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2022 年物理学学科研究前沿

2023-第 09 期

科学研究的世界呈现出蔓延生长、不断演化的景象。科研管理者和政策制定者需要掌握科研的进展和动态，以有限的资源来支持和推进科学进步。对于他们而言，洞察科研动向、尤其是跟踪新兴专业领域对其工作具有重大的意义。

科睿唯安通过持续跟踪全球最重要的科研和学术论文，研究分析论文被引用的模式和聚类，通过揭示成簇的高被引论文共同被引用的活跃度和频率来反映研究前沿。

本期快报结合中国科学院科技战略咨询研究院、中国科学院文献情报中心及科睿唯安联合发布的《2022 研究前沿》，介绍了物理学学科领域的部分研究前沿。

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《2022 研究前沿》¹报告的结论指出：物理学领域的热点前沿主要集中于凝聚态物理、高能物理和理论物理；其中，凝聚态物理方向的热点前沿有 5 个，分别为笼目晶格金属、磁性拓扑绝缘体 MnBi_2Te_4 、高效金属卤化物钙钛矿发光二极管、非厄米系统的拓扑态、高压下富氢化合物的高温超导电性；高能物理方向的热点前沿有 3 个，分别为 μ 子反常磁矩的测量、味对称性与轻子质量、四夸克和五夸克态奇特强子；理论物理方向的热点前沿有 2 个，分别为聚焦量子场论中的散射振幅研究和绝对平行引力理论。

其中，**高效金属卤化物钙钛矿发光二极管**是首次出现的热点前沿，本次快报重点对其进行介绍。



2022 该领域研究前沿相关报道

发光二极管 (LED) 是一种半导体光电子器件，具有能耗低、寿命长、体积小、可靠性高、显色丰富等优点，目前广泛应用于照明、显示、节能等领域。随着人们对照明和显示设备的需求不断提高，新的发光材料和器件的研发受到广泛关注。近年来，金属卤化物钙钛矿材料因其优异的光电性能，成为新兴的发光材料，金属卤化物钙钛矿发光二极管也成为研究热点前沿领域。

2014 年，剑桥大学等报道了首个室温下电致发光的金属卤化物钙钛矿发光二极管，引发了金属卤化物钙钛矿发光二极管的研究热潮。外量子效率是衡量发光二极管光电转换效率的重要标准，经过多年的发展，近红外、红光和绿光金属卤化物钙钛矿发光二极管的外量子效率都已突破 20%。然而，蓝光金属卤化物钙钛矿发光二极管的外量子效率还有待进一步的提升，因此，蓝光金属卤化物钙钛矿发光二极管近年来获得了深入的研究，其外量子效率正在不断提高。

¹ 《2022 研究前沿》下载地址：https://mp.weixin.qq.com/s/D4nOmSi9PdBcV_xfVpsHPg



该领域前沿论文推荐

利用 ESI 数据库的 “Research Fronts” ，从 Physics 领域的 1081 个研究前沿中筛选出与高效金属卤化物钙钛矿发光二极管相关性最高的 5 个前沿。

前沿 1: TWO-DIMENSIONAL ORGANIC-INORGANIC HYBRID RARE-EARTH DOUBLE PEROVSKITE FERROELECTRICS;TWO-DIMENSIONAL ORGANIC-INORGANIC HYBRID DOUBLE PEROVSKITE FERROELASTIC;CHIRAL 2D ORGANIC INORGANIC HYBRID PEROVSKITE;TWO-DIMENSIONAL HYBRID IODIDE DOUBLE PEROVSKITE (4);HYBRID RARE-EARTH DOUBLE PEROVSKITE RELAXOR FERROELECTRICS

前沿 2: SPECTRA STABLE BLUE PEROVSKITE LIGHT-EMITTING DIODES;EFFICIENT SKY-BLUE PEROVSKITE LIGHT-EMITTING DIODES;HIGH-PERFORMANCE BLUE PEROVSKITE LIGHT-EMITTING DIODES ENABLED;QUASI-TWO-DIMENSIONAL BLUE PEROVSKITE LIGHT-EMITTING DIODES;COLOR-STABLE HIGHLY LUMINESCENT SKY-BLUE PEROVSKITE LIGHT-EMITTING DIODES

前沿 3: HIGH-PERFORMANCE INORGANIC METAL HALIDE PEROVSKITE TRANSISTORS;HALIDE PEROVSKITES;ENGINEERING COPPER IODIDE (CUI);MULTIFUNCTIONAL P-TYPE TRANSPARENT SEMICONDUCTORS;ELECTRICAL DOPING

前沿 4: STABLE ROOM-TEMPERATURE CONTINUOUS-WAVE LASING;CONTINUOUS-WAVE LASING;ORGANIC-INORGANIC LEAD HALIDE PEROVSKITE SEMICONDUCTOR;EFFICIENT PEROVSKITE LIGHT-EMITTING DIODES;QUASI-2D PEROVSKITE FILMS

前沿 5: MIXED-HALIDE PEROVSKITE LEDS;STRONGLY CONFINED PEROVSKITE QUANTUM DOTS;PEROVSKITE NANOCRYSTALS;BLUE LEDS BASED;COMPREHENSIVE DEFECT SUPPRESSION

下表是上述前沿中筛选出来的该领域中近年来代表性的 5 篇前沿论文。

序号	标题	作者	出处	研究机构	出版年
1	HIGH-PERFORMANCE BLUE PEROVSKITE LIGHT-EMITTING DIODES ENABLED BY EFFICIENT ENERGY TRANSFER BETWEEN	REN, ZW;YU, JH;QIN, ZT;WANG, J;SUN,	ADVANCED MATERIALS 33 (1): - JAN 2021	CHINESE UNIVERSITY OF HONG KONG;UNIVERSITY OF HONG KONG;SOUTHERN UNIVERSITY OF SCIENCE & TECHNOLOGY;SOOCHOW UNIVERSITY - CHINA;etc	2021

	COUPLED QUASI-2D PEROVSKITE LAYERS	JY;CHAN, CCS;			
2	REARRANGING LOW-DIMENSIONAL PHASE DISTRIBUTION OF QUASI-2D PEROVSKITES FOR EFFICIENT SKY-BLUE PEROVSKITE LIGHT-EMITTING DIODES	PANG, PY;JIN, GR;LIAN G, ;WANG , BZ	ACS NANO 14 (9): 11420-11430 SEP 22 2020	HUAZHONG UNIVERSITY OF SCIENCE & TECHNOLOGY;UNIVERSITY OF MACAU;SOUTH CHINA UNIVERSITY OF TECHNOLOGY;	2020
3	LARGE CATION ETHYLAMMONIUM INCORPORATED PEROVSKITE FOR EFFICIENT AND SPECTRA STABLE BLUE LIGHT-EMITTING DIODES	CHU, ZM;ZHAO , Y;MA, F;ZHANG, CX;DENG , HX	NATURE COMMUNICATIONS 11 (1): - AUG 20 2020	CHINESE ACADEMY OF SCIENCES;UNIVERSITY OF CHINESE ACADEMY OF SCIENCES, CAS;INSTITUTE OF SEMICONDUCTORS, CAS;	2020
4	TRIPLET MANAGEMENT FOR EFFICIENT PEROVSKITE LIGHT-EMITTING DIODES	QIN, CJ;MATS USHIMA, T;POTSC AVAGE, WJ	NATURE PHOTONICS 14 (2): 70+ FEB 2020	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE (CNRS);UNIVERSITES DE STRASBOURG ETABLISSEMENTS ASSOCIES;UNIVERSITE DE STRASBOURG;UDICE-FRENCH RESEARCH UNIVERSITIES;SORBONNE UNIVERSITE;LEAGUE EUROPEAN RES UNIV LERU;etc	2020

5	COMPREHENSIVE DEFECT SUPPRESSION IN PEROVSKITE NANOCRYSTALS FOR HIGH-EFFICIENCY LIGHT-EMITTING DIODES	KIM, YH;KIM, S;KAKEK HANI, A	NATURE PHOTONICS 15 (2): 148-155 FEB 2021	HARBIN INSTITUTE OF TECHNOLOGY;UNIVERSITY OF VALENCIA;UNIVERSITY OF TENNESSEE SYSTEM;UNIVERSITY OF TENNESSEE KNOXVILLE;UNIVERSITY OF PENNSYLVANIA;etc	2021
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该领域 ESI 热点论文推荐

在 Web of Science 中，构建检索式 $TI=(Perovskite) AND (TI=(LED) OR TI=(LIGHT-EMITTING DIODES) OR TI=(LIGHT EMITTING DIODES))$ 。截止 2023 年 4 月 4 日，共有 7565 条检索结果。在这些结果中，发文量最多的机构见下表。

机构名称	发文数
CHINESE ACADEMY OF SCIENCES	447
CHINESE ACAD SCI	316
UNITED STATES DEPARTMENT OF ENERGY DOE	178
SOOCHOW UNIVERSITY CHINA	152
JILIN UNIVERSITY	139
SOOCHOW UNIV	132
JILIN UNIV	124
SWISS FEDERAL INSTITUTES OF TECHNOLOGY DOMAIN	123
UNIVERSITY OF CHINESE ACADEMY OF SCIENCES CAS	117
INDIAN INSTITUTE OF TECHNOLOGY SYSTEM IIT SYSTEM	110
ZHENGZHOU UNIVERSITY	105
HUAZHONG UNIVERSITY OF SCIENCE TECHNOLOGY	100
UNIV CHINESE ACAD SCI	100
UNIVERSITY OF CAMBRIDGE	98
NANYANG TECHNOLOGICAL UNIVERSITY	94

筛选其中 2020 年以来的热点论文，共有 8 篇，具体详情如下：

1.标题: Perovskite light-emitting diodes

作者: Fakharuddin, A (Fakharuddin, Azhar); Gangishetty, MK (Gangishetty, Mahesh K.); Abdi-Jalebi, M (Abdi-Jalebi, Mojtaba); Chin, SH (Chin, Sang-Hyun); Yusoff, AB (Yusoff, Abd Rashid bin Mohd); Congreve, DN (Congreve, Daniel N.); Tress, W (Tress,

Wolfgang); Deschler, F (Deschler, Felix); Vasilopoulou, M (Vasilopoulou, Maria); Bolink, HJ (Bolink, Henk J.)

来源出版物: NATURE ELECTRONICS **卷:** 5 **期:** 4 **页:** 203-216 **DOI:** 10.1038/s41928-022-00745-7 **提前访问日期:** APR 2022 **出版年:** APR 2022

被引频次合计: 56

入藏号: WOS:000784602200002

2.标题: Comprehensive defect suppression in perovskite nanocrystals for high-efficiency light-emitting diodes

作者: Kim, YH (Kim, Young-Hoon); Kim, S (Kim, Sungjin); Kakekhani, A (Kakekhani, Arvin); Park, J (Park, Jinwoo); Park, J (Park, Jaehyeok); Lee, YH (Lee, Yong-Hee); Xu, HX (Xu, Hengxing); Nagane, S (Nagane, Satyawan); Wexler, RB (Wexler, Robert B.); Kim, DH (Kim, Dong-Hyeok); Jo, SH (Jo, Seung Hyeon); Martinez-Sarti, L (Martinez-Sarti, Laura); Tan, P (Tan, Peng); Sadhanala, A (Sadhanala, Aditya); Park, GS (Park, Gyeong-Su); Kim, YW (Kim, Young-Woon); Hu, B (Hu, Bin); Bolink, HJ (Bolink, Henk J.); Yoo, S (Yoo, Seunghyup); Friend, RH (Friend, Richard H.); Rappe, AM (Rappe, Andrew M.); Lee, TW (Lee, Tae-Woo)

来源出版物: NATURE PHOTONICS **卷:** 15 **期:** 2 **页:** 148-155 **DOI:** 10.1038/s41566-020-00732-4 **提前访问日期:** JAN 2021 **出版年:** FEB 2021

被引频次合计: 381

入藏号: WOS:000604898500002

3.标题: High-performance quasi-2D perovskite light-emitting diodes: from materials to devices

作者: Zhang, L (Zhang, Li); Sun, CJ (Sun, Changjiu); He, TW (He, Tingwei); Jiang, YZ (Jiang, Yuezhi); Wei, JL (Wei, Junli); Huang, YM (Huang, Yanmin); Yuan, MJ (Yuan, Mingjian)

来源出版物: LIGHT-SCIENCE & APPLICATIONS **卷:** 10 **期:** 1 **文献号:** 61 **DOI:** 10.1038/s41377-021-00501-0 **出版年:** MAR 19 2021

被引频次合计: 109

入藏号: WOS:000630737600001

4.标题: Suppression of temperature quenching in perovskite nanocrystals for efficient and thermally stable light-emitting diodes

作者: Liu, MM (Liu, Mingming); Wan, Q (Wan, Qun); Wang, HM (Wang, Huamiao); Carulli, F (Carulli, Francesco); Sun, XC (Sun, Xiaochuan); Zheng, WL (Zheng, Weilin); Kong, L (Kong, Long); Zhang, Q (Zhang, Qi); Zhang, CY (Zhang, Congyang); Zhang, QG (Zhang, Qinggang); Brovelli, S (Brovelli, Sergio); Li, L (Li, Liang)

来源出版物: NATURE PHOTONICS **卷:** 15 **期:** 5 **页:** 379-385 **DOI:** 10.1038/s41566-021-00766-2 **提前访问日期:** MAR 2021 **出版年:** MAY 2021

被引频次合计: 139

入藏号: WOS:000623840900002

5.标题: Perovskite Light-Emitting Diodes with EQE Exceeding 28% through a Synergetic Dual-Additive Strategy for Defect Passivation and Nanostructure Regulation

作者: Liu, Z (Liu, Zhe); Qiu, WD (Qiu, Weidong); Peng, XM (Peng, Xiaomei); Sun, GW (Sun, Guanwei); Liu, XY (Liu, Xinyan); Liu, DH (Liu, Denghui); Li, ZC (Li, Zhenchao); He, FR (He, Fangru); Shen, CY (Shen, Chenyang); Gu, Q (Gu, Qing); Ma, FL (Ma, Fulong); Yip, L (Yip, Hin-Lap); Hou, LT (Hou, Lintao); Qi, ZJ (Qi, Zhengjian); Su, SJ (Su, Shi-Jian)

来源出版物: ADVANCED MATERIALS **卷:** 33 **期:** 43 **文献**

号: 2103268 **DOI:** 10.1002/adma.202103268 **提前访问日期:** SEP 2021 **出版年:** OCT 2021

被引频次合计: 159

入藏号: WOS:000697331500001

6.标题: Origins and influences of metallic lead in perovskite solar cells

作者: Liang, JW (Liang, Jiwei); Hu, XZ (Hu, Xuzhi); Wang, C (Wang, Chen); Liang, C (Liang, Chao); Chen, C (Chen, Cong); Xiao, M (Xiao, Meng); Li, JS (Li, Jiashuai); Tao, C (Tao, Chen); Xing, GC (Xing, Guichuan); Yu, R (Yu, Rui); Ke, WJ (Ke, Weijun); Fang, GJ (Fang, Guojia)

来源出版物: JOULE **卷:** 6 **期:** 4 **页:** 816-833 **DOI:** 10.1016/j.joule.2022.03.005 **提前访问日期:** APR 2022 **出版年:** APR 20 2022

被引频次合计: 43

入藏号: WOS:000798575600013

7.标题: Lead halide-templated crystallization of methylamine-free perovskite for efficient photovoltaic modules

作者: Bu, TL (Bu, Tongle); Li, J (Li, Jing); Li, HY (Li, Hengyi); Tian, CC (Tian, Congcong); Su, J (Su, Jie); Tong, GQ (Tong, Guoqing); Ono, LK (Ono, Luis K.); Wang, C (Wang, Chao); Lin, ZP (Lin, Zhipeng); Chai, NAY (Chai, Nian Yao); Zhang, XL (Zhang, Xiao-Li); Chang, JJ (Chang, Jingjing); Lu, JF (Lu, Jianfeng); Zhong, J (Zhong, Jie); Huang, WC (Huang, Wenchao); Qi, YB (Qi, Yabing); Cheng, YB (Cheng, Yi-Bing); Huang, FZ (Huang, Fuzhi)

来源出版物: SCIENCE 卷: 372 期: 6548 特刊: SI 页: 1327-

DOI: 10.1126/science.abh1035 出版年: JUN 18 2021

被引频次合计: 176

入藏号: WOS:000665616000032

8.标题: Optimized carrier extraction at interfaces for 23.6% efficient tin-lead perovskite solar cells

作者: Hu, SF (Hu, Shuaifeng); Otsuka, K (Otsuka, Kento); Murdey, R (Murdey, Richard); Nakamura, T (Nakamura, Tomoya); Truong, MA (Minh Anh Truong); Yamada, T (Yamada, Takumi); Handa, T (Handa, Taketo); Matsuda, K (Matsuda, Kazuhiro); Nakano, K (Nakano, Kyohei); Sato, A (Sato, Atsushi); Marumoto, K (Marumoto, Kazuhiro); Tajima, K (Tajima, Keisuke); Kanemitsu, Y (Kanemitsu, Yoshihiko); Wakamiya, A (Wakamiya, Atsushi)

来源出版物: ENERGY & ENVIRONMENTAL SCIENCE 卷: 15 期: 5 页: 2096-

2107 DOI: 10.1039/d2ee00288d 提前访问日期: APR 2022 出版年: MAY 18 2022

被引频次合计: 53

该领域东大相关研究

东大相关研究论文共有 65 篇, 其中高被引论文 9 篇, 热点论文 1 篇, 高被引和热点论文具体详情如下:

1.标题: A Universal Ternary-Solvent-Ink Strategy toward Efficient Inkjet-Printed Perovskite Quantum Dot Light-Emitting Diodes

作者: Wei, CT (Wei, Changting); Su, WM (Su, Wenming); Li, JT (Li, Jiantong); Xu, B (Xu, Bo); Shan, QS (Shan, Qingsong); Wu, Y (Wu, Ye); Zhang, FJ (Zhang, Fengjuan); Luo,



MM (Luo, Manman); Xiang, HY (Xiang, Hengyang); Cui, Z (Cui, Zheng); Zeng, HB (Zeng, Haibo)

来源出版物: ADVANCED MATERIALS **卷:** 34 **期:** 10 **文献**

号: 2107798 **DOI:** 10.1002/adma.202107798 **提前访问日期:** JAN 2022 **出版年:** MAR 2022

被引频次合计: 34

入藏号: WOS:000748794900001

2.标题: Perovskite Light-Emitting Diodes with EQE Exceeding 28% through a Synergetic Dual-Additive Strategy for Defect Passivation and Nanostructure Regulation

作者: Liu, Z (Liu, Zhe); Qiu, WD (Qiu, Weidong); Peng, XM (Peng, Xiaomei); Sun, GW (Sun, Guanwei); Liu, XY (Liu, Xinyan); Liu, DH (Liu, Denghui); Li, ZC (Li, Zhenchao); He, FR (He, Fangru); Shen, CY (Shen, Chenyang); Gu, Q (Gu, Qing); Ma, FL (Ma, Fulong); Yip, L (Yip, Hin-Lap); Hou, LT (Hou, Lintao); Qi, ZJ (Qi, Zhengjian); Su, SJ (Su, Shi-Jian)

来源出版物: ADVANCED MATERIALS **卷:** 33 **期:** 43 **文献**

号: 2103268 **DOI:** 10.1002/adma.202103268 **提前访问日期:** SEP 2021 **出版年:** OCT 2021

被引频次合计: 159

入藏号: WOS:000697331500001

3.标题: A lead-halide perovskite molecular ferroelectric semiconductor

作者: Liao, WQ (Liao, Wei-Qiang); Zhang, Y (Zhang, Yi); Hu, CL (Hu, Chun-Li); Mao, JG (Mao, Jiang-Gao); Ye, HY (Ye, Heng-Yun); Li, PF (Li, Peng-Fei); Huang, SPD (Huang, Songping D.); Xiong, RG (Xiong, Ren-Gen)

来源出版物: NATURE COMMUNICATIONS **卷:** 6 **文献**

号: 7338 **DOI:** 10.1038/ncomms8338 **出版年:** MAY 2015

被引频次合计: 490

入藏号: WOS:000355540900001

4.标题: Low-bandgap mixed tin-lead iodide perovskite absorbers with long carrier lifetimes for all-perovskite tandem solar cells

作者: Zhao, DW (Zhao, Dewei); Yu, Y (Yu, Yue); Wang, CL (Wang, Changlei); Liao, WQ (Liao, Weiqiang); Shrestha, N (Shrestha, Niraj); Grice, CR (Grice, Corey R.); Cimaroli, AJ (Cimaroli, Alexander J.); Guan, L (Guan, Lei); Ellingson, RJ (Ellingson, Randy J.); Zhu, K (Zhu, Kai); Zhao, XZ (Zhao, Xingzhong); Xiong, RG (Xiong, Ren-Gen); Yan, YF (Yan, Yanfa)

来源出版物: NATURE ENERGY **卷:** 2 **期:** 4 **文献**

号: 17018 **DOI:** 10.1038/nenergy.2017.18 **出版年:** APR 2017

被引频次合计: 543

入藏号: WOS:000402829300001

5.标题: A molecular perovskite solid solution with piezoelectricity stronger than lead zirconate titanate

作者: Liao, WQ (Liao, Wei-Qiang); Zhao, DW (Zhao, Dewei); Tang, YY (Tang, Yuan-Yuan); Zhang, Y (Zhang, Yi); Li, PF (Li, Peng-Fei); Shi, PP (Shi, Ping-Ping); Chen, XG (Chen, Xiao-Gang); You, YM (You, Yu-Meng); Xiong, RG (Xiong, Ren-Gen)

来源出版物: SCIENCE **卷:** 363 **期:** 6432 **特刊:** SI **页:** 1206-

+ **DOI:** 10.1126/science.aav3057 **出版年:** MAR 15 2019

被引频次合计: 317

入藏号: WOS:000461329000046

6.标题: Observation of Vortex Domains in a Two-Dimensional Lead Iodide Perovskite Ferroelectric

作者: Zhang, HY (Zhang, Han-Yue); Song, XJ (Song, Xian-Jiang); Chen, XG (Chen, Xiao-Gang); Zhang, ZX (Zhang, Zhi-Xu); You, YM (You, Yu-Meng); Tang, YY (Tang, Yuan-Yuan); Xiong, RG (Xiong, Ren-Gen)

来源出版物: JOURNAL OF THE AMERICAN CHEMICAL

SOCIETY **卷:** 142 **期:** 10 **页:** 4925-4931 **DOI:** 10.1021/jacs.0c00371 **出版年:** MAR 11 2020

被引频次合计: 109

入藏号: WOS:000526392200050

7.标题: Fabrication of Efficient Low-Bandgap Perovskite Solar Cells by Combining Formamidinium Tin Iodide with Methylammonium Lead Iodide

作者: Liao, WQ (Liao, Weiqiang); Zhao, DW (Zhao, Dewei); Yu, Y (Yu, Yue); Shrestha, N (Shrestha, Niraj); Ghimire, K (Ghimire, Kiran); Grice, CR (Grice, Corey R.); Wang, CL (Wang, Changlei); Xiao, YQ (Xiao, Yuqing); Cimaroli, AJ (Cimaroli, Alexander J.); Ellingson, RJ (Ellingson, Randy J.); Podraza, NJ (Podraza, Nikolas J.); Zhu, K (Zhu, Kai); Xiong, RG (Xiong, Ren-Gen); Yan, YF (Yan, Yanfa)

来源出版物: JOURNAL OF THE AMERICAN CHEMICAL

SOCIETY **卷:** 138 **期:** 38 **页:** 12360-12363 **DOI:** 10.1021/jacs.6b08337 **出版年:** SEP 28 2016

被引频次合计: 300

入藏号: WOS:000384518400015

8.标题: The First 2D Homochiral Lead Iodide Perovskite Ferroelectrics: [R- and S-1-(4-Chlorophenyl)ethylammonium](2)PbI₄

作者: Yang, CK (Yang, Chen-Kai); Chen, WN (Chen, Wang-Nan); Ding, YT (Ding, Yan-Ting); Wang, J (Wang, Jing); Rao, Y (Rao, Yin); Liao, WQ (Liao, Wei-Qiang); Tang, YY (Tang, Yuan-Yuan); Li, PF (Li, Peng-Fei); Wang, ZX (Wang, Zhong-Xia); Xiong, RG (Xiong, Ren-Gen)

来源出版物: ADVANCED MATERIALS **卷:** 31 **期:** 16 **文献**

号: 1808088 **DOI:** 10.1002/adma.201808088 **出版年:** APR 19 2019

被引频次合计: 205

入藏号: WOS:000468005400016

9.标题: Lead-Free Inverted Planar Formamidinium Tin Triiodide Perovskite Solar Cells Achieving Power Conversion Efficiencies up to 6.22%

作者: Liao, WQ (Liao, Weiqiang); Zhao, DW (Zhao, Dewei); Yu, Y (Yu, Yue); Grice, CR (Grice, Corey R.); Wang, CL (Wang, Changlei); Cimaroli, AJ (Cimaroli, Alexander J.); Schulz, P (Schulz, Philip); Meng, WW (Meng, Weiwei); Zhu, K (Zhu, Kai); Xiong, RG (Xiong, Ren-Gen); Yan, YF (Yan, Yanfa)

来源出版物: ADVANCED MATERIALS **卷:** 28 **期:** 42 **页:** 9333-

+ **DOI:** 10.1002/adma.201602992 **出版年:** NOV 9 2016

被引频次合计: 519

入藏号: WOS:000391174600009