolism
Article

IGF-2 Preprograms Maturing Macrophages to Acquire Oxidative Phosphorylation-Dependent Anti-inflammatory Properties

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https://doi.org/10.1016/j.cmet.2019.01.006

SUMMARY

Recent investigations revealed that macrophages could be trained with an altered responsiveness, raising the possibility of combating autoimmune diseases by imparting anti-inflammatory capabilities to these cells. While investigating the effect of mesenchymal stem cells on experimental autoimmune encephalomyelitis (EAE), we found a critical role of insulin-like growth factor 2 (IGF-2) in training macrophages to become anti-inflammatory during their maturation. IGF-2 exerts its effects by preprogramming maturing macrophages to commit oxidative phosphorylation (OXPHOS). IGF-2-preprogrammed macrophages maintained the mitochondrial complex V activities even upon pro-inflammation stimulation, thus enabling an elevated programmed death-ligand 1 (PD-L1) expression. PD-L1 neutralization abolished the beneficial effect of IGF-2 on EAE. Furthermore, adoptive transfer of IGF-2-preprogrammed macrophages to EAE mice increased Tregs and alleviated the diseases. Our results demonstrate that shaping macrophage responsiveness by IGF-2 is effective in managing inflammatory diseases, and the OXPHOS commitment can be preset to determine the anti-inflammatory fate of macrophages.

INTRODUCTION

Macrophages are present in virtually all tissues and play key roles during innate as well as adaptive immune responses (Wynn et al., 2013; Wynn and Vannella, 2016). They can originate from circulating monocytes derived from myeloid progenitor cells (Shi and Pamer, 2011; Varol et al., 2015). In response to different environmental cues, macrophages exert either pro-inflammatory or anti-inflammatory functions (Mosser and Edwards, 2008; Murray and Wynn, 2011). Recent advances in immunometabolism have revealed that pro-inflammatory macrophages and anti-inflammatory macrophages opt for distinct metabolic pathways upon activation to meet their demands for energy and the production of specific functional-cell-associated factors (O'Neill and Pearce, 2016; Pearce and Pearce, 2013; Van den Bossche et al., 2017). For instance, the traditionally defined M1 macrophages carry out glycolysis, which causes succinate accumulation (Mills et al., 2016; Tannahill et al., 2013). The increase in succinate supports interleukin-1β (IL-1β) production through stabilizing hypoxia-inducible factor-1α (HIF-1α) (Mills et al., 2016; Tannahill et al., 2013). On the other hand, M2 macrophages possess a high basal mitochondrial oxygen consumption rate (OCR), and M2 activation can be blocked by the inhibition of oxidative phosphorylation (OXPHOS) (Huang et al., 2014, 2016). The importance of cellular metabolism in regulating macrophages' functions was further illustrated by the recognition of "trained immunity" (Netea et al., 2016). Macrophages that interact with bacterial components such as β-glucan are metabolically programmed for glycolysis and would possess an enhanced pro-inflammatory responsiveness to secondary stimulation (Cheng et al., 2014). Such characteristics of macrophages are regarded as defensive mechanisms against foreign pathogens (Quintin et al., 2014). However, it is not known whether macrophages could be trained to commit persistent OXPHOS and acquire anti-inflammatory functional fate.

Mesenchymal stem and/or stromal cells (MSCs), owing to their ability to modulate immune responses, have been widely employed to treat various inflammatory diseases in animal models and in humans (Shi et al., 2017, 2018; Uccelli et al., 2008). A series of studies have demonstrated that the curative effects of MSCs on inflammatory diseases are related to their production of inducible nitric oxide synthase (iNOS), indoleamine 2,3-dioxygenase, tumor necrosis factor-inducible gene 6 (TSG-6), or prostaglandin E2 (PGE-2), whose expressions in MSCs are now known to be elicited by inflammatory cytokines, especially interferon gamma (IFN-γ) (Galleu et al., 2017; Lee et al., 2009; Németh et al., 2009; Ren et al., 2008, 2009). Interestingly, it has been reported that human MSCs could effectively ameliorate autoimmune diseases in mice (Galleu et al., 2017; Robles et al., 2015; Yañez et al., 2006). It is worth noting that mouse IFN-γ does not bind to human receptors, and human cells do not persist in the mouse body (Hemmi et al., 1992; Su et al., 2014). Therefore,

Cell Stem Cell
Previews

FOXO3, a Molecular Search for the Fountain of Youth

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https://doi.org/10.1016/j.stem.2019.02.008

FOXO3 has been consistently associated with longevity and with a reduction in the prevalence of cardiovascular disease. In this issue, Yan et al. (2019) report that FOXO3-activated vascular cells derived from human embryonic stem cells (ESCs) promote multiple vascular functions and reverse cellular aging through the transcriptional repression of CSRP1.

The forkhead box O3 (FOXO3) protein belongs to a family of evolutionarily conserved transcription factors characterized by a distinct fork-head DNA-binding domain (Weigel and Jäckle, 1990). In addition to FOXO3, the FoxO subclass includes FOXO1, FOXO4, and FOXO6. Initially implicated in regulating insulin signaling, FoxOs are recognized as master regulators that translate environmental stimuli into adaptive responses. In the presence of stress stimuli or in the absence of growth factors, FOXO3 translocates to the nucleus and induces upregulation of target genes related to protein turnover, glucose metabolism, inflammatory and immunological responses, oxidative stress, cell-cycle regulation, tumor suppression, cell survival, and cell death (Morris et al., 2015). In response to growth factors, including insulin, insulin-like growth factor, epidermal growth factor, and erythropoietin, FOXO3 is phosphorylated downstream of PI3K by the protein kinase Akt; this phosphorylation constitutes a signal to export FOXO3 from the nucleus to the cytoplasm and thereby turns off transcription of target genes and leads to the degradation of FOXO3 via the ubiquitin-proteasome pathway (Greer and Brunet, 2005; Arden, 2006). The transcriptional activity of FOXO3 can be regulated by post-translational modifications that include phosphorylation, acetylation, ubiquitination, and methylation (Stefanetti et al., 2018). Genetic polymorphisms (single nucleotide polymorphisms [SNPs]) in *FOXO3* have been associated with longevity (Willcox et al., 2008). However, the molecular mechanisms related to a protective role for such SNPs in contributing to longevity still remain unclear. A correlation has been found between longevity-associated variants and a reduced incidence of aging-related cardiovascular disease (Willcox et al., 2008), although the role of FOXO3 in healthy aging remains to be further elucidated.

In this issue of *Cell Stem Cell*, Yan and colleagues (Yan et al., 2019) took a different approach that allowed them to study the effects of activated FOXO3 on reversing cellular aging through physiological processes, such as cell-cycle arrest, resistance to oxidative-stress-induced apoptosis, cell proliferation, vascular degeneration, and tumor suppression. Aiming to enhance the functionality of vascular cell populations, they generated a constitutively active form of FOXO3 by alanine substitution of two classical FOXO3 phosphorylation sites. In human mesenchymal stromal cells (MSCs), this resulted in the relocation of FOXO3 to the nucleus and constitutive activation of the cells, which are referred to as $FOXO3^{2SA/2SA}$. Using adenoviral vector-mediated gene editing, they created homozygous $FOXO3^{2SA/2SA}$ human embryonic stem cells (ESCs) that could be successfully differentiated into vascular endothelial cells (VECs), vascular smooth muscle cells (VSMCs), and MSCs. In these cell types, the activation of FOXO3 resulted in similar protective changes, including a slightly higher proliferation rate, upregulation of FOXO3 target genes, and increased resistance to oxidative-stress-induced apoptosis, in cellular-aging-associated functions. The *in vivo* biological relevance of these observations was studied in an established mouse ischemic-injury model. It was found that administration of either $FOXO3^{2SA/2SA}$ hMSC or a mixture of $FOXO3^{2SA/2SA}$ hVEC and hVSMC resulted in more rapid recovery of blood flow and less limb necrosis than in control mice treated with wild-type cells. These data not only indicate enhanced therapeutic activity of FOXO3-activated, ESC-derived vascular cells but also confirm that FOXO3 activation reverses cellular senescence (Greer and Brunet, 2005). Although not examined, the FOXO3-altered secretome could also be a major factor in an autocrine or endocrine fashion. Further confirmation was obtained from samples of patients with Werner syndrome (WS), a rare autosomal-recessive disorder caused by mutations in the WRN gene and characterized by premature aging and cancer predisposition. Reduced expression of biomarkers for senescence (P16, P21, and LaminB1) was found in FOXO3-enhanced, WS-derived bone marrow MSCs. This anti-senescence effect of FOXO3 was found to be exerted through the downregulation of cysteine- and glycine-rich protein 1 (CSRP1), which is linked to the recruitment of the deacetylase SIRT-1 for creating a repressive chromatin environment. These data suggest a role for FOXO3 in accelerated aging in these patients, but they also indicate that FOXO3 activation might serve as a molecular connection at the interface of aging and cancer. FoxO transcription factors were identified through the cloning of chromosomal translocation breakpoints associated with cancer (Arden, 2006). In addition, spontaneous occurrence of lineage-restricted tumors is primarily observed in FOXO1-, FOXO3-, FOXO4-triple-knockout mice (Dansen & Burgering 2008). $FOXO3^{2SA/2SA}$ hMSCs exhibited upregulation of a range of tumor

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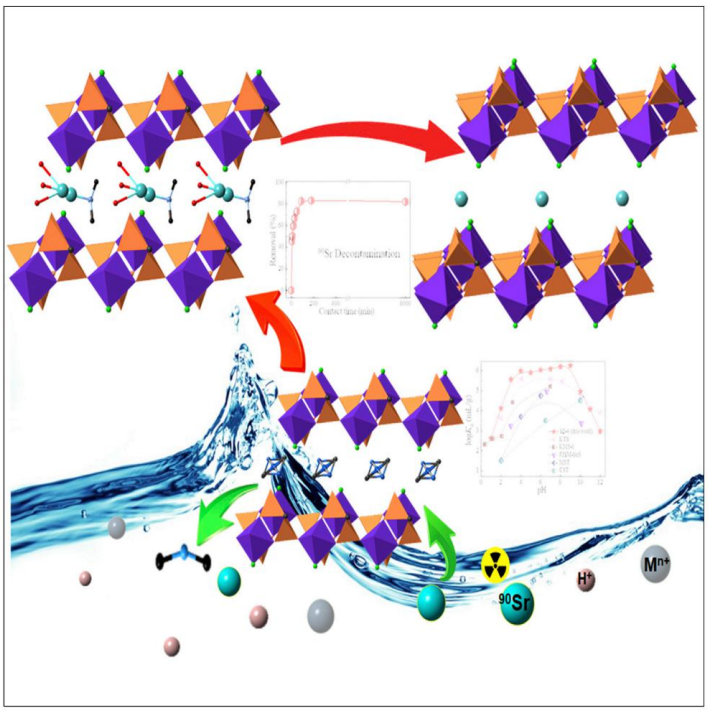
Distinctive Two-Step Intercalation of Sr^{2+} into a Coordination Polymer with Record High ^{90}Sr Uptake Capabilities



Here, Zhang et al. report an atypical oxidic ion-exchange material SZ-4 that can remove $^{90}Sr^{2+}$ with record-high removal efficiencies in both acidic solution and seawater, where a distinctive two-step intercalation mechanism is directly visualized by single-crystal structures during *in situ* Sr^{2+} sorption process, revealing a new type of Sr^{2+} uptake selectivity achieved through collaborative coordination by the oxidic layer and the dimethylamine interlayer as a soft N-donor ligand.

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HIGHLIGHTS

SZ-4 can remove $^{90}Sr^{2+}$ with record-high efficiencies in acidic solution and seawater

Sr^{2+} can be immobilized in the structure of SZ-4 as a new ^{90}Sr waste form model

The intercalation mechanism is visualized by crystal structures during uptake process

Sr^{2+} coordination by interlayer dimethylamine contributes to the uptake selectivity

Zhang et al., Chem 5, 977–994
April 11, 2019 © 2019 Elsevier Inc.
https://doi.org/10.1016/j.chempr.2019.02.011

$[Ln_6O_8]$ Cluster-Encapsulating Polyplumbites as New Polyoxometalate Members and Record Inorganic Anion-Exchange Materials for ReO_4^- Sequestration

Jian Lin, Lin Zhu, Zenghui Yue, Chuang Yang, Wei Liu, Thomas E. Albrecht-Schmitt, Jian-Qiang Wang, and Shuao Wang**

Various types of polyoxometalates (POMs) have been synthesized since the 19th century, but their assortment has been mostly limited to Groups 5 and 6 metals. Herein, a new family of POMs composed of a carbon group element as the addenda atoms with two distinct phases, $LnPbOClO_4$-1 (Ln = Sm to Ho, Y) and $LnPbOClO_4$-2 (Ln = Er and Tm) is reported. Both structures are built from $[Ln_6O_8]$ rare-earth metal hexamers being incorporated in $[Pb_{18}O_{32}]$/$[Pb_{12}O_{24}]$ polyplumbites, and unbound perchlorates as charge-balancing anions. Impressively, $YPbOClO_4$-1 and $ErPbOClO_4$-2 exhibit exceptional uptake capacities (434.7 and 427.7 mg g^{-1}) toward ReO_4^-, a chemical surrogate for the key radioactive fission product in the nuclear fuel cycle $^{99}TcO_4^-$, which are the highest values among all inorganic anion-exchange materials reported until now. The sorption mechanism is clearly elucidated and visualized by single-crystal-to-single-crystal structural transformation from $ErPbOClO_4$-2 to a perrhenate-containing complex $ErPbOReO_4$, revealing a unique ReO_4^- uptake selectivity driven by specific interaction within $Pb\cdots O\text{-}ReO_3^-$ bonds.

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DOI: 10.1002/advs.201900381

The chemistry of polyoxometalate (POM) has been extensively studied for decades, owning to their aesthetic structural diversity and broad functionality in areas of catalysis, photolytic reduction, medicine, etc.[1] Numerous *iso*-POM nanoaggregates have been reported but their building units are mostly limited to oxoanions based on the Groups 5 and 6 transition metals (Mo, W, V, Nb, and Ta).[2] Those metals in their highest oxidation states are typically four- to seven-coordinate and the metal cores are normally off-centered due to the presence of short bonds between transition metals and yl O atoms. An emerging derivative of POMs is uranyl peroxide clusters, which are built from UO_2^{2+} cations with two *trans* yl oxo groups, and more than 120 uranyl peroxide clusters featuring over 50 geometries have been reported.[3] The tunable dimensions of POMs with a myriad of high number of metal centers per anion (up to 368) result in the encapsulation of heavy metal cations in the nanocages, which could not only retain the individual properties of POMs but also give rise to novel functions attributed from the encapsulated metal centers.[4] Despite the abundance of POMs, polymolybdates and polytungstates are the dominant derivatives.[5] Extending the species of POMs to other groups of elements and developing of new synthetic protocols for new family of POMs are of necessity.

Plumbite appears to be a logical candidate anion for hierarchical arrangement of moieties from monomeric anion to POMs for two reasons. First, Pb in plumbite is naturally off-centered owning to the presence of stereochemically active lone-pair electrons on the metal centers.[6] As a result, the Pb–O–Pb bridges introduce a corrugated geometry when plumbites are properly aligned, providing the curvature suitable for the formation of polyanionic cage clusters. Second, hyperpolarizable oxyanions such as borate, tellurite, and plumbite, can interconnect to form numerous arrays of polyanionic structures, thereby making plumbite potential fundamental building block for synthesizing new POMs.[7]

Guided by the aforementioned strategy, we have succeeded in synthesizing a new family of POMs built from oxoanions of the carbon group element Pb with two distinct topologies, $[Ln_6(OH)_8(H_{30}Pb_{18}O_{32})]\cdot(ClO_4)_{12}\cdot(H_2O)_6$ (**$LnPbOClO_4$-1**, Ln = Y,

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Textile-Based Wireless Pressure Sensor Array for Human-Interactive Sensing

Baoqing Nie, Rong Huang, Ting Yao, Yiqiu Zhang, Yihui Miao, Changrong Liu, Jian Liu, and Xinjian Chen**

A textile-based wireless pressure sensor array (WiPSA) is proposed for flexible remote tactile sensing applications. The WiPSA device is composed of a fabric spacer sandwiched by two separate layers of passive antennas and ferrite film units. Under the external pressure, the mechanical compression of the flexible fabric spacer leads to an inductance change, which can further be transduced to a detectable shift of the resonant frequency. Importantly, WiPSA integrates the ferrite film featuring an ultrahigh permeability, which effectively improves the device sensitivity and avoids the interference of conductive materials simultaneously. The device performance with a high quality factor (>35) and sensitivity (–0.19 MHz kPa^{-1}) within a pressure range of 0–20 kPa is demonstrated. In addition, WiPSA achieves excellent reproducibility under periodical pressures (>20 000 cycles), temperature fluctuations (15–103 °C), and humidity variations (40–99%). As a proof of concept for human-interactive sensing, WiPSA is successfully 1) integrated with a flexible wrist band for fingertip pressure-guided direction choices, 2) developed into a smart wireless insole to map the plantar stress distributions, and 3) embedded into a waist-supporting belt to resolve the contact pressure between the belt and human abdomen in a remote transmitting scheme.

1. Introduction

The development of electronic textiles (E-textile) is an active research area in biomedicine and robotics, which allows design of devices with a great physical flexibility, outstanding wearability, and easy integration to various fabric substrates that cannot be achieved by the traditional electronic device fabrication.[1] Textile-based pressure sensors have been proposed for a variety of applications, including wearable health monitoring, intelligent home care, medical diagnostics, and human motion detections.[2] Different sensing mechanisms based on capacitive, resistive, or piezoelectric measurements have been introduced for the development of pressure sensors in E-textile.[3] For instance, Li et al. developed a capacitive textile pressure sensor by assembly of a compliant ion-conductive polymer sandwiched between two layers of conductive fabrics to monitor pressure distributions at soft interfaces.[2c] Lee's group reported a capacitive fabric pressure sensor sewn in a glove to control quadrotor movements by detecting finger motions.[3c] However, there remain several critical issues to be addressed in this research field, including complexity of wiring, poor resilience, and signal fluctuations induced by the environmental changes, which limit the practical applications of smart E-textile devices.

Wearable electronics that exploit the technologies of wireless transmissions, such as radio frequency identification or near field communication, offers a concise platform to detect healthcare signals, including body temperature, electrophysiology, pressure, and sweat.[4] Many wireless sensors are relied on passive components, such as an inductor (L) and a capacitor (C) to transfer information in electromagnetic fields in response to external physical changes.[5] This design is featured with several intrinsic advantages, such as simplified electrical connection, no requirement for power source, long lifetime, and ease for miniaturization. Recently, a transparent soft contact lens sensor has been developed for wirelessly recording intraocular pressure. The device is built on a flexible dielectric layer sandwiched between two inductive spiral electrodes, allowing for the measurements of the intraocular pressure changes by the coupling of the capacitance and inductance.[6] Bao's group has reported a millimeter-scaled passive pressure sensor by stacking a deformable dielectric film between two inductive spiral layers, with a demonstration of in vivo intracranial pressure monitoring in mice.[7] The development of flexible wireless sensing technologies is on the urgent demand of biomedical applications, where remote detection, implantability, and robust performance are critically important.

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DOI: 10.1002/adfm.201808786

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Boosting H_2O_2-Guided Chemodynamic Therapy of Cancer by Enhancing Reaction Kinetics through Versatile Biomimetic Fenton Nanocatalysts and the Second Near-Infrared Light Irradiation

Tingting Wang, Hao Zhang, Hanghang Liu, Qiang Yuan, Feng Ren, Yaobao Han, Qiao Sun, Zhen Li, and Mingyuan Gao*

Fenton reaction–based chemodynamic therapy (CDT) has attracted considerable attention for tumor treatment, because the Fenton reaction can degrade endogenous H_2O_2 within the tumor to form reactive oxygen species (ROS) to kill cancer cells. The kinetics of the Fenton reaction has significantly influenced its treatment efficacy. It is crucial to enhance the reaction kinetics at the maximum H_2O_2 concentration to quickly produce vast amounts of ROS to achieve treatment efficacy, which to date, has not been realized. Herein, reported is an efficacious CDT treatment of breast cancer using biomimetic CS-GOD@CM nanocatalysts, which are rationally designed to significantly boost the Fenton reaction through improvement of H_2O_2 concentration within tumors, and application of the second near-infrared (NIR-II) light irradiation at the maximum concentration, which is monitored by photoacoustic imaging. The biomimetic nanocatalysts are composed of ultra-small $Cu_{2-x}Se$ (CS) nanoparticles, glucose oxidase (GOD), and tumor cell membrane (CM). The nanocatalysts can be retained in tumor for more than two days to oxidize glucose and produce an approximately 2.6-fold increase in H_2O_2 to enhance the Fenton reaction under the NIR-II irradiation. This work demonstrates for the first time the CDT treatment of cancer enhanced by the NIR-II light.

1. Introduction

Fenton reaction–based chemodynamic therapy (CDT) as an emerging nanocatalytic treatment has attracted increasing interest in recent years, because it uses endogenous chemicals (e.g., H_2O_2) overproduced in cancer cells to generate reactive oxygen species (ROS) to kill cancer cells.[1–3] The overproduced H_2O_2 in cancer cells is efficiently degraded under the catalysis of versatile metal ions (e.g., Fe^{2+}, Mn^{2+}, Cu^{+}, Pt^{2+}, Co^{2+}, and V^{2+}) to produce hydroxyl ($^{\bullet}OH$) radicals for treatment.[4–8] Thereby, the generation of $^{\bullet}OH$ radicals plays a significant role and determines the efficacy of CDT treatment.[9] Although advances in nanotechnology offer a promising way to facilitate cancer therapy through Fenton reaction,[10] there are some challenges that remain to be solved for improving the efficacy of treatment. One of them is the reaction kinetics of Fenton reaction, and how to maximally speed up the Fenton reaction in a controllable way has been a challenge for enhancing the efficacy of therapy.

The reaction kinetics of Fenton reaction strongly depends on the performance of catalysts and reaction parameters. For example, Fe^{2+} ions and their based materials could be an excellent Fenton catalyst in a low pH range from 2.0 to 4.5, but the high pH in cancer (pH = 6.5–6.9) significantly degrades the performance of Fe^{2+} ions in the Fenton reaction for cancer therapy.[1,4] To enhance their performance, the UV light was used to reduce Fe^{3+} ions into Fe^{2+} ions for recycling of Fenton reaction.[11–15] Since the UV light has limited penetration depth, up-conversion nanoparticles have been used to convert near-infrared (NIR) light into UV light for photo-Fenton reaction to improve its therapeutic efficacy.[16] However, the conversion efficiency could drastically influence the kinetics of Fenton reaction. Another option is the deposition of Fenton catalysts on the surface of nanomaterials with NIR absorbance to enhance Fenton reaction. For example, He et al. deposited iron hydroxide/oxide particles on the surface of graphene oxide sheets to boost the generation of ROS under the NIR irradiation.[17] For these hybrid Fenton catalysts, their performance is strongly dependent on the electron and energy transfer between their interface under the NIR irradiation. Therefore, great efforts have been devoted to rationally design

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DOI: 10.1002/adfm.201906128

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3D Superelastic Scaffolds Constructed from Flexible Inorganic Nanofibers with Self-Fitting Capability and Tailorable Gradient for Bone Regeneration

Lihuan Wang, Yuyou Qiu, Haijun Lv, Yang Si, Lifang Liu, Qi Zhang, Jianping Cao, Jianyong Yu, Xiaoran Li, and Bin Ding**

Repair of bone defects with irregular shapes or at soft tissue insertion sites faces a huge challenge. Scaffolds capable of adapting to bone cavities, generating stiffness gradients, and inducing osteogenesis are necessary. Herein, a superelastic 3D ceramic fibrous scaffold is developed by assembly of intrinsically rigid, structurally flexible electrospun SiO_2 nanofibers with chitosan as bonding sites (SiO_2 NF-CS) via a lyophilization technique. SiO_2 NF-CS scaffolds exhibit excellent elasticity (full recovery from 80% compression), fast recovery rate (>500 mm min^{-1}), and good fatigue resistance (>10 000 cycles of compression) in an aqueous medium. SiO_2 NF-CS scaffolds induce human mesenchymal stem cell (hMSC) elongation and differentiation into osteoblasts. In vivo self-fitting capability is demonstrated by implanting compressed SiO_2 NF-CS scaffolds into different shaped mandibular defects in rabbits, with a spontaneous recovery and full filling of defects. Rat calvarial defect repair validates enhanced bone formation and vascularization by cell (hMSC) histomorphology analysis. Further, subchondral bone scaffolds with gradations in SiO_2 nanofibers are developed, leading to a stiffness gradient and spatially chondrogenic and osteogenic differentiation of hMSCs. This work presents a type of 3D ceramic fibrous scaffold, which can closely match bone defects with irregular shapes or at different implant sites, and is promising for clinical translation.

1. Introduction

Treatment of complex bone defects with irregular shapes or at interfacial zone with soft tissues, such as cartilage-to-bone, tendon-to-bone and ligament-to-bone insertion sites remains a clinical challenge.[1,2] Autograft remains gold standard for bone repair, however it has been severely limited in clinical practice due to restricted availability, significant donor site morbidity and poor capability for machining to accommodate irregular defects.[3] There is increasing evidence that poor contact with the host bone tissue results in bone resorption and bad osseointegration.[4] Alternatively, bone substitutes, such as ceramics and cement have been universally used in clinical practice. However, rigid ceramics have a similar drawback of poor machinability. The development of injectable cements allows minimally invasive surgery and perfect match with the surrounding bone tissues. Nevertheless, the cements are normally nonporous or of minimally porous, which hinders cell in-growth, vascularization and bone regeneration.[5] In addition, these systems are not suitable for repair of bone defect at interfacial transition zone with soft tissue where possesses gradations in mineral content, stiffness, and cellular phenotype.[6] As an example, subchondral bone defect commonly involves both bone and articular cartilage lesions, thus simultaneous bilineage regeneration spatially is required within a single scaffold.[7] Moreover, subchondral bones undergo cyclic mechanical compression.[8] Hence, in addition to gradients in chemical, mechanical, and biological properties, subchondral bone scaffolds are required to provide elasticity to withstand cyclic compression.

Shape-memory and shape-recovery materials have been emerging candidates for groundbreaking applications in regenerative medicine, such as tissue engineering,[9] sutures,[10] and vascular stents.[11] The shape-recovery property guarantees scaffold implantation in a compressed state via minimally invasive surgery, and self-fitting to bone defect sites. Shape-memory scaffolds such as poly(ε-caprolactone)- or poly(L-lactide)-based scaffolds for bone tissue engineering have been demonstrated the

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DOI: 10.1002/adfm.201901407

Nano Energy 57 (2019) 600–607

Contents lists available at ScienceDirect

Nano Energy

journal homepage: www.elsevier.com/locate/nanoen

Full paper

Enhancing proliferation and migration of fibroblast cells by electric stimulation based on triboelectric nanogenerator

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ARTICLE INFO

Keywords:
Triboelectric nanogenerator
Electric stimulation
Fibroblast cells
Proliferation
Migration
Biosafety evaluation

ABSTRACT

Cell stimulation by electric signal is an important approach for the advancement of biomedicine. Triboelectric nanogenerators (TENG), capable of converting mechanical energies to electricity, provides an alternative strategy to stimulate cells in a desired fashion. In this work, a TENG driven electric stimulation system has been designed for biosafety evaluation and exploration of the fibroblast cell behaviors. A rotatory disc-shaped TENG (RD-TENG) was fabricated to obtain an adjustable range of alternating current outputs. The peak current generated in a range of 10–50 μA is suitable for promoting cellular proliferation behavior of L929 cells. At the optimum value of 50 μA, the promotion rate reached 53.8 ± 2.66% after two-day of intermittent stimulation. Also, the migration rate was increased by about 67% than that of the cells in the control group. In addition, under stimulation, the proliferation-related gene of L929 cells - proliferating cell nuclear antigen (Pcna) and the two migration-related genes - fibroblast growth factor 2 (Fgf2) and delta like non-canonical notch ligand 1 (Dlk1) were also found up-regulated, suggesting that TENG stimulation regulates cell proliferation and migration at the level of gene expression. The present study demonstrates the effectiveness of TENG and its safe operation conditions in biomedical stimulation, which paves a way for practical application of TENG on tissue formation, reepithelialization and tissue remodeling.

1. Introduction

Bioelectricity phenomenon is the basic attribute of life activity. The generation of bioelectric signals appears in all the living activities of organism. For example, the potential difference could be observed in the development of neural tube, in the epithelial wound site and on the surface of tumor cells [1,2]. Thus formed endogenous bioelectric field not only plays an important role in biological morphogenesis and growth, but also participates in the vital pathological process of the body such as wound healing, tissue regeneration and so on [3–5]. As a result, the study of electric stimulation, especially for stimulating cells, has great significance to the advance of biomedicine.

As compared to the method of chemical stimulation and mechanical cue, electric stimulation shows technical superiorities in many aspects, such as mild stimulating condition to induce less damage, easier to implement and precise for parameter control [6–8]. Furthermore, electric stimulation when combined with other therapeutic methods could also open numerous feasibilities to exhibit grand performance improvement. Besides, it is worthy of mentioning that the immune response of the organism won't be stimulated in whole process. However, the electric stimulation signal output devices utilized in the current clinical medicine practice or in experimental research are all commercial electrical stimulators, which are generally expensive and requires professional operation and maintenance. Apparently, in the contemporary trend for developing and implementing personalized medical care and service, an electrical stimulator output device with the

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https://doi.org/10.1016/j.nanoen.2018.12.077
Received 19 November 2018; Received in revised form 24 December 2018; Accepted 25 December 2018
Available online 27 December 2018

JACS
JOURNAL OF THE AMERICAN CHEMICAL SOCIETY
Cite This: J. Am. Chem. Soc. 2019, 141, 8030−8034
Communication
pubs.acs.org/JACS

Direct Radiation Detection by a Semiconductive Metal−Organic Framework

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Supporting Information

ABSTRACT: Semiconductive metal−organic frameworks (MOFs) have attracted extraordinary research interest in recent years; however, electronic applications based on these emerging materials are still in their infancy. Herein, we show that a lanthanide-based semiconductive MOF (**SCU-12**) can effectively convert X-ray photons to electrical current signals under continuous hard X-ray radiation. The semiconductive MOF-based polycrystalline detection device presents a promising X-ray sensitivity with the value of 23.8 μC Gy_{air}^{-1} cm^{-2} under 80 kV_p X-ray exposure, competitive with the commercially available amorphous selenium (α-Se) detector. The lowest detectable X-ray dose rate is 0.705 μGy s^{-1}, representing the record value among all X-ray detectors fabricated by polycrystalline materials. This work discloses the first demonstration of hard radiation detection by semiconductive MOFs, providing a horizon that can guide the synthesis of a new generation of radiation detection materials by taking the advantages of structural designability and property tunability in the MOF system.

Detection of X-ray photons is critical in multipurpose fields including medical diagnostics and therapeutics, homeland security, astrophysics, and scientific facilities.[1−3] Compared with scintillator-based indirect detection materials, semiconductors can directly convert X-ray photons to charge carriers, with the merits of improved energy and spatial resolution, as well as more portable packaging.[4] Over the past decades, versatile semiconductors were prolifically developed for detecting X-ray photons. These materials include amorphous Se, crystalline Ge/Si, crystalline PbI_2, TlBr, Cd(Zn)Te (CZT), and halides-based ternary compounds.[1,5−7] Although many of these materials have been commercialized, they face severe bottlenecks in practical applications. For example, the utilization of Si and Se is limited within a narrow spectrum range with energy below 40 keV due to poor X-ray absorptivity and low detection efficiency in the high energy regime.[1,6] The band gap of Ge is only 0.7 eV, leading to high leakage current, and therefore it has to be utilized strictly below the cryogenic temperature.[7] In addition, feasible crystal growth and processing are the critical requirements to produce chemically stable and cost-effective materials. An efficient radiation detection material is recognized with traits of high Z_{eff}, large signal-to-noise ratio and low leakage current, as well as large charge carrier mobility and lifetime product ($\mu\tau$).[8,9]

Metal−organic frameworks (MOFs) assembled by metal nodes/clusters and organic linkers are an emerging class of materials with high crystallinity, inherent porosity, designable architecture, and tunable functionalities, which provides a diverse platform for developing functional materials for many different applications.[10−13] However, their applications toward radiation detection is quite scarce. Recently, only three cases of "scintillating MOFs" exhibit the radiation induced luminescence.[14−16] To the best of our knowledge, direct radiation detection materials have never been reported for MOFs, which may partially due to the lagging development of the semiconductive MOFs. The recent research frontier of semiconductive MOFs focuses on achieving high electrical conductivity toward applications in the chemiresistive sensor, field-effect transistors, and supercapacitors.[17−20] However, detection of hard radiation is impractical using these reported semiconductive MOFs, primarily owing to the poor X-ray absorptivity of light elements for constructing the MOFs and low signal-noise ratio from high leakage current.

Herein, we report the first investigation on the detection of X-ray photons by a terbium-based semiconductive MOF, $[(CH_3)_2NH_2]Tb_2L_3(DMF)_2(H_2O)_2(HCOO)$ (**SCU-12**, L = $C_6Cl_2O_4^{2-}$). Semiquinoid ligand was selected as the conducting medium given its accessible redox-active property (Scheme S1). As shown in Figure 1a, comparison results on the attenuation efficiency of representative detection materials Si, **SCU-12**, and isotypical compounds by altering Tb^{3+} with lighter elements of Al^{3+} and In^{3+} confirm our hypothesis.

Received: February 6, 2019
Published: May 7, 2019

DOI: 10.1021/jacs.9b01270
J. Am. Chem. Soc. 2019, 141, 8030−8034

JACS
JOURNAL OF THE AMERICAN CHEMICAL SOCIETY
Article
Cite This: J. Am. Chem. Soc. 2019, 141, 3265−3273
pubs.acs.org/JACS

Quantitatively Visualizing Tumor-Related Protease Activity *in Vivo* Using a Ratiometric Photoacoustic Probe

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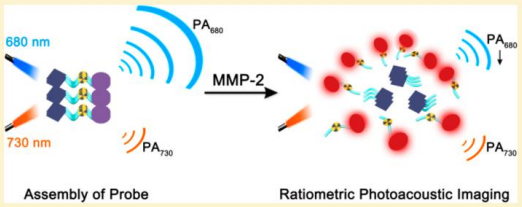
Supporting Information

ABSTRACT: The abnormal expression of tumor-related proteases plays a critical role in cancer invasion, progression, and metastasis. Therefore, it is considerably meaningful to non-invasively assess the proteases' activity *in vivo* for both tumor diagnosis and therapeutic evaluation. Herein, we report an activatable probe constructed with a near-infrared dye (Cy5.5) and a quencher (QSY21) covalently linked through a peptide substrate of matrix metalloproteinases-2 (MMP-2) that was chosen as a model for tumor-associated proteases. Upon cleavage with activated MMP-2, this probe emitted an MMP-2-concentration-dependent fluorescence. Quite unexpectedly, owing to the variation in the aggregation state of both the dye and its quencher as a consequence of the cleavage, the responsive probe presented a dramatic MMP-2-concentration-dependent absorption at around 680 nm, while that at around 730 nm was MMP-2 concentration independent. These features allowed detection of MMP-2 activity via both fluorescence and photoacoustic (PA) imaging *in vitro*, respectively. Moreover, taking the PA signal at 730 nm as an internal reference, the PA signal at 680 nm allowed quantitative detection of MMP-2 expression in breast cancer *in vivo*. We thus envision that our current approach would offer a useful tool for studying the malignant impacts of versatile tumor-associated proteases *in vivo*.



INTRODUCTION

Abnormal tumor microenvironmental factors such as low extracellular pH, hypoxia, and up-regulated expression of tumor-related proteases are widely accepted as cancer signatures.[1,2] Matrix metalloproteinases (MMPs) are known to be important biomarkers involved in tumorigenesis, invasiveness, metastasis, and angiogenesis of cancers,[3−5] and MMP-2 is one of the most vital MMPs, as it is overexpressed in the majority of solid tumors in, for example, breast,[6] bladder,[7] colon,[8] prostate,[9] and stomach cancers.[10] Therefore, the assessment of MMP-2 activity *in vivo* is of great relevance for clinical diagnosis and therapeutic evaluation of cancers.[11] Non-invasive detection of the protease activity through optical imaging has been reported.[12−26] For example, with the aid of a dual-ratiometric target-triggered fluorescent probe, simultaneous and quantitative mapping of tumor microenvironment protease activity and pH was successfully demonstrated. Moreover, the overexpression of MMPs was found to be well-correlated, in both time and location, with abnormal pH *in vivo*, and their synergistic effects largely govern the heterogeneous invasion of malignant tumors.[27,28] Apparently, fluorescence imaging offers great potential for visualizing the malignant molecular behaviors. Nevertheless, the limited penetration depth of visible light limits its clinical translation. Fortunately, photoacoustic (PA) imaging, synergistically integrating optical imaging and ultrasound imaging, overcomes the limitations of conventional fluorescence imaging and provides a deeper tissue imaging capacity with high spatial resolution.[29−38]

Although a number of responsive PA probes have recently been reported for non-invasively detecting MMPs *in vivo*,[39−46]

Received: December 21, 2018
Published: January 28, 2019

DOI: 10.1021/jacs.8b13628
J. Am. Chem. Soc. 2019, 141, 3265−3273

Applied Catalysis B: Environmental 254 (2019) 47–54

Contents lists available at ScienceDirect

Applied Catalysis B: Environmental

journal homepage: www.elsevier.com/locate/apcatb

Powerful uranium extraction strategy with combined ligand complexation and photocatalytic reduction by postsynthetically modified photoactive metal-organic frameworks

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ARTICLE INFO

Keywords:
Uranium
Photocatalysis
Metal-organic framework
Extraction
Post-synthesis

ABSTRACT

Uranium enrichment is perhaps the most critical chemical process throughout the nuclear fuel cycle including uranium mining, uranium extraction from seawater, used fuel reprocessing and disposal, and environmental contamination remediation. New uranium extraction technology is still highly desirable at current stage, although a variety of extraction methods have been established and developed in the past several decades but all with clear demerits. Herein we present a new uranium extraction strategy with combined ligand complexation and photocatalytic reduction based on postsynthetically functionalized metal-organic frameworks (MOFs). The highly robust and photoactive MOF PCN-222 is modified with phosphono- and amino groups that can capture U (VI) from solution. Upon visible light irradiation, the photo-induced electrons from the MOF host can efficiently reduce U(VI) pre-enriched in MOF, affording neutral uranium species that evacuate the MOF structure and regenerating the active site readily for capturing additional U(VI). This auto-recycled process offers an ultrahigh uranium extraction capacity not limited by the number of adsorption sites and more importantly an extra uranium uptake selectivity over these non-redox-active competing metal cations, and can be utilized for uranium separation over extremely wide uranium concentrations and pH ranges, showing a powerful application potential.

1. Introduction

Nuclear power remains to be the most mature technology that can partially substitute fossil energy and provide low-cost electrical power without greenhouse gas emissions [1–4]. However, uranium used in nuclear reactors currently only comes from the mining and milling process, which has already created a global environmental issue of uranium pollution in natural water systems and soils that attracts tremendous public attention [5,6]. In addition, more than 95% of the mass of the used nuclear fuel is the remaining uranium, giving rise to a significant demand for reprocessing the used fuel to further increase the uranium burning efficiency, because of the upcoming shortage of uranium reserving in terrestrial ores [7,8]. Alternatively, uranium in oceans represents another major resource supply of uranium while uranium extraction from seawater currently faces both scientific and technological barriers to be further developed and commercialized [9,10]. Therefore, searching for new materials and strategies for uranium extraction from aqueous solution would be highly desirable aiming for the sustainable development of nuclear power in a variety of aspects including but are not limited to uranium mining, uranium extraction from seawater, used fuel reprocessing and disposal, radioactive waste water treatment, and environmental contamination remediation.

During the past several decades, many different types of solid adsorbent materials have been established and further developed to extract U(VI) (the predominate valence state of uranium under ambient condition) from aqueous solutions, such as inorganic oxides [11–14], modified activated carbon [1,15–17], layered metal sulfides [18–20] or layered hydroxides [21–24], nonporous polymers [25], metal-organic frameworks (MOFs) [26–29], covalent organic frameworks (COFs) [30,31], porous organic polymers (POPs) [2,32], and others [33–37].

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https://doi.org/10.1016/j.apcatb.2019.04.087
Received 7 March 2019; Received in revised form 24 April 2019; Accepted 25 April 2019
Available online 26 April 2019

ACS NANO
Cite This: ACS Nano 2019, 13, 6647−6661
www.acsnano.org

ARTICLE

Spatiotemporally Light-Activatable Platinum Nanocomplexes for Selective and Cooperative Cancer Therapy

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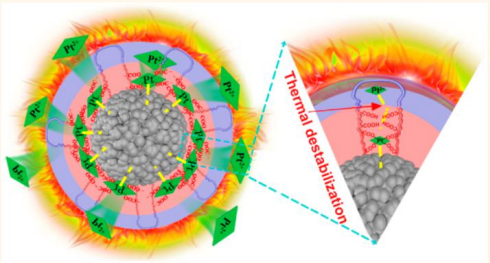
Supporting Information

ABSTRACT: **Highly efficient nanoarchitectures are of great interest for achieving precise chemotherapy with minimized adverse side effects in cancer therapy. However, a major challenge remains in exploring a rational approach to synthesize spatiotemporally selective vehicles for precise cancer chemotherapy. Here, we demonstrate a rational design of bifunctional light-activatable platinum nanocomplexes (PtNCs) that produce dually cooperative cancer therapy through spatiotemporally selective thermo-chemotherapy. The Pt^{4+}-coordinated polycarboxylic nanogel is explored as the nanoreactor template, which is exploited to synthesize bifunctional PtNCs consisting of a zero-valent Pt^0 core and a surrounding bivalent Pt^{2+} shell with tunable ratios through a facile and controllable reduction. Without light exposure, chemotherapeutic Pt^{2+} ions are tightly bound on the surface of PtNCs, efficiently reducing undesirable drug leakage and nonselective damage on normal tissues/cells. Upon light exposure, PtNCs generate much heat *via* photothermal conversion from the Pt^0 core and simultaneously trigger a rapid release of chemotherapeutic Pt^{2+} ions, thereby leading to the spatiotemporally light-activatable synergistic effect of thermo-chemotherapy. Moreover, PtNCs show enhanced tumor accumulation through the heat-triggered hydrophilicity−hydrophobicity transition upon immediate light exposure after injection, dramatically facilitating *in vivo* tumor regression through their cooperative anticancer efficiency. This rational design of spatiotemporally activatable nanoparticles provides an insightful tool for precise cancer therapy.**



KEYWORDS: *bifunctional platinum nanocomplex, nanoreactor, photothermal therapy, activatable chemotherapy, cooperative cancer therapy*

Cancer is a serious hazard to human health. For instance, hepatocellular carcinoma (HCC) is the second leading cause of global cancer-related deaths, and single-modality treatment such as chemotherapy alone usually suffers from many limitations such as toxicity, drug tolerance, recurrence, and metastasis.[1−4] Recently, multifunctional nanoparticles have emerged as promising targeted delivery platforms of chemotherapeutic compounds, exhibiting a favorable synergy between chemotherapy and other therapeutic modalities.[5−7] The tailor-made design of nanostructures shows great promise to overcome multiple barriers in cancer-targeted drug delivery such as blood circulation, vessel extravasation, intratumoral penetration, and intracellular drug release, together with minimized adverse side effects, thereby increasing the accessibility of therapeutic compounds to subcellular targets in organelles.[8,9] In particular, a variety of smart nanoparticles have been extensively explored to deliver the payloads (such as chemotherapeutics, siRNA, photosensitizers, and gasotransmitters) for satisfying their intracellular delivery in response to intrinsic stimuli such as lysosomal pH, redox, and reactive oxygen species, being responsible for tumor-specific drug delivery.[10−15] To further achieve precise drug release, some external stimuli (*e.g.*, light, heat, ultrasound, and magnetism) have also been utilized to

Received: February 2, 2019
Accepted: May 14, 2019
Published: May 14, 2019

DOI: 10.1021/acsnano.9b00972
ACS Nano 2019, 13, 6647−6661

ACS NANO
Cite This: ACS Nano 2019, 13, 11488−11499
www.acsnano.org

ARTICLE

Engineered Graphene Oxide Nanocomposite Capable of Preventing the Evolution of Antimicrobial Resistance

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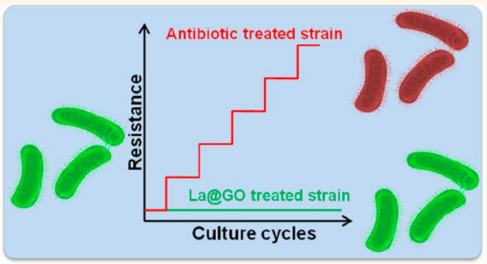
Supporting Information

ABSTRACT: **Antimicrobial resistance (AMR) is spreading worldwide and keeps evolving to adapt to antibiotics, causing increasing threats in clinics, which necessitates the exploration of antimicrobial agents for not only killing of resistant cells but also prevention of AMR progression. However, so far, there has been no effective approach. Herein, we designed lanthanum hydroxide and graphene oxide nanocomposites (La@GO) to confer a synergistic bactericidal effect in all tested resistant strains. More importantly, long-term exposure of *E. coli* (AMR) to subminimum inhibitory concentrations of La@GO does not trigger detectable secondary resistance, while conventional antibiotics and silver nanoparticles lead to a 16- to 64-fold increase in tolerance. The inability of *E. coli* to evolve resistance to La@GO is likely due to a distinctive extracellular multitarget invasion killing mechanism involving lipid dephosphorylation, lipid peroxidation, and peptidoglycan disruption. Overall, our results highlight La@GO nanocomposites as a promising solution to combating resistant bacteria without inducing the evolution of AMR.**



KEYWORDS: *antimicrobial resistance, evolution, nanoparticles, lanthanum hydroxide, graphene oxide*

Widespread use of antibiotics in livestock and patients has led to the rapid progression and spreading of antimicrobial resistance (AMR).[1,2] Resistant microbes have developed diverse intrinsic resistance mechanisms by mutations in chromosomal genes for alteration of antibiotic

Received: June 25, 2019
Accepted: September 30, 2019
Published: September 30, 2019

DOI: 10.1021/acsnano.9b04970
ACS Nano 2019, 13, 11488−11499

ACS NANO
Cite This: ACS Nano 2019, 13, 12694−12702
www.acsnano.org

ARTICLE

Optimization of Antibacterial Efficacy of Noble-Metal-Based Core−Shell Nanostructures and Effect of Natural Organic Matter

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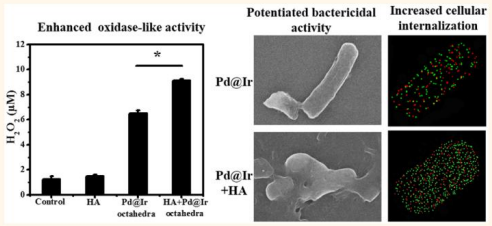
Supporting Information

ABSTRACT: **Noble-metal-based nanomaterials made of less toxic metals have been utilized as potential antibacterial agents due to their distinctive oxidase-like activity. In this study, we fabricated core−shell structured Pd@Ir bimetallic nanomaterials with an ultrathin shell. Pd@Ir nanostructures show morphology-dependent bactericidal activity, in which Pd@Ir octahedra possessing higher oxidase-like activity exert bactericidal activity stronger than that of Pd@Ir cubes. Furthermore, our results reveal that the presence of natural organic matter influences the antibacterial behaviors of nanomaterials. Upon interaction with humic acid (HA), the Pd@Ir nanostructures induce an elevated level of reactive oxygen species, resulting in significantly enhanced bactericidal activity of the nanostructures. Mechanism analysis shows that the presence of HA efficiently enhances the oxidase-like activity of nanomaterials and promotes the cellular internalization of nanomaterials. We believe that the present study will not only demonstrate an effective strategy for improving the bactericidal activity of noble-metal-based nanomaterials but also provide an understanding of the antibacterial behavior of nanomaterials in the natural environment.**



KEYWORDS: *bimetallic core−shell nanostructures, morphology, natural organic matter, oxidase-like activity, antibacterial efficiency*

Owing to their unique physicochemical properties, noble metal nanomaterials have been widely applied in various areas ranging from industrial catalysis to daily necessities.[1−4] In particular, without the risk of drug resistance, noble metal nanomaterials have shown potential applications in bactericidal fields. Ag nanoparticles, as one of most common noble-metal-based antibacterial agents, possess strong antibacterial activity but also show unacceptable toxicity to normal cells or tissues.[5,6] Therefore, the exploration of noble-metal-based nanomaterials with excellent antibacterial activity and high biosafety is highly desirable.

Previous studies have revealed that noble metal nanomaterials composed of less toxic and even nontoxic metal elements including gold (Au),[7−9] palladium (Pd),[10] and platinum (Pt)[11−13] could selectively kill bacterial cells without producing significant toxicity to human cells. The selective bacteria killing effect is ascribed to the distinctive oxidase- and peroxidase-like activities of noble metal nanomaterials with environmental selectivity.[14] However, the bactericidal activity of noble metal nanomaterials still needs to be improved.[15−17] Compared with their single-component counterparts, bimetallic core−shell structured nanoparticles[18−20] can provide more attractive opportunities for marked enhancement in specific catalytic activity due to the synergistic effects between the core and the shell. Based on the above illustration, we

Received: June 4, 2019
Accepted: October 23, 2019
Published: October 23, 2019

DOI: 10.1021/acsnano.9b04366
ACS Nano 2019, 13, 12694−12702

ACS NANO
Cite This: ACS Nano 2019, 13, 1342−1353
www.acsnano.org

ARTICLE

Boosting the Radiosensitizing and Photothermal Performance of $Cu_{2-x}Se$ Nanocrystals for Synergetic Radiophotothermal Therapy of Orthotopic Breast Cancer

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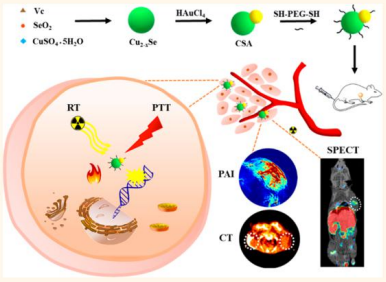
Supporting Information

ABSTRACT: **The small difference between tumor and normal tissues in their responses to ionizing radiation has been a significant issue for radiotherapy of tumors. Herein, we report that dumbbell-shaped heterogeneous copper selenide-gold nanocrystals can serve as an efficient radiosensitizer for enhanced radiotherapy. The mean lethal dose of X-rays to 4T1 tumor cells can be drastically decreased about 40%, that is, decreasing from 1.81 to 1.10 Gy after culture with heterostructures. Due to the synergetic effect of heterostructures, the dose of X-rays is also much lower than those obtained from mixture of $Cu_{2-x}Se$ + Au nanoparticles (1.78 Gy), $Cu_{2-x}Se$ nanoparticles (1.72 Gy) and Au nanoparticles (1.50 Gy), respectively. We demonstrate that the sensitivity enhancement ratio of $Cu_{2-x}Se$ nanoparticles was significantly improved 45% (*i.e.*, from 1.1 to 1.6) after the formation of heterostructures with gold. We also show that the heteronanocrystals exhibit an enhanced photothermal conversion efficiency, due to the synergetic interactions of localized surface plasmon resonance. These properties highly feature them as a multimodal imaging contrast agent (particularly for photoacoustic imaging, computed tomography imaging, and single photon emission computed tomography after labeled with radioisotopes) and as a radiosensitizer for imaging guided synergetic radiophotothermal treatment of cancer. The research provides insights for engineering low-Z nanomaterials with high-Z elements to form heteronanostructures with enhanced synergetic performance for tumor theranostics.**



KEYWORDS: *heterogeneous nanoparticles, radiosensitizer, radiotherapy, photothermal therapy, multimodal imaging*

Radiotherapy (RT) is one of the most important and effective methods for the treatment of solid tumors, as more than half of tumor patients would receive RT during treatment.[1] RT mainly uses high-energy radiation (*e.g.*, X-rays or γ-rays) to target cancerous tissues and then directly or indirectly damages the deoxyribonucleic acid (DNA) of cells, leading to apoptosis and death of irradiated cells.[2,3] Despite its various advantages, the small difference between tumor and normal tissues in their responses to ionizing radiation leads to the difficulty in successfully curing solid cancers by RT alone without injury to normal tissues.[4−6] Therefore, how to improve the efficacy of RT remains a significant issue for cancer treatment.[7]

To maximize the radiosensitivity of tumor tissue to radiations and minimize the damage of radiations to normal tissue simultaneously, a number of high-Z elements (*e.g.*, gold, bismuth, wolfram, platinum, gadolinium) based nanomaterials have been exploited as radiosensitizers,[8−16] which can penetrate into tumors *via* the enhanced permeability and retention (EPR) effect.[17,18] These nanomaterials could be a generation of theranostic agents for multimodal imaging

Received: September 5, 2018
Accepted: February 1, 2019
Published: February 1, 2019

DOI: 10.1021/acsnano.8b06795
ACS Nano 2019, 13, 1342−1353

ACS NANO
Cite This: ACS Nano 2019, 13, 11686−11697
www.acsnano.org

ARTICLE

pH-Switchable Antimicrobial Nanofiber Networks of Hydrogel Eradicate Biofilm and Rescue Stalled Healing in Chronic Wounds

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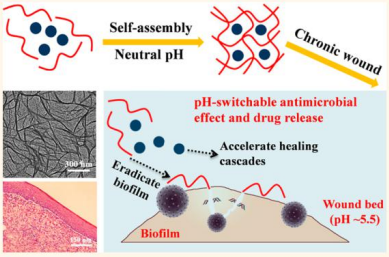
Supporting Information

ABSTRACT: **Biofilm infections can induce chronic inflammation and stall the normal orchestrated course of wound-healing cascades. Herein, pH-switchable antimicrobial hydrogel with nanofiber networks for biofilm eradication and rescuing stalled healing in chronic wounds is reported on the basis of the self-assembly of a designed octapeptide (IKFQFHFD) at neutral pH. This hydrogel is biocompatible and exhibits an acidic pH (pathological environment of infected chronic wounds)-switchable broad-spectrum antimicrobial effect via a mechanism involving cell wall and membrane disruption. The antimicrobial activity of hydrogel is derived from its acidic pH-dependent nanofiber network destabilization and activated release of IKFQFHFD, which is antimicrobial only at acidic pH due to the antimicrobial peptide-like molecular structure. In addition, supramolecular nanofiber networks loaded with drugs of cypate (photothermal agent) and proline (procollagen component) are further developed. *In vitro* experiments show that loaded drugs exhibit acidic pH (pH ~ 5.5)-responsive release profiles, and synergistic biofilm eradication and subsequent healing cascade activation of cells proliferation are achieved on the basis of the supramolecular nanofiber networks. Remarkably, the nanofiber networks of hydrogel enable *in vivo* complete healing of MRSA biofilm infected wound in diabetic mice within 20 days, showing great potential as promising chronic wound dressings. The proposed synergistic strategy for eradicating biofilm and activating subsequent healing cascades may offer a powerful modality for the management of clinical chronic wounds.**



KEYWORDS: *antimicrobial hydrogel, biofilm eradication, chronic wound healing, pH-switchable drug release, nanofiber network*

Chronic wounds (venous ulcers, diabetic ulcers, and pressure ulcers) pose mounting public health concerns and cause an enormous medical and financial burden.[1−3] Despite continuous improvements in tissue engineering and regeneration to target and accelerate the wound-healing cascades including hemostasis, inflammation, proliferation, and remodeling, it is still challenging to effectively rescue the stalled healing in chronic wounds. This situation is more prevalent and serious in diabetic foot ulcers in which more than 25% of patients will eventually undergo limb amputation

Received: July 17, 2019
Accepted: September 6, 2019
Published: September 6, 2019

DOI: 10.1021/acsnano.9b05608
ACS Nano 2019, 13, 11686−11697

ACS NANO
Cite This: ACS Nano XXXX, XXX, XXX−XXX
www.acsnano.org

ARTICLE

Optimization of Antibacterial Efficacy of Noble-Metal-Based Core−Shell Nanostructures and Effect of Natural Organic Matter

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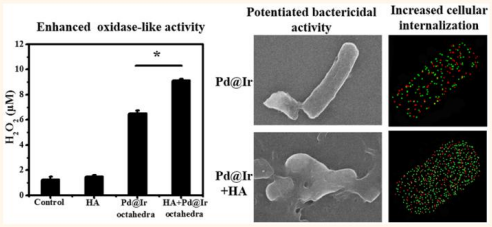
Supporting Information

ABSTRACT: **Noble-metal-based nanomaterials made of less toxic metals have been utilized as potential antibacterial agents due to their distinctive oxidase-like activity. In this study, we fabricated core−shell structured Pd@Ir bimetallic nanomaterials with an ultrathin shell. Pd@Ir nanostructures show morphology-dependent bactericidal activity, in which Pd@Ir octahedra possessing higher oxidase-like activity exert bactericidal activity stronger than that of Pd@Ir cubes. Furthermore, our results reveal that the presence of natural organic matter influences the antibacterial behaviors of nanomaterials. Upon interaction with humic acid (HA), the Pd@Ir nanostructures induce an elevated level of reactive oxygen species, resulting in significantly enhanced bactericidal activity of the nanostructures. Mechanism analysis shows that the presence of HA efficiently enhances the oxidase-like activity of nanomaterials and promotes the cellular internalization of nanomaterials. We believe that the present study will not only demonstrate an effective strategy for improving the bactericidal activity of noble-metal-based nanomaterials but also provide an understanding of the antibacterial behavior of nanomaterials in the natural environment.**



KEYWORDS: *bimetallic core−shell nanostructures, morphology, natural organic matter, oxidase-like activity, antibacterial efficiency*

Owing to their unique physicochemical properties, noble metal nanomaterials have been widely applied in various areas ranging from industrial catalysis to daily necessities.[1−4] In particular, without the risk of drug resistance, noble metal nanomaterials have shown potential applications in bactericidal fields. Ag nanoparticles, as one of most common noble-metal-based antibacterial agents, possess strong antibacterial activity but also show unacceptable toxicity to normal cells or tissues.[5,6] Therefore, the exploration of noble-metal-based nanomaterials with excellent antibacterial activity and high biosafety is highly desirable.

Previous studies have revealed that noble metal nanomaterials composed of less toxic and even nontoxic metal elements including gold (Au),[7−9] palladium (Pd),[10] and platinum (Pt)[11−13] could selectively kill bacterial cells without producing significant toxicity to human cells. The selective bacteria killing effect is ascribed to the distinctive oxidase- and peroxidase-like activities of noble metal nanomaterials with environmental selectivity.[14] However, the bactericidal activity of noble metal nanomaterials still needs to be improved.[15−17] Compared with their single-component counterparts, bimetallic core−shell structured nanoparticles[18−20] can provide more attractive opportunities for marked enhancement in specific catalytic activity due to the synergistic effects between the core and the shell. Based on the above illustration, we

Received: June 4, 2019
Accepted: October 23, 2019
Published: October 23, 2019

DOI: 10.1021/acsnano.9b04366
ACS Nano XXXX, XXX, XXX−XXX

NANO LETTERS
Cite This: Nano Lett. 2019, 19, 9112−9120
Letter
pubs.acs.org/NanoLett

Smart, Elastic, and Nanofiber-Based 3D Scaffolds with Self-Deploying Capability for Osteoporotic Bone Regeneration

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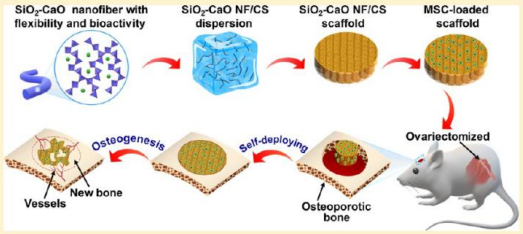
Supporting Information

ABSTRACT: It has been a major challenge to treat osteoporotic bone defects with irregular shapes. Although bioactive glass offers an attractive material for bone regeneration, its inherent brittleness has greatly limited its scope of application. Herein, we report the fabrication of bioactive glass (SiO_2−CaO) nanofibers with excellent flexibility to even allow for 180° bending. The bioactive glass nanofibers could be further assembled into 3D fibrous scaffolds with chitosan serving as the linkers. The scaffolds constructed from an assembly of $85SiO_2$−15CaO nanofibers and chitosan ($85SiO_2$−15CaO NF/CS) possessed significantly better mechanical properties when benchmarked against both $75SiO_2$−25CaO nanofiber- and chitosan-based scaffolds. Moreover, the $85SiO_2$−15CaO NF/CS scaffolds exhibited an elastic behavior, with full recovery from 80% compression and good fatigue resistance over 1000 cycles of compression under water. Upon implantation, the elastic fibrous scaffolds were able to deform and fit irregularly shaped bone defects, followed by a self-deploying behavior to achieve a perfect match with the cavities. When applied to the repair of an osteoporotic calvarial defect in a rat model, the $85SiO_2$−15CaO NF/CS scaffolds showed substantial promotion of bone regrowth and vascularization. This new class of 3D fibrous scaffold provides a promising advancement in engineering smart materials for complex bone repair.



KEYWORDS: *Bioactive glass nanofibers, flexibility, 3D nanofibrous scaffolds, self-deploying capability, osteoporotic bone regeneration*

Repair of complex osteoporotic bone defects remains a huge challenge due to the poor bone remodeling adjacent to implants and delayed new bone formation.[1−3] It has been reported that the occurrence of osteogenesis can induce decreased implant−bone contact dramatically in the cancellous bone area as compared with the normal bones.[4] Therefore, the enhanced primary bone contact and long-term bone integration of implants would favor osteoporotic bone repair significantly. Instead of rigid autograft, allograft, and ceramics, injectable cements have been developed to enable close contact with the host bone via minimally invasive surgery. However, the dense and almost nonporous structure of bone cements blocks cell growth inside and vascularization.[5] Recent evidence supports the superiority of porous engineered scaffolds with shape-recovery capability for graft and stabilization of complex bone defects.[6,7] However, the shape-recovery scaffolds commonly lack an inorganic component and are incapable to mimic the native bone composition.

Bioactive ceramics and bioactive glasses have been universally applied in clinical practice for bone repair owing to strong interfacial bonds between the implants and bones. Among them, bioactive glasses, a kind of Class A bioactive materials, which can promote the formation of a biologically active carbonate hydroxyapatite layer and exhibit excellent bioactivity, osteoconductivity, and osteoinductivity, have been widely employed in orthopedic and dental repair clinically since the 1980s.[8,9] Typically, bioactive glasses are formulated into bulk, granular, and foam forms,[10] which show less resemblance to the nanofibrous architecture of native bone

Received: October 19, 2019
Revised: November 22, 2019
Published: November 25, 2019

DOI: 10.1021/acs.nanolett.9b04313
Nano Lett. 2019, 19, 9112−9120

Anion-Exchange Materials

International Edition: DOI: 10.1002/anie.201814640
German Edition: DOI: 10.1002/ange.201814640

Successful Decontamination of $^{99}TcO_4^-$ in Groundwater at Legacy Nuclear Sites by a Cationic Metal-Organic Framework with Hydrophobic Pockets

Daopeng Sheng[+], Lin Zhu[+], Xing Dai[+], Chao Xu, Peng Li, Carolyn I. Pearce, Chengliang Xiao, Jing Chen, Ruhong Zhou, Tao Duan, Omar K. Farha, Zhifang Chai, and Shuao Wang**

Abstract: *^{99}Tc contamination at legacy nuclear sites is a serious and unsolved environmental issue. The selective remediation of $^{99}TcO_4^-$ in the presence of a large excess of NO_3^- and SO_4^{2-} from natural waste systems represents a significant scientific and technical challenge, since anions with a higher charge density are often preferentially sorbed by traditional anion-exchange materials. We present a solution to this challenge based on a stable cationic metal-organic framework, SCU-102 ($Ni_2(tipm)_3(NO_3)_4$), which exhibits fast sorption kinetics, a large capacity (291 mg g^{-1}), a high distribution coefficient, and, most importantly, a record-high TcO_4^- uptake selectivity. This material can almost quantitatively remove TcO_4^- in the presence of a large excess of NO_3^- and SO_4^{2-}. Decontamination experiments confirm that SCU-102 represents the optimal Tc scavenger with the highest reported clean-up efficiency, while first-principle simulations reveal that the origin of the selectivity is the recognition of TcO_4^- by the hydrophobic pockets of the structure.*

Anionic pollutants are challenging to deal with due to their high environmental mobility, because the majority of natural minerals are either neutral or have a negative net charge.[1] To efficiently remove anionic pollutants from aqueous systems, cationic framework materials that exhibit strong targeted host–guest interaction are highly desirable.[2] Over the past decade, the number of known cationic framework materials has grown exponentially.[3] These materials include, but are not limited to, natural hydrotalcite clays (also known as layered double hydroxides),[4] cationic lanthanide hydroxide,[5] cationic polymeric materials,[6] and cationic metal-organic frameworks (MOFs).[7] For the majority of these materials, the electrostatic interaction dominates the overall host–guest interaction and therefore, anionic guests with a higher charge density are generally more likely to be captured by the cationic framework. This general trend is known as the Hofmeister bias selectivity and the removal of anionic pollutants with low charge is very challenging.[2b–e] Among these, the remediation of $^{99}TcO_4^-$ from contaminated natural water systems is a typical case. In the United States, the contamination of $^{99}TcO_4^-$ in the groundwater at both the Hanford and Savannah river sites is a severe issue and a result of both planned and unplanned discharge of liquid nuclear waste to the subsurface, resulting in concentrations at least one order of magnitude higher than the federal drinking water limit of 900 pCi L^{-1}.[8] This issue remains unsolved, partially due to the fact that TcO_4^- has a low charge density while in the contaminated water systems, anions with higher charge densities such as NO_3^- and SO_4^{2-} often coexist in huge excess. In some cases, anions with an even higher charge density, that is, PO_4^{3-} and SiO_3^{2-}, may also be present.[9] Anion-exchange selectivity is therefore the key parameter to pursue for practical application purposes.

We recently presented two general strategies for building specific types of cationic MOFs to reverse the Hofmeister bias, aiming at a selective TcO_4^- remediation. One is the utilization of a relatively soft-acidic open metal site (for example, Ag^+) that can selectively coordinate to the anions with low charge density during the anion-exchange process.[7b] This strategy, however, faces the severe issue of structural-transformation-induced crystal cracking after the anion

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Supporting information and the ORCID identification number(s) for the author(s) of this article can be found under: https://doi.org/10.1002/anie.201814640.

九、获奖情况

序号	成果编号	成果名称	成果类型	获奖等级	获奖人员
1	2019-F-304-2-01-R01	多元催化剂嵌入法富集去除低浓度 VOCs 增强技术及应用	国家技术发明奖	二等奖	路建美、陈冬赟、李娜君、贺竞辉、张克勤、李爱军
2	2019-J-233-2-01-R01	血液系统疾病出凝血异常诊疗新策略的建立及推广应用	国家科学技术进步奖	二等奖	吴德沛、阮长耿、韩悦、武艺、陈苏宁、黄玉辉、王兆钺、戴克胜、傅建新、赵益明
3	2018-1-43-R1	移植相关性出凝血疾病及其关键机制研究	江苏省科学技术奖	一等奖	韩悦、赵益明、王兆钺、傅建新、戚嘉乾、张翔、唐雅琼、周莉莉、王虹、吴德沛、阮长耿
4	2018-2-2-R1	多模态医学影像处理与分析及其在疾病诊断中的应用	江苏省科学技术奖	二等奖	陈新建、陈浩宇、郑健、朱伟芳、石霏、向德辉
5	2018-3-140-R5	电离辐射所致海马依赖性认知功能障碍的机制研究	江苏省科学技术奖	三等奖	田野、张力元、徐兴顺、王琛、杨红英、谢红、冀胜军
6	2018-216	造血干细胞移植后出凝血异常的发生机制与诊疗新策略研究	教育部科技进步	一等奖	韩悦、傅建新、赵益明、徐杨、唐雅琼、王兆钺、戚嘉乾、陈佳、吴德沛、阮长耿
7	2019-236	肿瘤辐射生物效应作用机制及临床应用	教育部科技进步	二等奖	王忠敏、刘芬菊、丁晓毅、杜杰、黄蔚、杨楠楠、陈克敏、俞家华、陆健
8	2018HGY004	大规模核事故快速高通量生物剂量评价及伤员分类	国防科学技术进步奖	三等	刘玉龙、戴宏、冯骏超、卞华慧、王优优
9	2018HGY004	大规模核事故快速高通量生物剂量评价及伤员分类	中核集团科技奖	三等	刘玉龙、戴宏、冯骏超、卞华慧、王优优

十、内部交叉融合课题

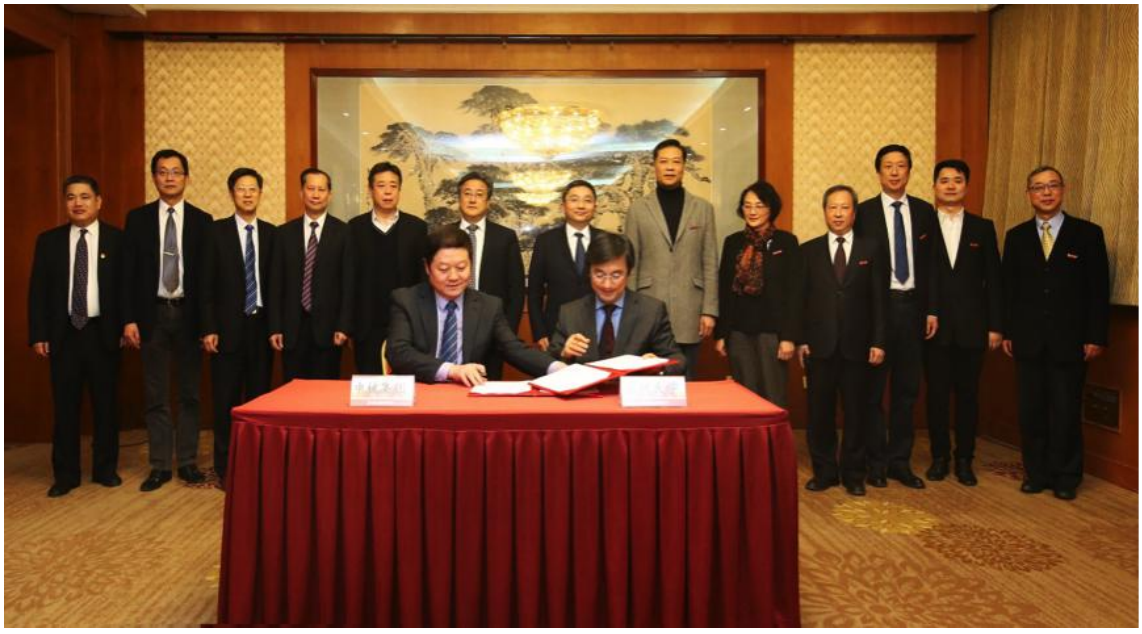
序号	项目编号	申请人	职称	项目名称	资助经费 (万，3 年)
1	GZN1201901	张学光	教授	$^{124}I/^{131}I$ 标记 B7-H3 人源化抗体在人脑胶质瘤生物显像和免疫治疗的实验研究	150
2	GZN1201902	钟志远	教授	钇 90 标记的生物可降解凝胶微球用于肝癌放射栓塞治疗	150
3	GZN1201903	时玉舫	教授	电离辐射诱导间充质干细胞核纤层构象改变在细胞衰老中的生物学效应及机制	150
4	GZN1201904	黄玉辉	教授	基于肿瘤血管正常化和交互增敏模式的新型放射免疫协同治疗策略	150

十一、开放课题

序号	项目编号	类别	负责人	工作单位	课题名称	金额（万）	执行时间
1	GZK1201901	A	刘晓龙	苏州大学附属第二医院	Miwi/piR1851-Lsm4 信号通路在电离辐射诱发精子损伤中的作用及机制研究	5	2019.06-2020.12
2	GZK1201902	A	胡　广	苏州大学基础医学与生物科学学院	基于生物网络的α离子辐射诱导的肺癌发生发展机制的模型构建及应用	5	2019.06-2020.12
3	GZK1201903	A	沈明敬	苏州大学附属第二医院	靶向抑制肿瘤相关巨噬细胞旁分泌 CXCL5 下调 PD-L1 增加肺癌核素放射敏感性的机制研究	5	2019.06-2020.12
4	GZK1201904	A	魏文祥	苏州大学基础医学与生物科学学院	ELP3 的组蛋白乙酰化修饰对肝癌 DNA 损伤修复的作用及其抗辐射的分子机制	5	2019.06-2020.12
5	GZK1201905	A	章　斌	苏州大学附属第一医院	碘标记 RGD-HSA@ABZ 纳米颗粒靶向诊治乳腺癌实验研究	5	2019.06-2020.12
6	GZK1201906	A	王利利	苏州大学附属第一医院	虎杖苷石墨烯水凝胶通过调节肠道细菌 Roseburia 及其代谢产物 5-HIAA 救治肠道放射损伤的研究	5	2019.06-2020.12
7	GZK1201907	A	张子祥	苏州大学附属第一医院	乳铁蛋白通过肠道菌群防治放射性肠损伤	5	2019.06-2020.12
8	GZK1201908	A	王优优	苏州大学附属第二医院	事故致铀中毒患者的遗传效应研究	5	2019.06-2020.12
9	GZK1201909	A	程侠菊	苏州大学生物医学研究所	SPECT/CT 成像引导下的 PD1 小分子抑制剂 PSdis 肿瘤免疫治疗研究	5	2019.06-2020.12
10	GZK1201910	A	谷子（Sophia Gu）	新南威尔士大学	放射性标记的锰基层状双氢氧化物纳米材料用于乳腺癌靶向双模态成像	5	2019.06-2020.12

序号	项目编号	类别	负责人	工作单位	课题名称	金额（万）	执行时间
11	GZK1201911	B	刘鹏飞	江阴市人民医院	PAX2 在食管鳞癌中过表达机制及其对放射敏感性的影响	3	2019.06-2020.12
12	GZK1201912	B	张　积	苏州大学附属第二医院	放射和 PD-1 抗体联合治疗泪腺腺样囊性癌前期评估研究	3	2019.06-2020.12
13	GZK1201913	B	任雪梅	中国科学院合肥物质科学研究院	238U/227Th 与氧化石墨烯联合生物毒性及机理研究	3	2019.06-2020.12
14	GZK1201914	B	杨晓东	苏州大学附属第二医院	HMGB1 作为直肠癌放疗调节靶蛋白及其机制研究	3	2019.06-2020.12
15	GZK1201915	B	文　玲	苏州大学附属第一医院	基于上转换发光分子影像探针的乳腺癌淋巴结转移成像及放射-免疫联合治疗研究	3	2019.06-2020.12
16	GZK1201916	B	张　妤	苏州大学附属第一医院	基于肿瘤微环境响应型金纳米探针的光声/CT 导航下肿瘤放疗增敏研究	3	2019.06-2020.12
17	GZK1201917	B	张　勇	潍坊医学院	用于核应急和医学辐射伤害的膏剂的研究	3	2019.06-2020.12
18	GZK1201918	B	陆赛全	复旦大学附属肿瘤医院	基于一项随机、多中心、三期临床试验数据的食管癌放射治疗中正常肺组织放射性剂量与肺毒性相关性研究	3	2019.06-2020.12
19	GZK1201919	B	汤在祥	苏州大学医学部公共卫生学院	基于泛癌症图谱的放疗敏感性基因挖掘方法与相关基因验证研究	3	2019.06-2020.12
20	GZK1201920	B	吴曙华	苏州大学附属第二医院	DNA-PKcs 参与 DNA 损伤偶联的细胞有丝分裂进程调控机制研究	3	2019.06-2020.12

十二、2019 大事记



1 月 22 日，与中国核工业集团签署战略合作框架协议

3 月 11 日，苏州市政协主席周伟强一行调研考察

3 月 11 日，独墅湖医院质子治疗加速器研讨会在苏州大学成功召开

3 月 21 日，中核集团领导一行来苏大放医国家重点实验室交流

4 月 10 日，“身在辐中，安全为重”——辐射安全文化宣传月活动启动仪式

4 月 22 日，苏州大学—瓦里安医疗“放疗新星”启航仪式

4 月 30 日，与苏州市人民政府、中国广核集团签署战略合作框架协议

4 月 30 日，质子肿瘤治疗国产化及临床应用研究中心揭牌

5 月 11 日，身临辐境”—放射医学与辐射防护国家重点实验室开放日

5 月 17 日-18 日，放射医学与辐射防护行业联盟成立

5 月 18 日，第一届苏州大学放射生物学研讨会

5 月 26 日，“身临辐境”放射医学与辐射防护国家重点实验室公众开放日

6 月 19 日，苏州大学放射医学及交叉学科第七届战略发展研讨会

7 月 12 日，靶向放射性药物创新与转化中心成立

9 月 12 日，苏大放医与中国同辐股份有限公司签约

9 月 18 日，不负使命与核同行”——苏州大学全国科普日系列活动“两弹一星”精神和核工业精神宣讲会

10 月 31 日至 11 月 1 日，“放射化学学科人才发展战略研讨会”

10 月 27 日至 11 月 1 日，亚洲核合作论坛（FNCA）“2019 年 FNCA 肿瘤放疗研讨会”

11 月 2 日，放射医学与辐射防护国家重点实验室第一届学术委员会　第二次会议暨学术交流会

11 月 13 日至 14 日，中国同辐-苏大放医-苏大附二院第一届学术研讨会暨放射医学与辐射防护行业联盟第一届学术研讨会

11 月 20 日，放射医学协同创新中心 2019 年推进会议

12 月 2 日，日本广岛大学—苏州大学放射医学与核应急双边研讨会

十三、科普活动

讲座1 蒋芸 主任

讲座2 涂彧 教授

讲座3 陈肖华 研究员

讲座4 陈洋宙 工程师

模拟放射性核素I-125洒落

通知人员按指定路线撤离

检查体表有无污染

标明核素洒落位置；进行表面污染测定；去污处理

4 月，“身在辐中，安全为重”—辐射安全文化宣传月活动。本次活动包含“辐射安全系列讲座”、“辐射安全事故应急演练”“辐射安全文化海报”等环节，参与人数近 1000 人。

5 月，“身临辐境”放射医学与辐射防护国家重点实验室开放日。本次活动邀请了苏州工业园区星海中学师生，以及社会公众共计 300 人，活动包含开幕式、“历史中的璀璨核星”核发展史的介绍、“核在我身边”核技术应用展览、“走进核科学前沿”互动活动、趣味实验环节。

7月，放射医学与辐射防护国家重点实验室暑期夏令营。本次活动主要内容有：邀请全国各地优秀本科生参与学院夏令营（“走进来”）以及我院学生参加全国各地行业内夏令营（“走出去”），如广西辐卫安夏令营、山东大华中测夏令营、上海仁机夏令营、北京华克夏令营、泰和城新加坡夏令营。

核科学知识科普讲座海报

9月，“不负使命、与核同行”—弘扬核科学精神及应用科普系列活动。本次活动主要内容有：核科学应用展、动感校园行、核科学知识科普讲座、“两弹一星”精神和核工业精神宣讲报告会、弘扬核科学精神电影展、放射医学与辐射防护科普教育基地主题曲及吉祥物征集大赛。本次活动参与人数达6870人。

十四、存在问题

1）根据实验室建设规划，实验场所应集中整体布局。经过 5 年建设，重点实验室用房将达 20,000 平方米。然而，目前实验室用房面积只有 16000 平方米左右，用房依然紧张，严重影响实验室调整和改造进度。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。目前开放式的放射性实验楼蕴藏着极大风险。

2）重点实验室科研成果原创性有待加强，基础研究应加强与国家重大需求的结合。期望在新的一年里，各类项目的申请能够更上一层楼，发表高水平论文，取得重要有显示度的成果。

3）高水平人才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。

4）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。

5）实验室重器欠缺。目前质子重离子肿瘤治疗装置处于关键时刻，这不仅关系到未来的战略发展规划、更关系到苏大总医院未来的地位。质子肿瘤治疗装置既是当前国际放射医学的前沿，也是重点实验室的重器，同时可使苏大总医院立于全国之巅。