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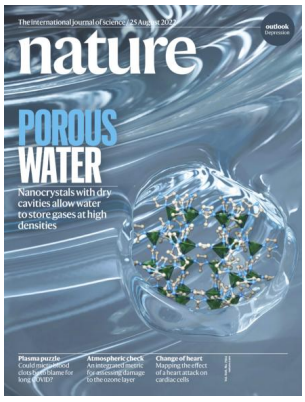
本期推荐报道 2022 年 8 月 Nature、Science 期刊上材料科学领域的部分最新论文。



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美国 Science(《科学》)、英国 Nature(《自然》)及美国 Cell(《细胞》)是国际公认的三大享有最高学术声誉的科技期刊，发表在这三大期刊上的论文简称 CNS 论文。

材料科学 8 月 Science 论文

[1]Synchronous assembly of chiral skeletal single-crystalline microvessels

手性骨架单晶微容器的同步组装

出版信息：Science, 5 AUG 2022, VOL 377, ISSUE 6606

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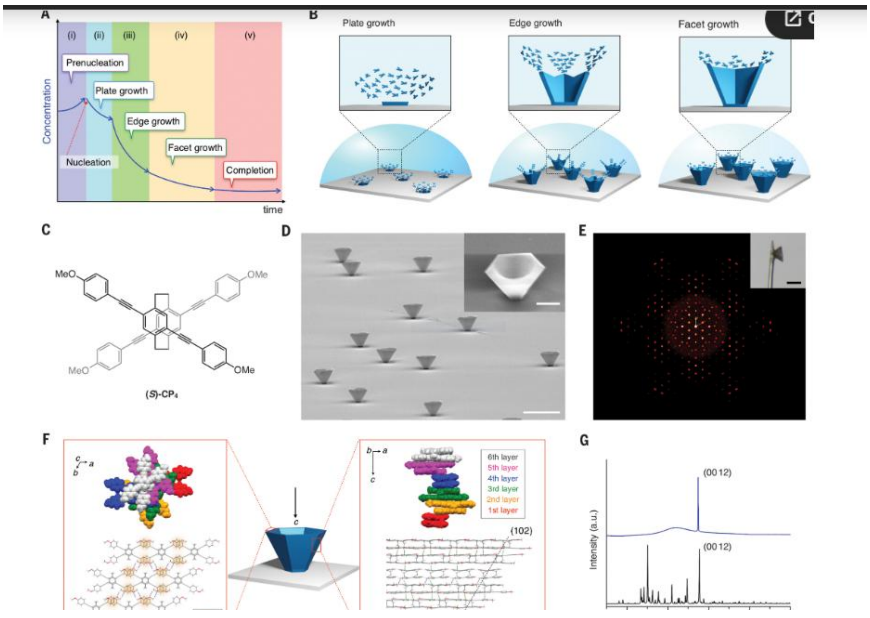
全文链接：https://www.science.org/doi/10.1126/science.abm9596

Abstract：Skeletal or concave polyhedral crystals appear in a variety of synthetic processes and natural environments. However, their morphology, size, and orientation are difficult to control because of their highly kinetic growth character. We report a methodology to achieve synchronous, uniaxial, and stepwise growth of micrometer-scale skeletal single crystals from planar-chiral double-decker molecules. Upon drop-casting of a heated ethanol solution onto a quartz substrate, the molecules spontaneously assemble into standing vessel-shaped single crystals uniaxially and synchronously over the wide area of the substrate, with small size polydispersity. The crystal edge is active even after consumption of the molecules and resumes stereoselective growth with successive feeding. The resultant morphology can be packed into polycyclic aromatic hydrocarbon–like microarchitectures and behaves as a microscopic container.

摘要翻译：骨架或凹型多面体晶体在各种合成过程和自然环境中普遍存在。然而，由于它们具有高动力学生长特性，其形态、大小和取向很难控制。研究组报道了一种从平面手性双层分子实现同步、单轴和分步生长微米尺度骨架单晶的方法。在将加热的乙醇溶液滴注到石英衬底上后，分子在衬底的宽广面积内单轴同步地自发组装成直立的容器形单晶，具有小尺寸的多分散性。晶体边缘即使在消耗分子后仍然活跃，且通过连续分子增加恢复立体选择性生长。生成的形态可包装为多环芳烃类的微结构，并表现为一个微观容器。

文中插图：



[2]

Flexible thermoelectrics based on ductile semiconductors

基于延展性半导体的柔性热电器件

出版信息：Science, 19 AUG 2022, VOL 377, ISSUE 6608

作者：QINGYU YANG, SHIQI YANG, PENGFEI QIU et al.

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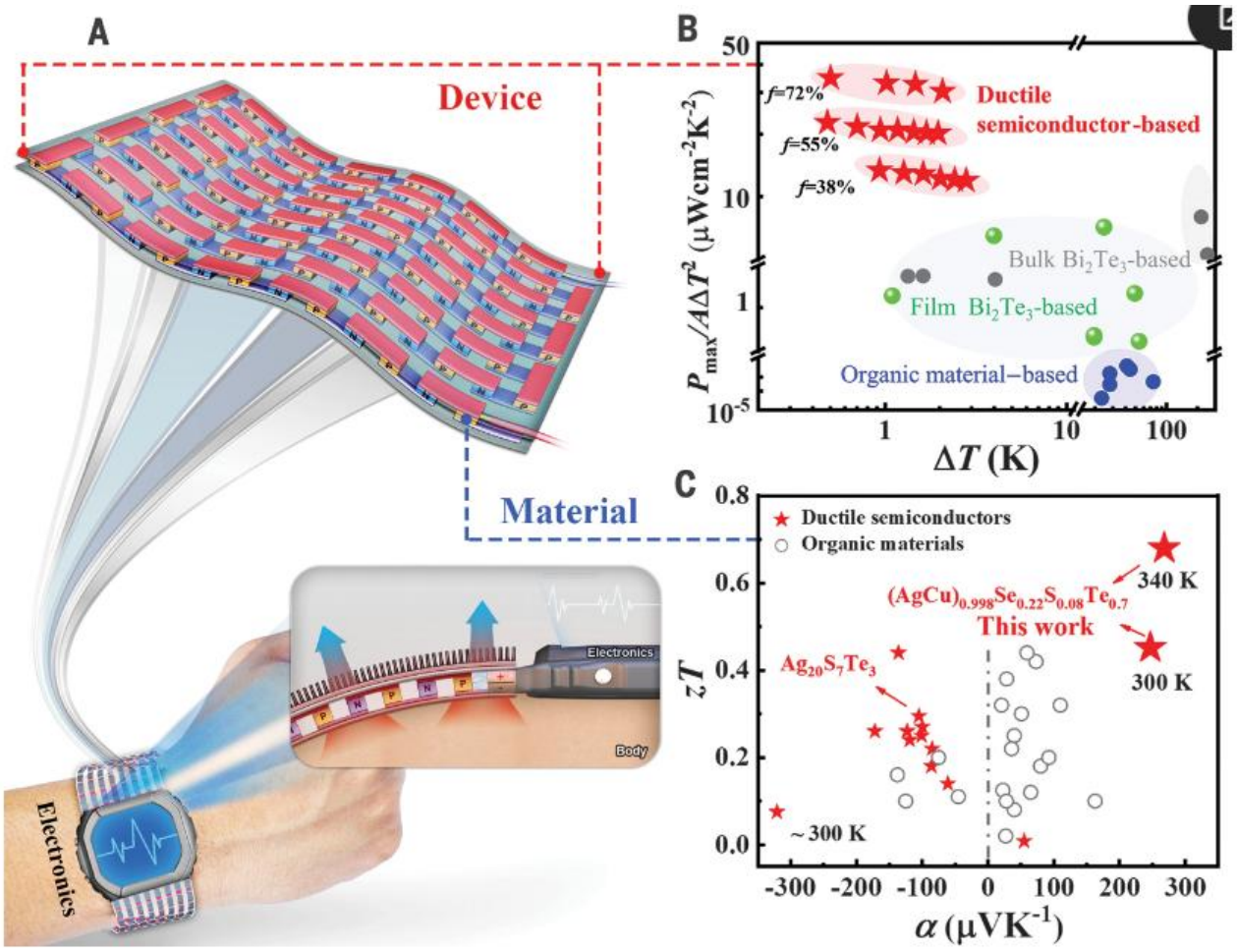
全文链接：https://www.science.org/doi/10.1126/science.abq0682

Abstract：Flexible thermoelectrics provide a different solution for developing portable and sustainable flexible power supplies. The discovery of silver sulfide – based ductile semiconductors has driven a shift in the potential for flexible thermoelectrics, but the lack of good p-type ductile thermoelectric materials has restricted the reality of fabricating conventional cross-plane π-shaped flexible devices. We report a series of high-performance p-type ductile thermoelectric materials based on the composition-performance phase diagram in AgCu(Se,S,Te) pseudoternary solid solutions, with high figure-of-merit values (0.45 at 300 kelvin and 0.68 at 340 kelvin) compared with other flexible thermoelectric materials. We further demonstrate thin and flexible π-shaped devices with a maximum normalized power density that reaches 30 μWcm−2 K−2. This output is promising for the use of flexible thermoelectrics in wearable electronics.

摘要翻译：硅是地球上最丰富的元素之一，从太阳能电池到计算机芯片，纯硅已经成为许多现代技术的基础。但作为一种半导体，硅的性能并不理想。本研究发现高纯度的立方砷化硼材料能克服这两个限制。该材料具有高电子-空穴迁移率，达到了 1600 平方厘米每伏特每秒，并具有出色的导热性。该结果展示了一种极具潜力的半导体材料。

文中插图：



[3]

Chip-less wireless electronic skins by remote epitaxial freestanding compound semiconductors

利用远程外延独立化合物半导体实现无芯片无线电子皮肤

出版信息：Science, 19 AUG 2022, VOL 377, ISSUE 6608

作者：YEONGIN KIM, JUN MIN SUH, JIHO SHINYUNPENG LIU et al.

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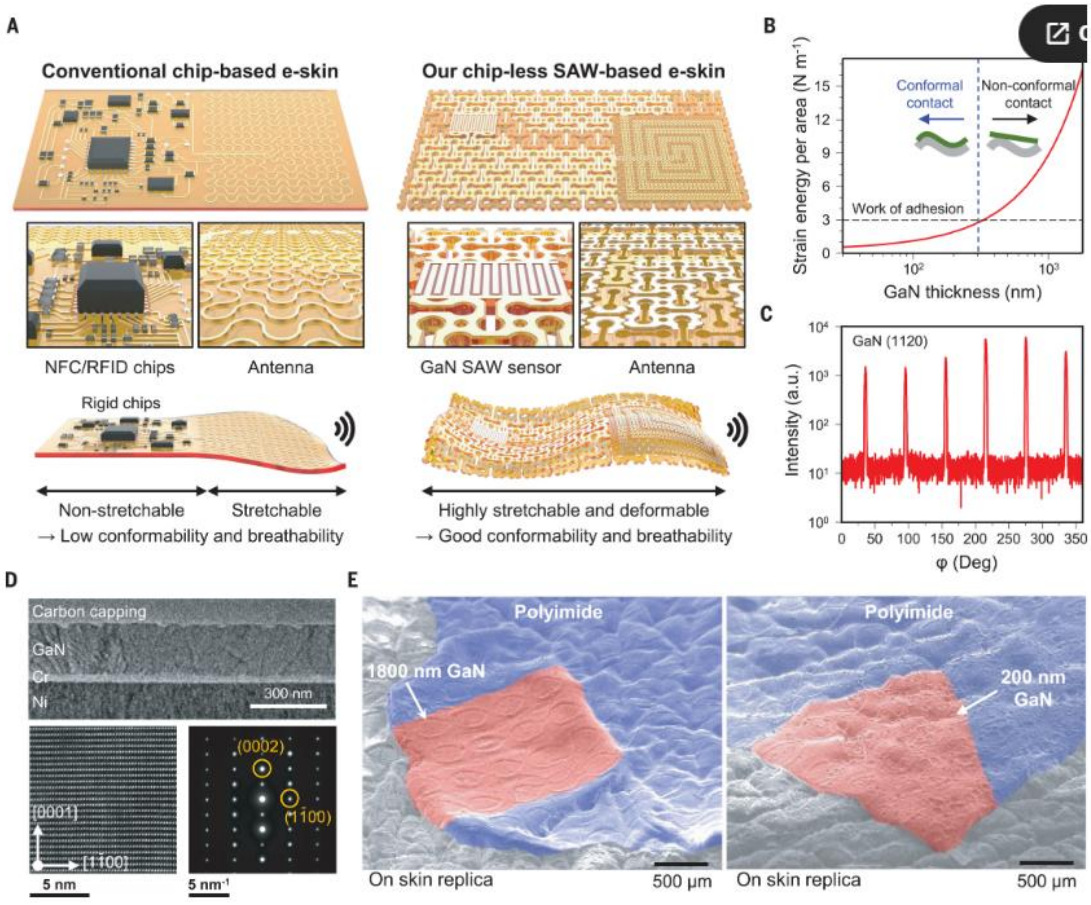
全文链接：https://www.science.org/doi/10.1126/science.abn7325

Abstract：Recent advances in flexible and stretchable electronics have led to a surge of electronic skin (e-skin)–based health monitoring platforms. Conventional wireless e-skins rely on rigid integrated circuit chips that compromise the overall flexibility and consume considerable power. Chip-less wireless e-skins based on inductor-capacitor resonators are limited to mechanical sensors with low sensitivities. We report a chip-less wireless e-skin based on surface acoustic wave sensors made of freestanding ultrathin single-crystalline piezoelectric gallium nitride membranes. Surface acoustic wave–based e-skin offers highly sensitive, low-power, and long-term sensing of strain, ultraviolet light, and ion concentrations in sweat. We demonstrate weeklong monitoring of pulse. These results present routes to inexpensive and versatile low-power, high-sensitivity platforms for wireless health monitoring devices.

摘要翻译：最近在柔性和可拉伸电子产品方面的进展推动了基于电子皮肤（e-skin）的健康监测平台的增多。传统的无线电子皮肤依赖于刚性的集成电路芯片，这不仅损害了整体的灵活性，同时也会消耗相当大的电力。基于电感电容谐振器的无芯片无线电子皮肤受限于灵敏度较低的机械传感器。我们报告一种基于独立式超薄单晶压电氮化镓薄膜表面声波传感器的无晶片无线电子皮肤。这种基于表面声波的电子皮肤可以提供对应变、紫外线和汗水中的离子浓度的高灵敏度、低功率的长期监测。我们示范了为期一周的脉搏检测。这些结果展示了无线健康监测设备可以提供低廉、通用、低耗能及高灵敏度服务的途径。

文中插图：



[4]

Nanocrystals with metastable high-pressure phases under ambient conditions

环境条件下具有亚稳态高压相的纳米晶体

出版信息：Science, 19 AUG 2022, VOL 377, ISSUE 6608

作者：TIANYUAN XIAO, YASUTAKA NAGAOKA, XIRUI WANG et al.

第一作者单位：Department of Chemistry, University of Florida, Gainesville, FL 32611, USA.

全文链接：https://www.science.org/doi/10.1126/science.abq7684

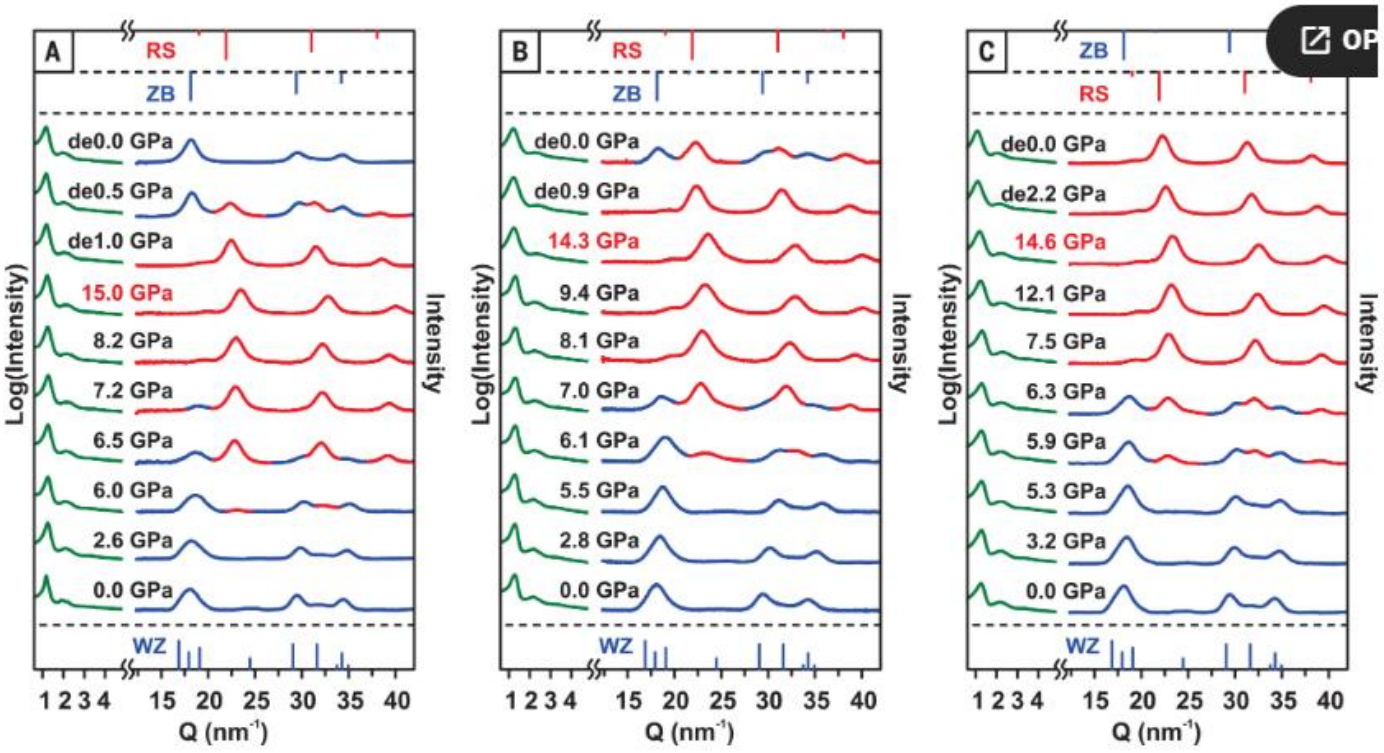
Abstract：

The ambient metastability of the rock-salt phase in well-defined model systems comprising nanospheres or nanorods of cadmium selenide, cadmium sulfide, or both was investigated as a function of composition, initial crystal phase, particle structure, shape, surface functionalization, and ordering level of their assemblies. Our experiments show that these nanocrystal systems exhibit ligand-tailorable reversibility in the rock salt – to – zinc blende solid-phase transformation. Interparticle sintering was used to engineer kinetic barriers in the phase transformation to produce ambient-pressure metastable rock-salt structures in a controllable manner. Interconnected nanocrystal networks were identified as an essential structure that hosted metastable high-energy phases at ambient conditions. These findings suggest general rules for transformation-barrier engineering that are useful in the rational design of next-generation materials.

摘要翻译：

具有反转极性的钙钛矿太阳能电池(p-i-n)的性能仍然受限于其电子提取界面处复合，因而也会降低电池的功率转换效率（PCE）。本研究通过热蒸发在钙钛矿/C60 界面处约 1nm 厚的 MgFx 中间层调节钙钛矿层的表面能，促进了电子提取，并从钙钛矿表面置换 C60 以减轻非辐射复合。这些效应使得开放电路伏特达到 1.92 伏，填充因子提高到 80.7%，稳定的 PCE 为 29.3%，在超过 1000 小时的湿热测试后串联电池保持了约 95%的初始性能。

文中插图：



[5]

Growth rules for irregular architected materials with programmable properties

具有可编程特性的不规则结构材料的生长规律

出版信息：Science, 26 AUG 2022, VOL 377, ISSUE 6609

作者：KE LIU, RACHEL SUN, AND CHIARA DARAIO

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全文链接：https://www.science.org/doi/10.1126/science.abn1459

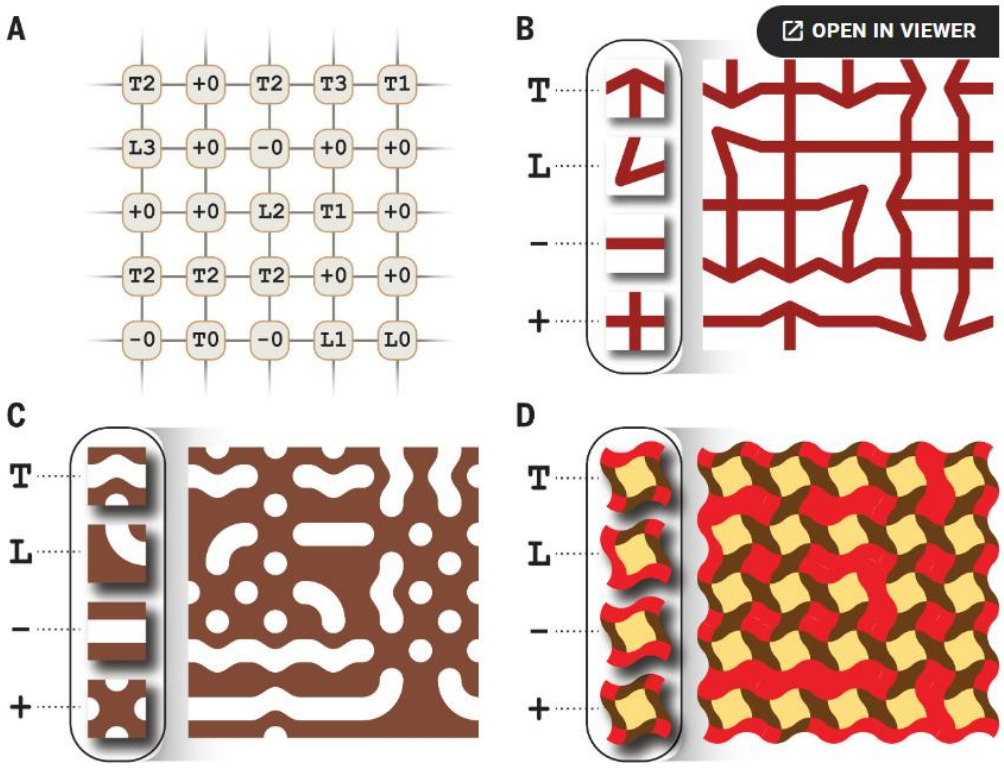
Abstract：

Biomaterials display microstructures that are geometrically irregular and functionally efficient. Understanding the role of irregularity in determining material properties offers a new path to engineer materials with superior functionalities, such as imperfection insensitivity, enhanced impact absorption, and stress redirection. We uncover fundamental, probabilistic structure–property relationships using a growth-inspired program that evokes the formation of stochastic architectures in natural systems. This virtual growth program imposes a set of local rules on a limited number of basic elements. It generates materials that exhibit a large variation in functional properties starting from very limited initial resources, which echoes the diversity of biological systems. We identify basic rules to control mechanical properties by independently varying the microstructure's topology and geometry in a general, graph-based representation of irregular materials.

摘要翻译：

生物材料显示了几何不规则且功能高效的微结构。了解不规则性在确定材料性能中的作用，为设计具有优异功能的材料提供了一条新途径，如缺陷不敏感性、增强冲击吸收和应力重定向。研究组使用一个增长启发的程序来揭示基本、概率的结构-属性关系，该程序唤起自然系统中随机结构的形成。这个虚拟增长程序对有限数量的基本元素强加了一套局部规则。从非常有限的初始资源开始，它产生的材料在功能特性上表现出很大的变化，这反映了生物系统的多样性。研究组确定了控制机械性能的基本规则，通过在一个通用的、基于图形代表的不规则材料中，独立改变微观结构的拓扑和几何性质。

文中插图：



[5]

Structurally integrated 3D carbon tube grid–based high-performance filter capacitor

结构集成的 3D 碳管栅极高性能滤波电容器

出版信息：Science, 26 AUG 2022, VOL 377, ISSUE 6609

作者：FANGMING HAN, OU QIAN, GUOWEN MENG, DOU LIN, GAN CHEN, SHIPING ZHANG, ET AL.

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全文链接：https://www.science.org/doi/10.1126/science.abh4380

Abstract：

Filter capacitors play a critical role in ensuring the quality and reliability of electrical and electronic equipment. Aluminum electrolytic capacitors are the most commonly used but are the largest filtering components, limiting device miniaturization. The high areal and volumetric capacitance of electric double-layer capacitors should make them ideal miniaturized filter capacitors, but they are hindered by their slow frequency responses. We report the development of interconnected and structurally integrated carbon tube grid–based electric double-layer capacitors with high areal capacitance and rapid frequency response. These capacitors exhibit excellent line filtering of 120-hertz voltage signal and volumetric advantages under low-voltage operations for digital circuits, portable electronics, and electrical appliances. These findings provide a sound technological basis for developing electric double-layer capacitors for miniaturizing filter and power devices.

摘要翻译：

滤波电容器在确保电气和电子设备的质量和可靠性方面发挥着关键作用。铝电解电容器是最常用的，但也是最大的滤波元件，限制了装置的小型化。双电层电容器的高面积、高体积电容本应使其成为理想的小型化滤波电容器，但其缓慢的频率响应阻碍了性能发展。研究组报道了互连和结构集成的碳管栅极双电层电容器的开发，具有高面积电容和快速频率响应。这些电容器在数字电路、便携式电子设备和电器低压操作下表现出对 120 赫兹电压信号的出色线滤波和体积优势。

这些发现为开发用于小型化滤波器和功率器件的双电层电容器提供了可靠的技术基础。

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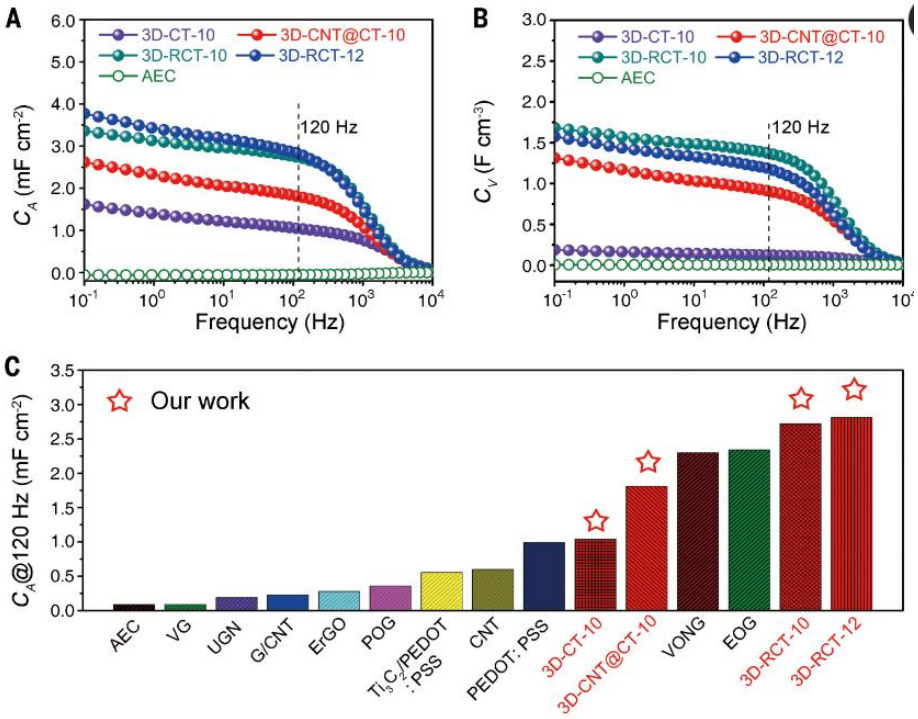

材料科学 8 月 Nature 论文

[1]Quantum cascade of correlated phases in trigonally warped bilayer graphene

三角弯曲双层石墨烯中相关相的量子级联

出版信息：Nature, 11 August 2022, Volume 608 Issue 7922

作者：Anna M. Seiler, Fabian R. Geisenhof, Felix Winterer et al.

第一作者单位：1st Physical Institute, Faculty of Physics, University of Göttingen, Göttingen, Germany

Physics of Nanosystems, Department of Physics, Ludwig-Maximilians-Universität München, Munich, Germany

全文链接：https://www.nature.com/articles/s41586-022-04937-1

Abstract：Here we report the observation of a cascade of correlated phases in the vicinity of electric-field-controlled Lifshitz transitions and van Hove singularities in Bernal bilayer graphene. We provide evidence for the observation of Stoner ferromagnets in the form of half and quarter metals. Furthermore, we identify signatures consistent with a topologically non-trivial Wigner－Hall crystal at zero magnetic field and its transition to a trivial Wigner crystal, as well as two correlated metals whose behaviour deviates from that of standard Fermi liquids. Our results in this reproducible, tunable, simple system open up new horizons for studying strongly correlated electrons.

摘要翻译：在此，我们报告在伯纳尔双层石墨烯中电场控制的 Lifshitz 转变和范霍夫奇点附近观察到的一系列相关相。我们为观察到以半金属和四分之一金属形式的斯通纳铁磁体提供了证据。此外，我们确定了在零磁场下拓扑非平凡维格纳-霍尔晶体及其向平凡维格纳晶体转变的特征，以及两种行为与标准费米液体的行为相偏离的相关金属。我们在这个可重复的、可调的、简单的系统中的结果为研究强相关电子研究打开了新的视野。

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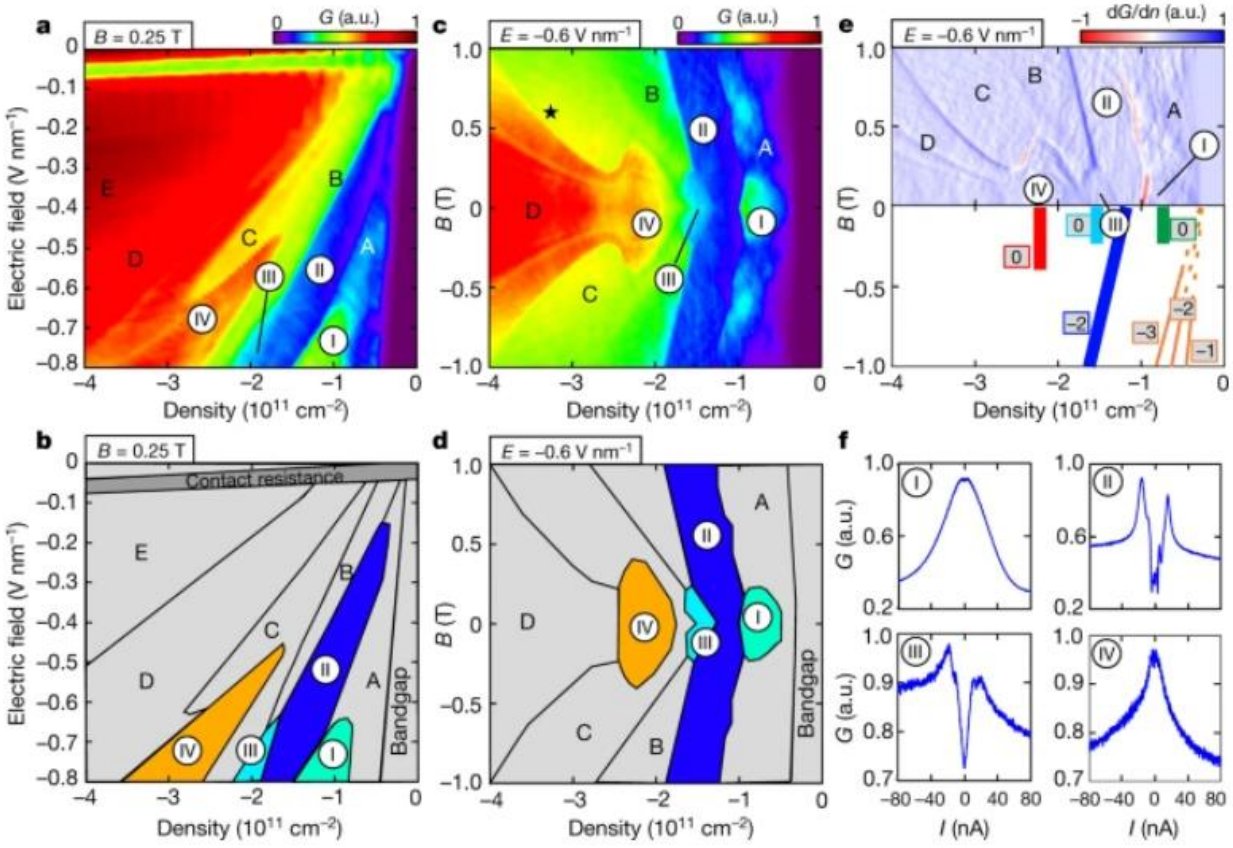

[2]

A mechanically strong and ductile soft magnet with extremely low coercivity

一种高强高塑、极低矫顽力的软磁体

出版信息：Nature, 11 August 2022, Volume 608 Issue 7922

作者：Liuliu Han, Fernando Maccari, Isnaldi R. Souza Filho et al.

第一作者单位：Max-Planck-Institut für Eisenforschung, Düsseldorf, Germany

全文链接：https://www.nature.com/articles/s41586-022-04935-3

Abstract： The electrification of transport, households and manufacturing leads to an increase in energy consumption owing to hysteresis losses. Therefore, minimizing coercivity, which scales these losses, is crucial. Yet meeting this target alone is not enough: SMMs in electrical engines must withstand severe mechanical loads; that is, the alloys need high strength and ductility. Here we introduce an approach to overcome this dilemma. We have designed a Fe–Co–Ni–Ta–Al multicomponent alloy (MCA) with ferromagnetic matrix and paramagnetic coherent nanoparticles (about 91 nm in size and around 55% volume fraction). They impede dislocation motion, enhancing strength and ductility. Their small size, low coherency stress and small magnetostatic energy create an interaction volume below the magnetic domain wall width, leading to minimal domain wall pinning, thus maintaining the soft magnetic properties. The alloy has a tensile strength of 1,336 MPa at 54% tensile elongation, extremely low coercivity of 78 Am−1 (less than 1 Oe), moderate saturation magnetization of 100 A m2 kg−1 and high electrical resistivity of 103 μΩ cm.

摘要翻译：交通、家庭和制造业的电气化，由于滞后损失，导致能源消耗增加。因此，降低矫顽力是至关重要的，它可以衡量这些损失。然而，仅仅实现这一目标是不够的：电机中的微型微结构元件必须承受严重的机械负载；也就是说，合金需要高强度和延展性。在此，我们介绍一种克服此类困境的方法。我们设计了一种 Fe-Co-Ni-Ta-Al 多元合金（MCA），它具有铁磁基体和顺磁性相干纳米颗粒（尺寸约为 91nm，体积分数约为 55%）。它们阻碍位错运动，增加强度和延展性。它们的小尺寸、低相干应力和小静磁能在磁畴壁宽度以下产生相互作用体积，导致畴壁钉扎最小化，从而保持软磁性。这种合金在 54%的拉伸伸长率下抗拉强度为 1336 MPa，矫顽力为 78 Am−1（小于 1 Oe），饱和磁化强度为 100 A m2 kg−1，电阻率为 103 μΩ cm.

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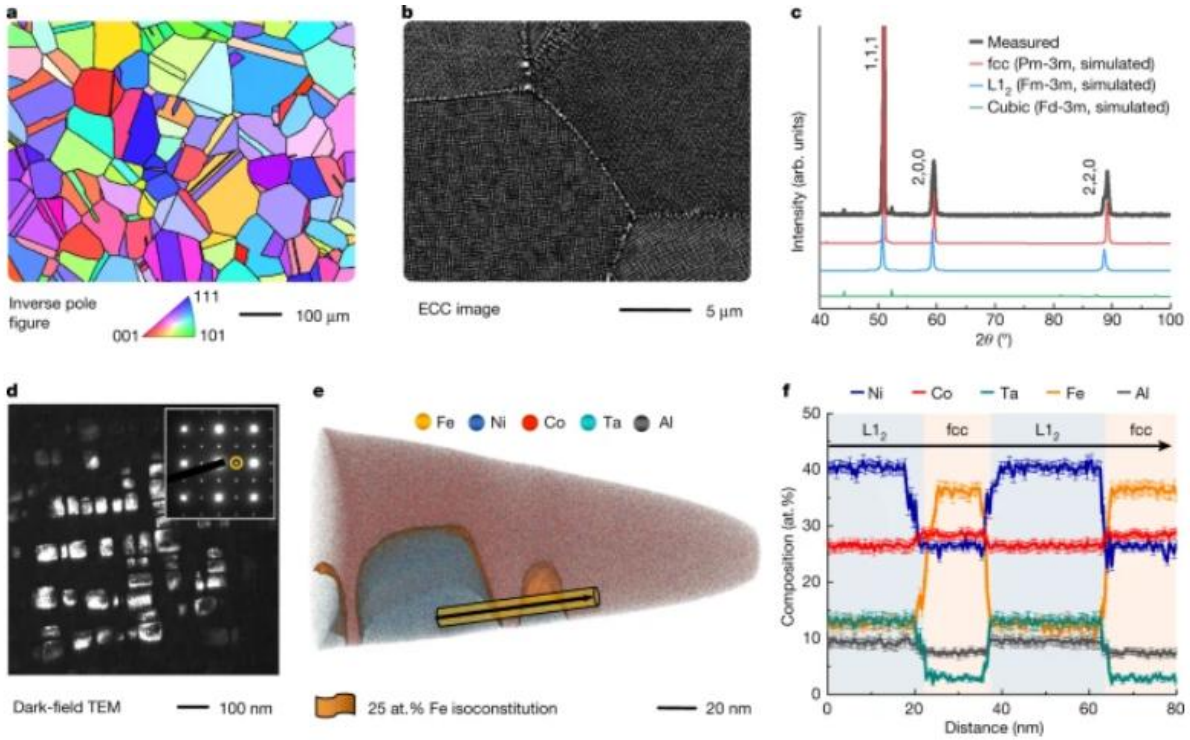

[3]

Floating perovskite-BiVO4 devices for scalable solar fuel production

可扩展太阳能燃料生产的漂浮钙钛矿-BiVO4 器件

出版信息：Nature, 18 August 2022, VOL 608, ISSUE 7923

作者：Virgil Andrei, Geani M. Ucoski, Chanon Pornrungroj, Chawit Uswachoke, Qian Wang, Demetra S. Achilleos, et al.

第一作者单位：Yusuf Hamied Department of Chemistry, University of Cambridge, Cambridge, UK

Optoelectronics Group, University of Cambridge, Cambridge, UK

全文链接：https://www.nature.com/articles/s41586-022-04978-6

Abstract: Photoelectrochemical (PEC) artificial leaves hold the potential to lower the costs of sustainable solar fuel production by integrating light harvesting and catalysis within one compact device. However, current deposition techniques limit their scalability, whereas fragile and heavy bulk materials can affect their transport and deployment. Here we demonstrate the fabrication of lightweight artificial leaves by employing thin, flexible substrates and carbonaceous protection layers. Lead halide perovskite photocathodes deposited onto indium tin oxide-coated polyethylene terephthalate achieved an activity of 4,266 μ mol H2g−1h−1 using a platinum catalyst, whereas photocathodes with a molecular Co catalyst for CO2 reduction attained a high CO:H2 selectivity of 7.2 under lower (0.1 sun) irradiation. The corresponding lightweight perovskite-BiVO4 PEC devices showed unassisted solar-to-fuel efficiencies of 0.58% (H2) and 0.053% (CO), respectively. Their potential for scalability is demonstrated by 100cm2 stand-alone artificial leaves, which sustained a comparable performance and stability (of approximately 24h) to their 1.7cm2 counterparts. Bubbles formed under operation further enabled 30 – 100 mg cm−2 devices to float, while lightweight reactors facilitated gas collection during outdoor testing on a river. This leaf-like PEC device bridges the gulf in weight between traditional solar fuel approaches, showcasing activities per gram comparable to those of photocatalytic suspensions and plant leaves. The presented lightweight, floating systems may enable open-water applications, thus avoiding competition with land use.

摘要翻译：光电化学（PEC）人工叶通过将采光和催化集成在一个紧凑设备中，具有降低可持续太阳能燃料生产成本的潜力。然而，当前的沉积技术限制了其可扩展性，而脆弱和沉重的块体材料可能会影响其运输和部署。研究组展示了通过使用薄而柔性的基底和碳质保护层制造轻质人工叶。沉积在铟锡氧化物包覆的聚对苯二甲酸乙二醇酯上的卤化铅钙钛矿光电阴极，使用铂催化剂时活性达到 4266μmol H2g−1h−1，而使用分子 Co 催化剂还原 CO2 的光电阴极在低（0.1 太阳）光照下的 CO:H2 选择性高达 7.2。相应的轻质钙钛矿-BiVO4 PEC 器件显示无辅助太阳能-燃料效率分别为 0.58%（H2）和 0.053%（CO）。100cm2 的独立人工叶证明了它们可扩展的潜力，性能和稳定性（约 24h）可与 1.7cm2 的同类物相媲美。运行中形成的气泡进一步使 30-100mg cm−2 的设备漂浮，而轻型反应器便于在河流中户外试验时收集气体。这种叶子状的 PEC 装置填补了传统太阳能燃料方法之间的重量鸿沟，每克展示的活性可与光催化悬浮液和植物叶子相媲美。这种轻型漂浮系统可实现开放水域应用，从而避免与土地使用相竞争。

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