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目 录

论文编号：12–001

高性能量子点电致发光器件

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摘要正文：

在过去几年中，量子点发光二极管原型器件的效率和寿命取得了巨大的进步，预示着以量子点发光二极管为基础的印刷显示技术有希望应用于新一代的低成本、大面积、节能、高色域、超薄柔性显示器件。[1] 我们课题组从量子点电致发光器件的机理入手，理解器件中激子形成和复合等基元过程，研究与器件寿命相关的原位化学过程，在此基础上针对性的发展载流子传输层的材料化学，设计新型器件结构，从而最终实现高性能电致发光器件。[2-7]

关键词：量子点；电致发光；激子

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论文编号：12–002

钙钛矿量子点的原位制备与集成应用研究

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摘要正文：

量子点具有光谱可调、溶液加工等特点，是备受关注的新一代光学材料，已经在照明显示、传感探测、太阳能电池、激光等领域展现出应用前景。近年来，钙钛矿量子点的出现，为发展量子点集成应用技术提供了机遇[1]。针对光电集成应用需求，我们发明了钙钛矿量子点的原位制备技术[2-3]，利用钙钛矿材料的溶液加工特性，通过引入聚合物或者有机分子配体控制结晶过程，在聚合物基质中直接制备出量子点[3-6]，或者在ITO基片上控制形核和生长过程直接制备量子点薄膜[7-9]，在此基础上开展了量子点的显示和传感应用探索。本报告将介绍实验室在这一方向取得的部分进展。

关键词：量子点；钙钛矿；电致发光；光致发光；探测传感

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论文编号：12–003

高温固态合成钙钛矿纳米晶

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摘要正文：

钙钛矿纳米晶具备半峰宽窄，发光波长可调，发光效率高等优异性能。目前液相合成法是钙钛矿纳米晶的主要合成方法。液相合成法的优势在于合成的纳米晶形貌可控且易于加工，制备的纳米晶荧光量子效率高，但其在合成和纯化过程中使用众多有机试剂，危害技术人员健康的同时亦对生态环境造成威胁。固态合成是传统荧光粉合成的主要方法，优势是在于合成成本低，合成过程绿色环保，而且产品信耐性远高于半导体纳米晶。因此，我们提出一个问题：是否可以象合成传统荧光粉一样利用高温固相法来合成钙钛矿纳米晶？

我们首先借鉴冶金过程的高温熔融析晶法，采用 SrX_2（X=Cl, Br, I）作为熔融介质，将其与卤素钙钛矿前体高温共融，通过熔融析晶在 $SrBr_2$ 介质内部生长 $CsPbBr_3$ 纳米晶，但因 $SrBr_2$ 是离子型化合物，对环境中的水氧较为敏感，所获得的 $CsPbBr_3$ 纳米晶复合物稳定性有限；而后以异丙醇铝作为前体，通过高温分解原位生成介孔 Al_2O_3 限域生长钙钛矿纳米晶，成功实现百克级 $CsPbX_3$ 纳米晶的一次性绿色合成。获得的 $CsPbBr_3$ 纳米晶荧光发射峰为 518 nm、半峰宽为 25 nm，光致发光量子产率可达 70%。该法合成的 $CsPbBr_3$-Al_2O_3 纳米晶拥有良好的热稳定性，300℃高温加热 12 h 后，仍保持原始发光量子产率的 80%以上，但由于 Al_2O_3 模板存在针孔，会导致外部水氧透过模板致使 $CsPbBr_3$ 纳米晶发生离解，环境稳定性不够。最后我们在高温（600-900℃）下将钙钛矿纳米晶沉积于分子筛孔道，然后巧妙地利用多孔分子筛高温坍塌的现象将纳米晶封装于致密的纳米二氧化硅载体。制备的 $CsPbBr_3$-SiO_2 不仅具有较高的光致发光量子产率（~71%），而且具有与 $Sr_2SiO_4:Eu^{2+}$ 绿色荧光粉相当的稳定性。

关键词：钙钛矿纳米晶；高温固相合成；稳定性

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金属卤化物发光材料及X射线探测应用

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摘要正文：

金属卤素钙钛矿由于具有缺陷容忍、高发光效率等突出优点，在辐射探测（X射线，gamma射线）领域崭露头角。但其水氧稳定性及铅毒性等仍制约其实际应用，开发具有高稳定性的新型非铅卤化物发光材料，对推动钙钛矿辐射探测器的实用化具有重大研究价值。本报告将介绍近期在非铅铜基、锡基卤化物材料探索、物性调控、X射线探测方面的研究进展，主要包括新型X射线闪烁体材料Rb_2CuBr_3、Rb_2CuCl_3，以及$Cs_2SnTeCl_6$合金化发光材料。

关键词：非铅卤化物；自限域激子发光；X射线探测

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论文编号：12–004

Metal halide emitters and application in X-ray scintillation

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Metal halide perovskite have attracted a lot of attentions in the field of X-ray and gamma ray detection, considering their excellent defect tolerance and high carrier collection efficiency. However, the moisture stability and lead toxicity have severely restricted their practical applications. Developing metal halides with high stability and non-toxic compositions is significant for this field. This talk will introduce our work on synthesizing the new materials of copper halides and tin halides emitters, as well as their application in X-ray scintillations.

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Controlled Anisotropic Epitaxy for CdSe@CdS Dot@Platelet Nanocrystals:

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Abstract：

Nanocrystals with different dimensional confinements have shown many interesting properties.[1-2] However, the anisotropic growth has only been realized in limited systems and the control mechanisms are unclear[3-5]. Here, wurtzite CdSe@CdS dot@platelet nanocrystals—a dot-shaped CdSe nanocrystal encased within an epitaxially-grown CdS nanoplatelet—are controllably synthesized with nearly monodisperse size/shape distribution and outstanding photoluminescence (PL) properties. The excellent size/shape control with their lateral to thickness dimension ratio up to 3 to 1 is achieved by systematically studying the synthetic parameters, which results in a simple, tunable yet reproducible epitaxy scheme. This special type of core/shell nanocrystals possess two-dimensional emission dipole with the ab plane of the wurtzite structure. While their near-unity PL quantum yield and mono-exponential PL decay dynamics are at the same level of the-state-of-art CdSe/CdS core/shell nanocrystals in dot shape, CdSe@CdS dot@platelet nanocrystals possess ~2 orders of magnitude lower probability for initiating PL blinking at single-nanocrystal level than the dot-shaped counterparts do.

Key words： Nanocrystals, Anisotropic growth, Polarization, Blinking

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论文编号：12–006

新型氮化物荧光粉的发现

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摘要正文：

稀土发光材料在照明、显示、安全、防伪、传感、生物和医学等应用领域发挥着重要作用，开发性能更好的材料对于提升器件的性能和拓宽应用范围意义重大。传统开发新材料所采用的试错法由于效率低、周期长而难以满足现在对新材料的需求。本文针对半导体照明应用的发光材料，分别采用单颗粒诊断法和高通量计算的方法筛选和发现新型氮化物荧光粉,如红光$La_{26-x}Sr_xSi_{41}O_{x+1}N_{80-x}:Eu^{2+}$，橙光HP-$CaSiN_2:Ce^{3+}$和宽带白光$Sr_2AlSi_2O_6N:Eu^{2+}$。本文还讨论了荧光粉晶体结构和发光光谱之间的构效关系。最后，将荧光粉与蓝光芯片结合制备了发光器件，验证了荧光粉的适用性。本文所提出的发现新材料的方法有助于加速新型荧光粉的研制，推动发光与显示器件的发展。

关键词：发光材料；固态照明；高通量计算；晶体结构；发光性能

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论文编号：12–006

Discovery of new nitride phosphors

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Luminescent materials play important roles in a variety of fields, such as lighting, display, safety, anticounterfeiting, sensing, biology and medicine. It is of great importance to develop new materials with better properties, thus enabling to improve the properties of devices and to broaden their applications. The traditional trial and error method cannot meet high demands for new materials as it is a time-consuming approach. In this paper, we screened and discovered new nitride phosphors for solid state lighting by using the single-particle-diagnosis and high-throughput calculations, respectively. The red-emitting $La_{26-x}Sr_xSi_{41}O_{x+1}N_{80-x}:Eu^{2+}$, orange-emitting HP-$CaSiN_2:Ce^{3+}$ and super-broad white-emitting $Sr_2AlSi_2O_6N:Eu^{2+}$ were discovered, and the relationship between the crystal structure and photoluminescence properties of these phosphors were discussed. Finally, these phosphors were evaluated by pumping with the blue light. The proposed methods for materials discovery will accelerate the development of new types of phosphors, and advance the lighting and display technologies.

Keywords: luminescent materials; solid state lighting; high-throughput calculations; crystal structure; photoluminescence

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稀土发光纳米生物标记：从基础到生物医学应用

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摘要正文：

与传统的分子探针如荧光染料和量子点相比，稀土掺杂无机纳米晶具有长荧光寿命、较大的Stokes与反Stokes位移、窄线宽、抗光漂白和低毒性等综合优势，是目前普遍看好的新一代荧光生物标记材料。近年来，这类功能纳米材料因在生物检测、成像以及疾病诊疗等领域的潜在应用而引起人们的广泛关注。我们将从基础的物理化学性质、光学性能设计到生物应用系统地介绍稀土掺杂无机纳米荧光标记材料的最新前沿进展，包括纳米探针的控制合成、表面修饰、电子结构、光学性能及其生物医学应用，重点展示该类材料在人体血清肿瘤标志物如CEA, AFP, PSA, uPAR, β-hCG, MicroRNA及循环肿瘤细胞等的均相和异相检测的示范应用[1-10]。

关键词：稀土纳米晶；上转换发光；时间分辨发光；荧光生物标记；肿瘤标志物

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论文编号：12–008

稀土荧光粉的结构设计与LED应用

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摘要正文：

随着蓝光发光二极管(LED: Light Emitting Diodes) 效率的提升和推广应用，“蓝光LED芯片+稀土荧光粉”(荧光粉也称为光转换材料)的组合技术，推动了稀土发光材料的研发，也是拓展和深化LED应用的重要方向。本报告结合报告人课题组在稀土发光材料领域所开展的基础研究工作，主要包括以下三个方面：（1）面向白光LED照明，提出了结构单元共取代和异价离子取代策略，调控4*f*5*d*电子跃迁的发光性质，实现高性能多光色发光；（2）面向背光源显示，提出了筛选高对称性矿物结构模型的材料设计原则，研发了系列窄带发射稀土荧光粉；（3）面向红色及红外LED光源，提出了激活离子在低配位数格位选择性占位和晶格限域的策略，研发了系列红色及红外LED光源用发光材料。

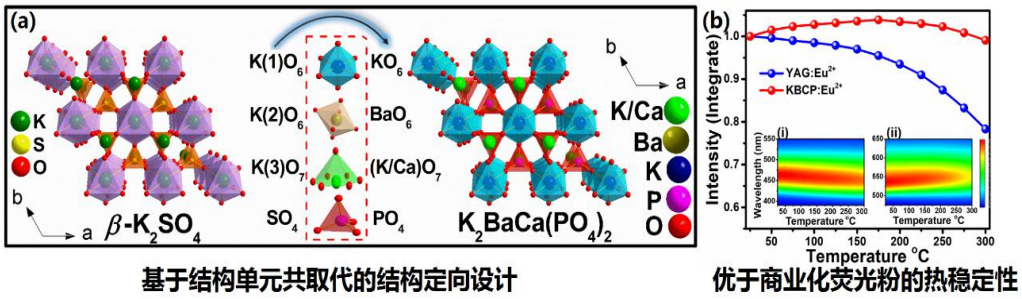

图 1 (a) 基于“结构单元共取代”策略，设计β-K_2SO_4型新物相 $K_2BaCa(PO_4)_2$ 的结构演变示意图；(b) $K_2BaCa(PO_4)_2$:Eu^{2+}展现出优于 YAG:Ce 的热稳定性。(Journal of the American Chemical Society, 2018, 140, 9730.)

关键词：荧光粉；稀土；LED

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激光照明用高效稳定荧光玻璃

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摘要正文：

激光照明（Laser lighting）是继LED照明之后新一代颠覆性的固态照明技术，是实现超高亮度和超大功率照明的必然选择。由于激光芯片的功率密度比相应的LED芯片大100倍以上，使发光材料更易产生由热猝灭而导致的发光饱和，从而造成整个照明器件失效。因此，激光照明用发光材料须比LED用发光材料具备更高的热稳定性和散热能力。荧光玻璃薄膜材料由于其优异的发光性能、高的热导率以及易合成等优势，在大功率激光白光照明领域具有良好的应用前景。本研究工作结合仿真计算和模拟，利用色度学原理和光谱光视效能函数，成功构建了光色调控模型，获得了高光学品质激光照明所需光谱特征，并据此在高热导率蓝宝石基片上设计和合成了一系列高显色/高光效、宽色域的荧光玻璃薄膜材料。同时，为进一步实现荧光玻璃薄膜材料的可控合成制备，本研究工作通过设计合理的散射模型，确定了气孔对荧光玻璃薄膜材料发光性能的影响规律，为高性能荧光玻璃薄膜材料合成工艺的设计和优化提供了指导。

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稀土发光材料与光电器件

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摘要正文：

稀土掺杂纳米晶发光材料显示出传统发光材料没有的独特光学特性，具有丰富的能级跃迁及独特的上/下光转换能力，在太阳能谱转换光电器件、照明与显示和生物医学应用等领域的科学意义和应用前景日益凸显。然而，随着面向高性能稀土发光及光电器件应用需求的不断提升，受限于稀土离子4f-4f跃迁吸收截面小（~10-19/cm2）、激发谱带窄、发光中心与晶格间存在较强的电子-声子耦合等因素导致的稀土上转换发光过程需要较高的激光功率密度和实际的稀土下转换量子剪裁发光吸收带不可调、效率低等问题，已经难以满足高性能的稀土发光材料和器件的需求。因此，我们聚焦于局域光场以及新型基质探索对稀土发光的调控作用，以材料发光调控机制、降低上转换激发阈值、提高稀土量子剪裁发光效率和改善器件性能：（1）实现了稀土离子掺杂钙钛矿纳米晶中的高效量子剪裁发光，突破了传统稀土量子剪裁发光吸收截面小、实际量子效率低的世界性难题；（2）提出了金属表面等离子体与三维光子晶体级联效应增强上转换发光新思路，大幅度降低上转换发光激发阈值；（3）发现了半导体表面等离子体增强稀土上转换荧光新方法，实现弱光应用。

关键词：稀土掺杂发光材料；钙钛矿量子点；局域光场调控；太阳能电池；光电探测器

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稀土掺杂四元压电半导体材料的力致发光特性研究

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摘要正文：

应力发光是指发光体在各种机械力作用下产生的动态发光现象。应力发光材料与普通发光材料不同，具有“力”激励发光特性，即：机械能直接转换成光能。由于无需光照和通电，应力发光材料在清洁光源和可视化应力探测方面具有独特的优势。据统计，迄今已有约半数的无机固体材料和近三分之一的有机固体材料被观察或测试到应力发光现象。然而这其中的多数只有在特定条件下才具有应力发光特性，由于这类晶体没有足够有效的发光中心，发光强度非常微弱。它们只有断裂或塑性形变时才会发光，因此是破坏性发光，属于不可恢复性发光行为。近年来发展的可恢复性应力发光压电半导体材料，例如ZnS:Mn/Cu压电半导体材料体系在数10万次以上反复动态力(~10kP压强)下保持可重复的发光(>100cd/m2)，在可视化应力传感和智能无源显示器件领域表现出极为重要的优势。然而，对于ZnS掺杂激活剂的选择较为有限，通常较为理想的发光中心主要锰和铜两种，限制发光光谱范围。本文以四元硫氧锌钙作为研究对象，同时实现了稀土离子(10种)和过渡金属离子的有效掺杂和高效力致发光，极大的拓宽了发光光谱范围，同时降低合成成本。基于应力发光材料，我们在解析机理的同时，展示了其在应力可视化原型柔性领域，例如电子签名笔，防伪标签和荧光棒等应用。

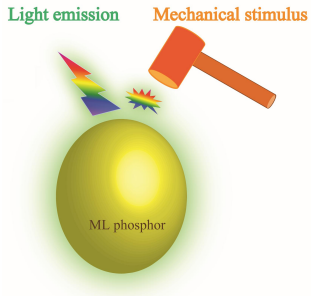

图1 应力发光材料在机械力作用下的发光示意图

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无镉量子点发光材料及 LED 器件

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摘要正文：

近年来，半导体量子点及钙钛矿材料由于具有高的发光效率和易于调节的光电子性质，在高色彩品质的薄膜显示器和固态发光器件等领域展现出其巨大的应用潜力。随着量子效率提升及电致发光原理、器件结构优化等研究的持续深入，量子点/钙钛矿 LED (QLED/PeLED)的发光效率已接近商业化有机 LED 的发光效率。从显示技术的长远发展来看，量子点电致发光显示将超越光致发光的量子点增亮膜和量子点彩色滤光片，有望成为下一代主流显示技术。目前许多国内外显示公司如韩国的三星、我国的京东方、TCL、海信等显示巨头都将 QLED 技术作为重点开发的对象。在这种背景下，QLED/PeLED 的研究成为近年来的研究热点领域之一，且发展非常迅速。此次报告将介绍当前无镉 QLED 及 PeLED 显示技术中存在的一些主要问题，并围绕高效、长寿命 LED 器件的构筑，分别从发光材料、载流子传输功能层和器件结构设计角度进行深入讨论。

关键词：量子点；钙钛矿；发光二极管；电致发光；器件结构

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非铅钙钛矿纳米晶载流子动力学研究

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摘要正文：

钙钛矿纳米晶$CsPbX_3$（X：Cl，Br，I）具有发光量子产率高、发光线宽窄、光谱易调谐等优点而受到广关注。其优异的发光性质使其在发光、显示等领域展现出巨大的潜在应用价值。但是人们也注意到钙钛矿纳米晶仍然存在两个致命缺点，阻碍了其大规模产业化应用。一是最常用的钙钛矿材料中含重金属铅，对环境危害较大；二是钙钛矿对水和空气极为敏感，导致钙钛矿层在空气中容易降解。因此寻找非铅且稳定性好的钙钛矿很有必要。科研人员已经开始了一些寻找非铅钙钛矿材料的尝试，但是目前非铅钙钛矿纳米晶发光效率远低于含铅钙钛矿材料。其中一个很重要的原因是缺乏对非铅钙钛矿中载流子动力学的深入研究。为此，我们开发了一系列在空气中稳定的非铅钙钛矿纳米晶，并采用飞秒瞬态吸收光谱等技术深入研究其载流子动力学机理。发现在非铅钙钛矿纳米晶中存在超快时间尺度的缺陷态捕获载流子过程。以此动力学指导材料改性，并通过钝化表面缺陷并调控自陷态激子，可将发光效率提升100多倍。

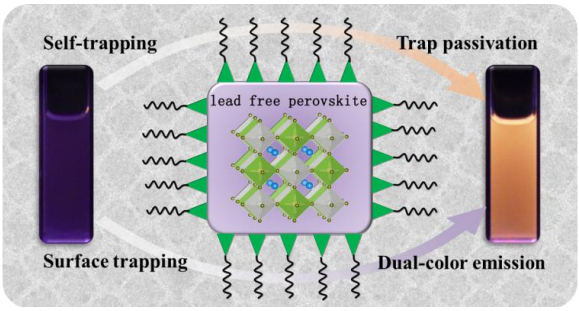

Fig. 1 Charge-carrier dynamics of lead-free halide perovskite nanocrystals

关键词：非铅钙钛矿；超快光谱；动力学；缺陷态

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环境对量子点发光性质的影响

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摘要正文：

胶体量子点是一种具有量子限域效应的可溶液加工的半导体纳米晶。因其具有可调的发射峰位、窄发射峰宽、高亮度、高光化学稳定性，量子点成为一类具有广阔应用前景的发光材料。随着合成化学的发展和发光机理的深入理解，目前多种高质量的量子点样品均可成功制备。但当量子点处于复杂的应用环境中，发光性质往往会发生改变。结合量子点单颗粒和集合体的稳态、瞬态光谱，我们分别研究了介电环境和气氛环境对量子点发光性质的影响。实验结果表明，局域介电环境不影响量子点单激子和多载流子态的发射能量，但影响荧光衰减动力学过程。且辐射复合速率比俄歇非辐射复合速率对局域介电环境更敏感，因此多载流子态荧光量子产率与介电环境相关。气氛环境实验表明，氧气能使量子点从低亮度的带电激子态去电离成为高效发光的中性单激子态，还原产物为超氧自由基。自发和光致的去电离速率都随着氧气分压增加而增加，但光致电离通道几乎不受氧气分压影响。此外，氧气均能稳定CdSe核和CdSe/CdS核/壳量子点的荧光性质，但仅对CdSe核量子点有不可逆的光刻蚀作用。环境对量子点荧光性质影响的物理和化学机理的揭示，为发展高稳定的量子点光电器件提供指引。

关键词：量子点；介电环境；气氛环境；发光性质

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无机纳米晶到有机分子的三线态能量转移及光子上转换

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摘要正文：

充分耦合无机半导体纳米晶高效的光吸收与有机分子长寿命三线态特性，构建杂化材料体系，有望在光催化合成、光动力疗法和太阳能高效转化等领域获得重要应用。实现上述耦合的物理过程是无机/有机界面三线态能量转移。然而，近期的光谱研究发现，该物理过程远比传统假设的Dexter传能机制复杂。为获得一个统一的物理图像并推动该领域发展，我们近期深入研究了无机/有机界面三线态能量转移动力学：率先揭示了纳米晶量子限域效应驱动的三线态能量转移[1]，展示了纳米晶缺陷态激子参与的三线态能量转移[2]，揭示了无机/有机界面电荷转移对三线态能量转移的介导作用[3-5]，以及提出了无机/有机界面三线态能量转移中的through-space和through-bond机制[6]。基于这些基本原理，我们实现了无机纳米晶敏化的高效三线态湮灭光子上转换。

关键词：量子点; 分子三线态; 能量转移; 光子上转换

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Structural Control, Broadband Emission and Exciton Dynamics of Two Dimensional Metal Halide Perovskites

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Abstract:

Two dimensional (2D) organic-inorganic metal halide perovskites (MHPs) have been regained enormous attention in the past decade due to their excellent moisture-stability with great potential on optical and electrical applications such as light-emitting diodes (LEDs), photodetectors and solar cells.[1-2] In this study, a series of 2D Cd-based and Pb-based MHPs have been successfully synthesized.[3-7] By introducing strong electronegative atom F, the formation of inter- and intramolecular hydrogen bonding network can be formed, thereby varying the structure and optical properties of inorganic layers. In addition, the broadband emission of Cd-based can be greatly boosted through band engineering. The broadband emission is also demonstrated to origin from Br vacancy. At last, the exciton dynamics of these samples have been thoroughly studied. These findings provides several effective approaches to tune the broadband emission of 2D MHPs.

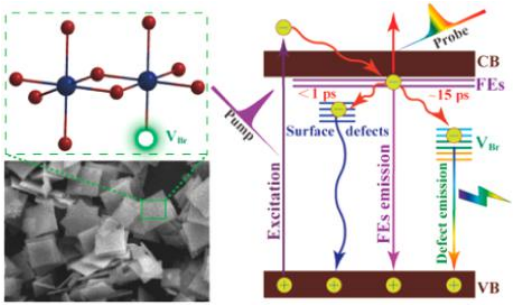

Fig. 1 The mechanism of V_{Br}-defect related emission and exciton dynamics

Keywords： broadband emission; metal halide perovskite; exciton dynamics;

论文编号：12–017

碳纳米点光谱调控及应用研究

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摘要正文：

碳基纳米材料以其卓越的电学和机械性能，掀起国际上的研究热潮。碳基材料通常为导体，其发光性能长期以来未有大的突破。发光碳纳米点是近十年发展起来的新型零维碳基半导体材料，在生物成像、医疗、照明等领域已展现出诱人的应用前景，其发光特性研究已成为低维半导体发光领域的新兴热点。我们课题组自2012年以来，针对如何调控碳纳米点发光带隙的难题，提出构建共轭尺寸可控氮掺碳基内核的研制方法，通过尿素与柠檬酸的制备体系，实现了碳纳米点在可见到近红外波段的高效发光；针对碳纳米点聚集诱导的荧光猝灭问题，提出碳纳米点原位无机壳层包覆的方法，实现碳纳米点固态体系下全色段稳定的高效发光；针对碳纳米点功能开发，提出基于组装手段调控碳纳米点光学特性的研究思路，实现了碳纳米点在近红外区高效的光热转换（53%）和喷水荧光信息打印；针对碳纳米点在生物医疗中的应用，研制出具有有效近红外吸收/近红外发射特性的碳纳米点，实现在红光和近红外波段的多光子荧光过程，并通过尾静脉注射方式，实现基于近红外发光碳纳米点的小鼠活体的肿瘤光声成像及光热治疗。

关键词：碳纳米点；光谱调控；固态发光；近红外发光；光热治疗

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论文编号：12–018

荧光碳点长寿命发射性能调控与应用研究

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摘要正文：

荧光碳点具有制备过程简单、光物理化学性能稳定、易于官能化修饰、发射光谱可调、水溶性及生物相容性好等优点，因而在化学/生物传感、生物成像、医学诊疗及光电器件等众多领域均表现出巨大的应用潜力。[1,2] 然而该领域研究目前主要集中在对其荧光发射性能的调控及应用，对其磷光与延迟荧光性能的关注还比较少，也缺乏系统深入的研究。本报告主要介绍我们课题组通过与不同材料进行复合的策略，一方面实现了碳点的三重发射特性（上、下转换荧光与磷光），另一方面调节了碳点单重态与三重态之间的能量带隙，实现了碳点的延迟荧光发射。

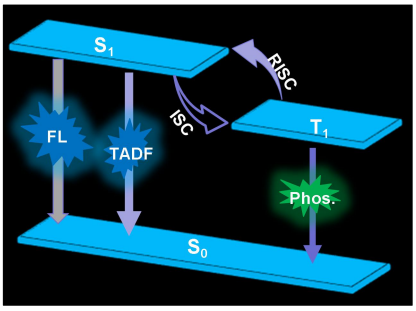

Fig. 1 Schematic illustration of the regulation of afterglow emission

关键词：荧光碳点；长寿命发射；高级防伪

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论文编号：12–018

Long afterglow emission of carbon dots and applications

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Abstract:

In recent years, luminescent carbon dots (CDs) have attracted tremendous attentions thanks to their numerous merits (e.g. superior optical and chemical properties, facile preparation and modification, and excellent biocompatibility), consequently demonstrating many potential applications including sensing, theranostics, bioimaging, optoelectronic devices, and so on. In this presentation, we will mainly focus on the long afterglow emission properties of CDs, including strategies for achieving triple-mode emission, afterglow emission in aqueous solution, and their applications.

论文编号：12–019

荧光碳点和硅点的生物医学应用

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摘要正文：

近年来，无金属发光颗粒，比如荧光碳点和硅点，由于其优异的光学性质、简易的表面修饰性能、以及良好的生物安全性等优点，受到了研究者们的广泛关注。本报告将介绍我们实验室在新型碳点和硅点的制备及生物医学应用等方面的进展。具体包括：（1）活细胞核仁靶向碳点（ACS Appl. Mater. Interfaces 2018, 10, 10664；ACS Appl. Mater. Interfaces 2019, 11, 32647.），（2）溶酶体靶向有机硅点（Nano Lett. 2018, 18, 1159.）；（3）细菌生物膜诊疗碳点及有机硅点（J. Mater. Chem. B 2019, 7, 5104; Small 2019, 15, 1901647.）；（4）可区分微生物死活状态的碳点和有机硅点（Nanoscale 2017, 9, 2150; Sensors and Actuators B: Chemical 2019, 295, 49.）；（5）线粒体靶向碳点以及可实现癌症诊疗的碳点（Nanoscale 2017, 9, 10948; Nanoscale 2017, 9, 15441; Nanoscale 2017, 9, 18368; Carbon 2018, 134, 232.）；（6）可区分细菌革兰氏类型并选择性杀死革兰氏阳性菌的碳点和硅点（ACS Appl. Mater. Interfaces 2016, 8, 32170; Adv. Funct. Mater. 2016, 26, 5958; Carbon 2019, 146, 827.）；（7）可用于多巴胺和离子检测的硅点（Anal. Chem. 2015, 87, 3360; Adv. Mater. Interfaces 2015, 2, 1500360.）；（8）可制备多功能纳米胶的有机硅点（Adv. Therap. 2019, 2, 1800140; Adv. Funct. Mater. 2019, 29, 1807772; Nanoscale Horiz. 2020, 5, 481.）；（9）可用于多功能纳米材料制备的碳点（ACS Appl. Mater. Interfaces 2018, 10, 42077; ACS Appl. Mater. Interfaces 2018, 10, 1544.）。

关键词：碳点；硅点；诊疗；抗菌；抗癌

论文编号：12–020

发光碳纳米点：从荧光到磷光

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摘要正文：

碳纳米点由于具有可调谐的光学特性、稳定性以及良好的生物兼容性在光电器件、生物成像诊疗、发光墨水等方面已经取得了令人欣慰的进展。在本次报告当中，我们主要介绍课题组近些年来在碳点荧光和磷光方面的工作。主要包括采用理论结合实验，制备出在深紫外区具有高发光量子效率的碳点，量子产率达到33%为报道的最高值，为碳点在紫外发光器件的应用奠定了基础[1]；采用无溶剂碳化的方法制备了具有红光/近红外发光的碳点，实现了多光子激发下的荧光和生物成像[2]；采用纳米限域的方法，实现了高效长寿命的水溶性磷光碳点[3]，为磷光材料实现在水溶液中的磷光发射提供了思路。

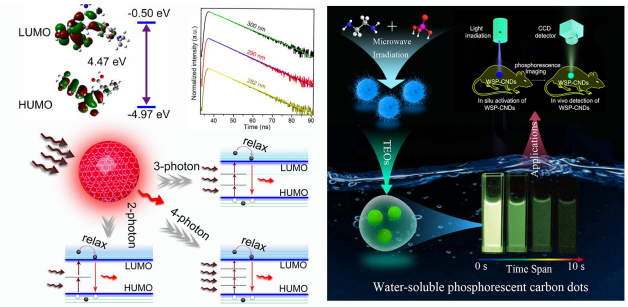

Fig. 1 Luminescence Carbon nanodots : From fluorescence to phosphorescence

关键词：碳纳米点；荧光；磷光

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论文编号：12–021

Au_2Pt-PEG-Ce6 Nanoformulation with Dual Nanozyme Activities for Synergistic Chemodynamic Therapy / Phototherapy

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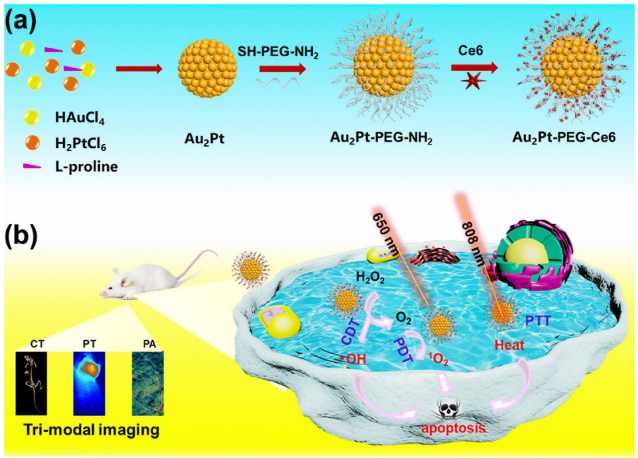
Abstracts:

Although synergistic therapy for tumors has displayed significant promise for effective treatment of cancer, developing a simple and effective strategy to build a multi-functional nanoplatform is still a huge challenge. By virtue of the characteristics of tumor microenvironment, such as hypoxia, slight acidity and H_2O_2 overexpression, Au_2Pt-PEG-Ce6 nanoformulation is constructed for collaborative chemodynamic (CDT) /phototherapy of tumors (**Scheme 1**). Specifically, the Au_2Pt nanozymes with multiple functions are synthesized in one step at room temperature. The photosensitizer chlorin e6 (Ce6) is covalently linked to Au_2Pt nanozymes for photodynamic therapy. Interestingly, the Au_2Pt nanozymes possess catalase- and peroxidase-like activities simultaneously, which not only can generate O_2 for relaxation of tumor hypoxia and enhancement of PDT efficiency but also can produce ·OH for CDT. All in all, the Au_2Pt-PEG-Ce6 exhibits great potential in multimodal imaging-guided synergistic PTT/PDT/CDT with remarkably tumor specificity and enhanced therapy.



Scheme 1. Schematic illustrations for the fabrication of Au_2Pt-PEG-Ce6 nanoformulation (a) and multimodal imaging-guided synergistic PTT/PDT/CDT by employing tumor microenvironment (b).

Keywords: Au2Pt-PEG-Ce6; Nanozymes; Synergistic therapy; Tri-modal imaging

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论文编号：12–022

发光金属卤化物的高压调控

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摘要正文：

压力作为一项有效的物理手段，可以非常有效地缩短原子之间的距离，进而改变物质的晶体结构、电子状态等本征属性。因此，高压作为新维度的实验变量，可以调节甚至控制材料的性质变化。此外，高压手段甚至可以用来捕获许多常压下难以探知到的新奇现象，并有可能把一些高压下的新物质截获到常压下。因此，高压作为一种有效的手段，在拓展新材料方面具有非常重要的科学意义。课题组将高压手段用于无机功能材料的研究，一方面可以从一个崭新的角度来研究材料晶体结构与光学性质的内在联系，[1]进而深入认识材料的物理本质；另一方面，还有望发现这些材料新奇的结构和现象，并将高压相截留到常压。

关键词：金属卤化物；高压；发光

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论文编号：12–022

High-pressure regulation of luminescent metal halides

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Abstracts:

Pressure, as a physical method, can effectively shorten the interatomic distance, and alter the nature of materials including crystal structure, electronic states, etc. Therefore, pressure as an experimental variable in a new dimension, and can tune and even control the change of properties in materials. Furthermore, the high-pressure method is even applied to capturing some novel phenomena that are unavailable at ambient conditions, and quenching new material under high pressure to the atmospheric pressure is possible. Hence, high pressure as an effective tool is of scientific importance in expanding novel materials. Our group applies high pressure in the research of inorganic functional materials. On the one hand, high pressure can be utilized to explore the interconnection between crystal structure and optical property, which further deepens the understanding of physical essence. On the other hand, it is expected to discover novel structure and phenomenon in material, and quench high-pressure phase to ambient conditions.

Keywords: Metal halides, High pressure, Luminescence

论文编号：12–023

Visualizing Single-nucleotide Variations in Nuclear Genome using Co-localization of Dual Engineered CRISPR probes

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Abstract:

Direct visualization of single-nucleotide variation (SNV) in single cells is of great importance for understanding the spatial organization of genomes and their relationship with cell phenotypes. Herein, we developed a new strategy for visualizing SNVs in nuclear genome using co-localization of dual engineered CRISPR probes (CoDEC). By engineering the structure of sgRNA, we incorporated a hairpin in the spacer domain for improving SNV recognition specificity, and a loop in the non-functional domain for localized signal amplification. Using a guide probe-based co-localization strategy, we can successfully distinguish on-target true positive signals from the off-target false positives with high accuracy. This newly developed method provides a facile way for studying in situ information of SNVs in individual cells for basic research and clinical applications with single-molecule and single-nucleotide resolutions.

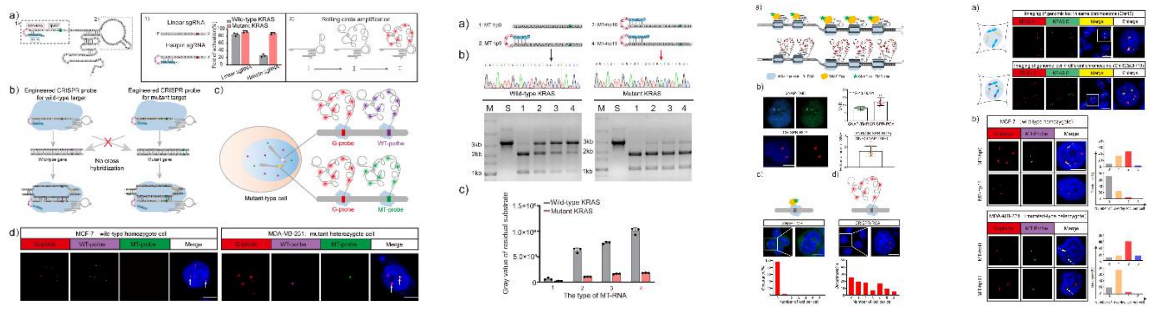

Fig. 1 Co-localization of dual engineered CRISPR (CoDEC) probes for imaging of single-nucleotide variations (SNVs) in nuclear genome. a) Structure of engineered sgRNA.

Fig. 2 Engineered sgRNAs with hairpin structure could improve the specificity of CRISPR probes for SNV discrimination.

Fig. 3 Engineered sgRNA with loop structure could be used to trigger RCA in MDA-MB-231 cells.

Fig. 4 CoDEC for highly specific imaging of SNVs in the KRAS gene in MCF-7 and MDA-MB-231 cells.

Keywords：Co-localization, CRISPR probes, In situ single cell imaging, Rolling circle amplification, Single nucleotide variation

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论文编号：12–024

高压诱导层状无铅卤素钙钛矿700倍荧光增强

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摘要正文：

二维双钙钛矿材料具有组分可调、激子结合能大、环境友好、稳定性高等优点，成为卤素钙钛矿的研究热点。然而，这类材料的室温荧光却极其微弱，这是由于其荧光来自于缺陷调控的辐射复合，而非自陷激子。我们发现一类新型层状有机-无机杂化钙钛矿类材料，其柔软的晶格允许较大的晶格畸变，能够大范围调控其电子-声子相互作用，从而在高压下，获得700倍的荧光增强。基于该理论，通过配体工程我们成功制备了常温常压下高效发光的二维双钙钛矿荧光粉。

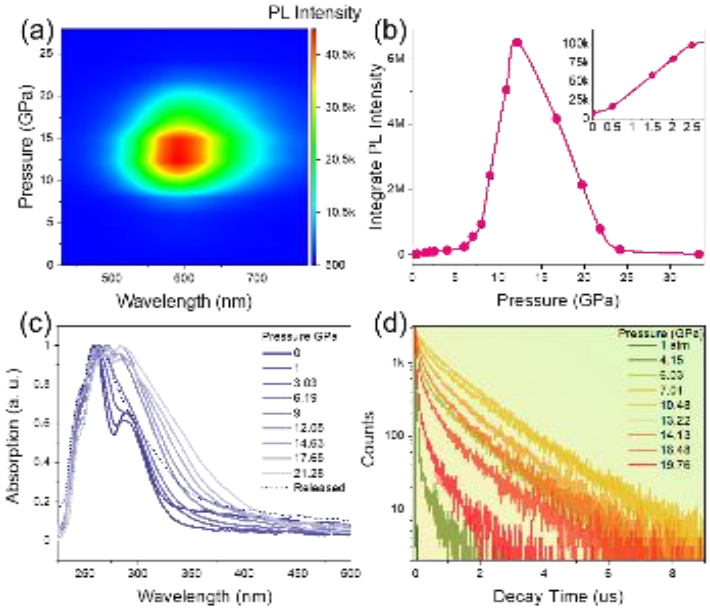

Fig. 1 In situ evolution of optical properties of layered double perovskite analogs under pressure.

关键词：电子声子耦合；二维钙钛矿；压力诱导发光

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论文编号：12–024

Pressure- Induced 700-Fold Emission Enhancement in Layered Halide Perovskite Analogs

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Abstract:

Layered double perovskites (LDPs) are getting more and more attention owing to their unique properties such as tunable component, high exciton binding energy, environment-friendly and high stability. However, the photoluminescence (PL) properties of LDPs are rarely discovered since the PL of LDPs is emitted from defect-mediated radiative recombination rather than the common self-trapped excitons. In this report, a new family of organic-inorganic hybrid LDPs are reported. The soft lattice allows large crystal distortion to modulate the electron-phonon coupling. As a result, 700-fold PL enhancement is obtained under pressure. Furthermore, highly efficient LDPs with bright and tunable PL under normal temperature and pressure can also be fabricated through rational design of ligand engineering.

论文编号：12–025

Inkjet Printing of Perovskite Quantum-Dot Electroluminescence Materials

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Abstract：

With the market success of core-shell CdSe quantum dots as down-conversion materials for LCDs, their application in future printed displays (QLEDs) has seen a resurgence of interest within the research community.[1] In addition to core-shell quantum dots, perovskite quantum dots also have recently attracted intense interest owing to potentially good electro-luminescent properties.[2] The electronic properties can be easily manipulated by molecular engineering, thus making them valuable as an additional set of materials for applications in printed displays. In this work, combining the relationship between solvents and ligands in perovskite quantum dots ($CsPbBr_3$) through tailored gradient evaporation strategy, a stable ink can be formulated, which greatly improves the uniformity of printed perovskite films, and realizes flexible printed devices for the first time.

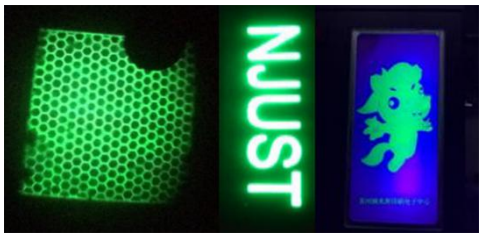

Fig. 1 Various robust photo/electro-luminescence patterns by directly ink-jet printing the $CsPbBr_3$ QDs.

Keywords: inkjet printing, electroluminescence, light-emitting diodes, perovskite, quantum dots

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论文编号：12–026

Sub-Wavelength Laser at Near-Infrared Communication Band

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Abstract：

Silicon-based lasers have played an important role in silicon-based optoelectronic integrated system. Recent studies demonstrated erbium silicate was an ideal candidate material for high performance silicon-based lasers in the telecom wavelength due to its high erbium concentrations. In previous work, erbium silicate itself cannot form a good cavity reflection surface, and it cannot obtain a laser simply by erbium silicate, and the addition of erbium alone will also produce serious quenching. Therefore, an auxiliary microcavity erbium-ytterbium silicate laser is proposed to compensate for the problem of the inability to form a laser caused by the intrinsic refractive index of the silicate material to achieve a good laser. We use traditional CVD process to obtain erbium-ytterbium silicate nanosheets with good optical properties, and then design and fabricate DBR microcavities based on 1.5μm wavelength fluorescence. Finally realize the laser. The results show that the erbium-ytterbium silicate composite material can realize laser generation in the communication band, and can be a potential candidate for the application of large-scale integrated silicon-based lasers in the future.

关键词：近红外激光；通讯波段；DBR微腔

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Broad-Band Emission in All-Inorganic Metal Halide Perovskite with Intrinsic Vacancies

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Abstract：

Efficient broad-band emissions related to self-trapped excitons (STEs) in three-dimensional (3D) all-inorganic perovskites ($CsPbX_3$) are generally accepted as difficult to form. Here, through doping ytterbium or erbium ions in $CsPbX_3$ crystals, we observe broadband luminescence of STEs with linewidth exceeding 200 nm and Stokes-shift of ~1 eV. Experiment-theory-combined study clarifies the Pb^{2+} in perovskite can be replaced by impurity ions, and the Pb^{2+} substitution defect and adjacent halide vacancy introduce defect states lying just below the conduction band minimum of perovskite. The strong electron-phonon coupling between the trapped carriers and the deformation of $[PbX_6]$ cage reduces the energy gap of perovskites. By regulating the excitation intensity and irradiation time, the relative intensity of these STEs emissions and band-edge emissions of PVK can be tuned, and therefore produced a tunable chromaticity of the emission spectra. This study shed new light on the permanent defects induced extrinsic STEs in 3D inorganic perovskites and provides a clear microscopic picture of the underlying formation mechanism of STEs. In view of the color-tunable emission properties, ions-doped PVK may find application in nanophotonic devices.

Keywords： perovskite, doping; defect, STEs, color tunable

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二维材料荧光图案化与机理探索

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摘要正文：

作为后石墨烯时代的新型二维材料，过渡金属硫族化合物呈现半导体特性，并且其电子结构随层数可调，随着层数由多层减薄致单层，其能带结构由间隙带隙转变为直接带隙，因而可实现光致发光。大部分二维过渡金属硫化物的带隙大小位于可见光范畴，为其在显示、照明、可见光通信等领域的应用奠定了基础。本次报告将汇报二维过渡金属硫化物荧光图案化方面的研究进展，从边界态、缺陷空间分布、物理/化学吸附等方面探索了导致单层过渡金属硫化物荧光图案化的原因，并利用缺陷工程实现了荧光量子产率的提升。

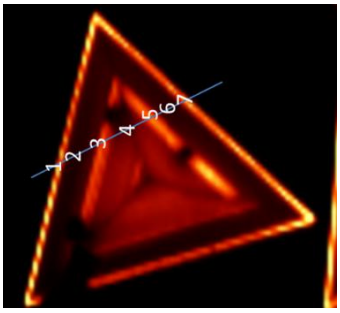

Fig. 1 Fluorescence image of a WS_2 monolayer

关键词：二维材料；荧光

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Enhancing quantum yield of $CsPb(Br_xCl_{1-x})_3$ nanocrystals through lanthanum doping for effcient blue light-emitting diodes

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Abstract:

All-inorganic perovskite quantum dots (PQDs) have attracted great attention in optoelectronic applications. However, the poor photoluminescence quantum yield (PLQY) and terrible external quantum efficiencies (EQE) of blue-emission PQDs light-emitting diodes (QLEDs) have limited their further development in display field. Here, a general strategy for enhancing PLQY and EQE through lanthanum ions doping is proposed. Density functional theory (DFT) calculations confirmed that the partial substitution of La^{3+} for Pb^{2+} leads to a reduced defect states, meanwhile, a higher carrier temperature and exciton binding energy are also obtained. In consequence, a maximum PLQY of 84.3% is obtained for La^{3+}-doped $CsPb(Br_xCl_{1-x})_3$ PQDs with emissions ranging from 448 to 500 nm. In terms of devices, phase separation and ion migration are effectively alleviated with La^{3+} profiting from the constricted lattice and stronger interaction between La and Cl. Resultantly, QLEDs with La^{3+}-doped PQDs show the maximum EQE of 2.17% (480 nm) and 3.25% (489 nm).

Keywords: Perovskite, Quantum dots, Lanthanum doping, Light-emitting diodes, Blue emission