《科学》（20260129出版）一周论文导读

作者：writer 来源：科学网

本文原地址：https://www.iikx.com/news/progress/38208.html

《科学》（20260129出版）一周论文导读。编译未玖

Science, 29 JAN 2026, VOL 391, ISSUE 6784

《科学》2026年1月29日，第391卷，6784期


AAAS
Science
GONE FISHING
Social cues inform foraging decisions pp. 442 & 475
29 JANUARY 2026
The radiation hazards awaiting deep-space travelers p. 436
A pathway for scalable ferroelectric memories pp. 445 & 474
Heritability of human life span pp. 448 & 504

物理学Physics

Wafer-scale ultrathin and uniform van der Waals ferroelectric oxide

晶圆级超薄均匀的范德华铁电氧化物

▲ 作者：QINCI WU, ZHONGRUI LI, BINGCHEN HAN, WEIYU SUN, QINYUN LIU, CHENGYUAN XUE, ET AL.

▲链接：

▲摘要：

铁电材料在非易失性存储器和下一代电子器件领域具有巨大潜力。但传统铁电氧化物薄膜通常存在结构不均匀、界面去极化以及性能下降等问题，尤其在微缩至先进技术节点时更为明显。

研究组展示了超薄范德华（vdW）高介电常数铁电氧化物Bi2SeO5的均匀晶圆级合成以及与后端工艺兼容的集成。该材料在单层厚度下仍能保持最佳矫顽场和稳健铁电性。

超薄vdW铁电氧化物与二维半导体形成了原子均匀的界面，并制备出了具有低工作电压（0.8伏特）、出色循环耐久性（>1.5×1012次循环）、快速写入速度（20纳秒）、高开/关比（106）、10年保持时间、超低能耗（2.8飞焦耳/比特/平方微米）以及小于5%器件间差异的铁电场效应晶体管（FeFET）阵列。采用这些FeFET的可重构逻辑存储电路可在低于1伏的供电电压下正常工作。

▲ Abstract：

Ferroelectrics have great potential for nonvolatile memory and next-generation electronics, but conventional ferroelectric oxide films generally suffer structural nonuniformity, interfacial depolarization, and performance degradation, particularly when downscaled to advanced technology nodes. We demonstrate uniform, wafer-scale synthesis and back-end-of-line – compatible integration of ultrathin van der Waals (vdW) high-dielectric constant ferroelectric oxide Bi2SeO5, retaining an optimal coercive field and robust ferroelectricity at monolayer thickness. Ultrathin vdW ferroelectric oxides formed atomically uniform interfaces with two-dimensional semiconductors and yielded ferroelectric field-effect transistor (FeFET) arrays with a low operating voltage (0.8 volts), exceptional cycling endurance (>1.5 × 1012 cycles), fast write speed (20 nanoseconds), high on/off ratio (106), 10-year retention, ultralow energy consumption (2.8 femtojoules per bit per square micrometer), and <5% device-to-device variation. Reconfigurable logic-in-memory circuits with these FeFETs function at supply voltages of <1 volt.

Probing supersolidity through excitations in a spin-orbit – coupled Bose-Einstein condensate

通过自旋-轨道-耦合的玻色-爱因斯坦凝聚态中的激发来探测超固态

▲ 作者：C. S. CHISHOLM, S. HIRTHE, V. B. MAKHALOV, R. RAMOS, R. VATRé, J. CABEDO, ET AL.

https://www.science.org/doi/10.1126/science.adv1209

▲摘要：

自旋-轨道耦合的玻色-爱因斯坦凝聚态是一种灵活的实验平台，可用于设计合成量子多体系统。特别是，其存在所谓的“ 条纹相 ”，这是超固态物质的一种实例。条纹相独特的激发光谱是其超固态特性的一个确切特征，但长期以来很难通过实验测量。

研究组对这些条纹进行了原位成像，并直接观测到了超流体激发和晶格激发现象。他们研究了超流流体动力学，并揭示了条纹压缩模式，从而证明该系统具有可压缩的晶体结构。通过这种模式的频率软化处理，研究组确定了超固态转变点。

该研究结果表明，具有自旋-轨道-
耦合效应的超固态是研究超固态现象及其丰富动力学的理想系统。

▲ Abstract：

Spin-orbit – coupled Bose-Einstein condensates are a flexible experimental platform to engineer synthetic quantum many-body systems. In particular, they host the so-called stripe phase, an instance of a supersolid state of matter. The peculiar excitation spectrum of the stripe phase, a definite footprint of its supersolidity, has been difficult to measure experimentally. In this work, we performed in situ imaging of the stripes and directly observed both superfluid and crystal excitations. We investigated superfluid hydrodynamics and revealed a stripe compression mode, thus demonstrating that the system possesses a compressible crystalline structure. Through the frequency softening of this mode, we located the supersolid transition point. Our results establish spin-orbit – coupled supersolids as ideal systems to investigate supersolidity and its rich dynamics.

材料科学Materials Science

Lithographic crystallinity regulation in additive fabrication of thermoplastics (CRAFT)

热塑性塑料增材制造中的光刻结晶度调控（CRAFT）

▲ 作者：ALEX J. COMMISSO, ERIC M. NAGEL, MEGHAN T. KIKER, ELIZABETH A. RECKER, ADAM BISCHOFF, MICHAEL J. HOLZMANN, ET AL.

▲链接：

https://www.science.org/doi/10.1126/science.aeb3637

▲摘要：

对于半结晶型聚烯烃热塑性塑料，有序晶体区域与无序非晶区域之间相互连接形成的平衡关系对其性能和加工性至关重要。然而，从注塑成型到三维（3D）打印的当代制造策略都是均质成型，无法实现结晶度的空间编码。

研究组开发了一种基于光的制造方法，用于在三维空间中对聚烯烃热塑性塑料的结晶度进行精确控制，使其具有优异的机械强度。光剂量能够调控聚合物立体化学，只需按下开关即可轻松制备出一系列不同的材料，从坚固的硬质塑料（如高密度聚乙烯）到更具延展性的材料（类似于低密度聚乙烯）。

将该发现应用于光刻灰度3D打印技术，可实现快速多材料制造，对光学和机械性能进行体素级操控，从而为信息存储、软体机器人和能量阻尼等领域开辟新途径。

▲ Abstract：

For semicrystalline polyolefin thermoplastics, the balance between interconnected ordered crystalline and disordered amorphous regions is paramount to their performance and processability. However, contemporary manufacturing strategies, from injection molding to three-dimensional (3D) printing, result in monolithic objects, unable to spatially encode crystallinity. We develop a light-based approach for fabricating mechanically robust polyolefin thermoplastics with microscopic control over crystallinity in 3D space. Light dosage governs polymer stereochemistry giving access to a continuum of materials, from strong rigid plastics, such as high-density polyethylene, to more extensible materials akin to low-density polyethylene, all at the flick of a switch. Leveraging this finding in lithographic grayscale 3D printing enables rapid multimaterial fabrication with voxel-level control over optical and mechanical properties, opening avenues in information storage, soft robotics, and energy damping.

化学Chemistry

Kinetic acceleration of MoS2 growth by oxy-metal-organic chemical vapor deposition

氧辅助金属有机化学气相沉积实现MoS2生长的动力学加速

▲ 作者：LEI LIU, YUSHU WANG, RUIKANG DONG, DONGXU FAN, SI MENG, LANG WU, ET AL.

▲链接：

https://www.science.org/doi/10.1126/science.aec7259

▲摘要：

动力学决定了薄膜的生长特性，尤其是对于原子薄的过渡金属二硫化物而言。金属有机（MO）化学气相沉积（CVD）技术在可扩展生长方面颇具前景，但其反应受到动力学限制，从而引发

纳米级畴尺寸以及碳污染问题。

研究组揭示了基本的动力学限制因素，并通过引入氧辅助的MOCVD（oxy-MOCVD）技术来突破这一瓶颈。通过氧气调控反应过程，MO前体能够转化为高纯度的过渡金属氧化物和硫族元素，从而生成尺寸和生长速率都比传统MOCVD大几个数量级的有序二硫化钼（MoS2）畴。

所得二硫化钼不含碳杂质，其平均迁移率超过100平方厘米/伏/秒。oxy-MOCVD技术的可扩展性通过制备150毫米单晶二硫化钼晶圆得到了验证，这证明工业规模生产是可行的。

▲ Abstract：

Kinetics determine the growth behavior of thin films, particularly for atomically thin transition-metal dichalcogenides. Metal-organic (MO) chemical vapor deposition (CVD) offers promise for scalable growth, but the reactions are kinetically limited, leading to nanometer-scale domain size and carbon contaminations. Here, we unveil the fundamental kinetic limitations and overcome them by introducing oxygen-assisted MOCVD (oxy-MOCVD) technology. By tuning reactions with oxygen, MO precursors are converted into high-purity transition-metal oxides and chalcogens, producing aligned molybdenum disulfide (MoS2) domains with a size and growth rate that are orders of magnitude larger than conventional MOCVD. The MoS2 is free of carbon impurities and exhibits average mobility exceeding 100 square centimeters per volt per second. The scalability of oxy-MOCVD is demonstrated by 150-millimeter single-crystal MoS2 wafers, proving the feasibility of industrial-scale production.

地球科学Earth Science

Extreme plate boundary localization promotes shallow earthquake slip at the Japan Trench

极端板块边界局域化促使日本海沟发生浅层地震滑动

▲ 作者：J. D. KIRKPATRICK, H. M. SAVAGE, C. REGALLA, S. SHREEDHARAN, C. ROSS, H. OKUDA, ET AL.

▲链接：

https://www.science.org/doi/10.1126/science.ady0234

▲摘要：

2011年矩震级9.1级的日本东北冲海啸地震在所有大地震中均属罕见，其在板块边界巨型逆冲断层最浅部分的峰值滑动位错高达50至70米。

国际海洋发现计划第405次考察所获取的钻芯样本和地球物理测井数据表明，巨型逆冲断层优先发育在输入太平洋板块沉积层中远洋黏土的顶部或底部，这些区域的物理性质存在显著差异。

这种偏好导致了一条狭窄的弱断层出现在前缘棱柱状泥岩与俯冲沉积物之间的主要机械界面，这

增强了浅层地震滑动的可能性，表明日本海沟可能比没有弱黏土的板块边界更容易发生大范围浅层滑动的破裂。

▲ Abstract：

The 2011 moment magnitude 9.1 Tohoku-oki earthquake is exceptional among great earthquakes for having peak slip of ~50 to 70 meters on the shallowest portion of the plate boundary megathrust. Drill cores and geophysical logs from InternationalOcean Discovery Program Expedition 405 demonstrate that the megathrust preferentially develops at the top or base of the pelagic clay in the sedimentary layers present on the incoming Pacific Plate, where pronounced contrasts in physical properties occur. This preference results in a narrow, weak fault located at a major mechanical contact between frontal prism mud and subducted sediments, which enhances the tendency for shallow seismic slip, suggesting that the Japan Trench may be more susceptible to ruptures with large shallow slip than are margins without weak clays.

High-resolution geodetic velocities reveal role of weak faults in deformation ofTibetan Plateau

高分辨率大地测量速度场揭示弱断裂在青藏高原地壳变形中的作用

▲ 作者：T. J. WRIGHT, G. A. HOUSEMAN, J. FANG, Y. MAGHSOUDI, A. J. HOOPER, J. R. ELLIOTT, ET AL.

▲链接：

https://www.science.org/doi/10.1126/science.adi3552

▲摘要：

理解控制大陆构造变形的关键机制，一直是地球动力学领域的根本性挑战。

研究组获得了青藏高原高分辨率的大地测量速度场数据，表明有几条主要的走滑断裂系分隔了变形分布更均匀的区域。他们认为，主要断裂系的集中应变由相对低粘度的延展性剪切带引发，这些剪切带贯穿地震活跃断裂面下方的岩石圈。

简单的模型计算表明，昆仑断裂带的高滑动率使得东西向延伸广泛分布在相对薄弱的藏南和藏中地区。中新世时期昆仑断裂带的活跃与南北地堑裂谷的开始同时发生，这表明两者之间存在因果关系。

▲ Abstract：

Understanding the key mechanisms that control the tectonic deformation of the continents remains a fundamental challenge in geodynamics. We present a high-resolution geodetic velocity field of theTibetan Plateau, which shows that a few major strike-slip fault systems separate regions of more uniformly distributed deformation. We suggest that focused strain on major fault systems is enabled by relatively low-viscosity ductile shear zones extending through the lithosphere beneath the seismically active fault planes. Simple model calculations show that high slip rates on the Kunlun Fault enable east-west extension to be distributed broadly across the relatively weak southern and centralTibetan Plateau. Activation of the Kunlun fault in the

Miocene at the same time as the onset of rifting in the north-south grabens suggests a causal relationship.

作者：未玖 来源：科学网微信公众号