《科学》（20250612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/33954.html

《科学》（20250612出版）一周论文导读。编译冯维维

Science, 12 June 2025, Volume 388, Issue 6752

《科学》，2025年6月12日，388卷，6752期

化学Chemistry

Acid-humidified CO2 gas input for stable electrochemical CO2 reduction reaction

酸加湿CO2气体输入用于稳定的电化学还原反应

▲ 作者：SHAOYUN HAO, AHMAD ELGAZZAR, SHOU-KUN ZHANG, TAE-UNG WI, FENG-YANG CHEN, YUGE FENG, PENG ZHU, AND HAOTIAN WANG

▲链接：

https://www.science.org/doi/10.1126/science.adr3834

▲摘要：

电化学还原二氧化碳是一个新兴的研究领域，其反应提供了一种环境可持续的方式，可将温室气体作为原料加以利用。优化的电极设计可最大限度地提高气体向催化剂的传输效率，但长期存在的一个问题是，由于碳酸氢盐的沉淀，设备会随时间发生堵塞。

研究者发现，向二氧化碳输入流中引入少量挥发性酸，可防止这种盐类沉淀，并促进持续还原反应长达4500小时。

▲ Abstract：

Electrochemical reduction of carbon dioxide is a burgeoning field of research because the reaction presents an environmentally sustainable means of using the greenhouse gas as a feedstock. Optimal electrode design would maximize the efficiency of gas transport to the catalyst, but a persistent problem has been clogging over time due to precipitation of bicarbonate salts. Hao et al. found that introducing a small amount of volatile acid into the carbon dioxide input stream can prevent this salt precipitation and promote continuous reduction for up to 4500 hours.

Evolutionary-scale enzymology enables exploration of a rugged catalytic landscape

进化尺度酶学助力探索复杂催化景观

▲ 作者：DUNCAN F. MUIR, GARRISON P. R. ASPER, PASCAL NOTIN, JACOB A. POSNER, DEBORA S. MARKS, MICHAEL J. KEISER, AND MARGAUX M. PINNEY

▲链接：

https://www.science.org/doi/10.1126/science.adu1058

▲摘要：

特定酶的催化活性在不同物种的直系同源物中可能存在显著差异，这取决于其所处环境和特定的代谢需求。但此类差异如何进化，又与哪些具体结构特征相关？研究者利用高通量微流控系统，对近200个腺苷酸激酶的直系同源物进行了活性测定，并基于结果构建了催化活性的全景视图。

研究发现，生长温度与酶活性的相关性极低，且高活性峰值在景观中广泛分布，很可能是独立进化的结果。当前的蛋白质语言模型虽能按结构对酶进行分组，却无法预测催化活性景观；不过，

利用实验活性数据训练模型仍具潜力。

▲ Abstract：

The catalytic activity of a particular enzyme can vary widely between orthologs in different species, depending on their environment and specific metabolic needs. But how do such differences evolve and relate to specific structural features? Using a high-throughput microfluidic system, Muir et al. assayed nearly 200 orthologs of the enzyme adenylate kinase and used the resulting data to build a landscape view of catalytic activity. There was minimal correlation between growth temperature and activity, and high activity peaks were widely distributed in the landscape and likely evolved independently. Current protein language models group enzymes by structure but fail in predicting the catalytic activity landscape; however, there is potential to train models using experimental activity data.

物理学Physics

Gate-driven band modulation hyperdoping for high-performance p-type 2D semiconductor transistors

高性能p型二维半导体晶体管的实现

▲ 作者：BEI ZHAO, ZUCHENG ZHANG, JUNQING XU, DINGLI GUO, TIANCHENG GU, GUIMING HE, PING LU, KUN HE, JIA LI, AND XIDONG DUAN

▲链接：

https://www.science.org/doi/10.1126/science.adp8444

▲摘要：

通过能带对准效应，二硒化钨双层结构可将其电子转移至相邻的二硫化锡单层，从而实现高浓度空穴掺杂。虽然离子注入技术常用于半导体薄膜掺杂，但在少层过渡金属硫族化合物中难以实施。

研究者证明，利用外部门极偏压调节范德瓦尔斯界面的能带偏移和电荷转移，可获得每平方厘米1.49×1014的空穴浓度，这一数值约为传统介电极限的五倍。

▲ Abstract：

Band alignment effects enable high levels of hole doping in a tungsten diselenide bilayer through its transfer of electrons into an adjacent tin disulfide monolayer. Ion implantation is often used to dope in semiconductor films, but this is difficult in few-layer transition metal dichalcogenides. Zhao et al. show that tuning of the band offset and charge transfer across the van der Waals interface with an external gate bias can produce a hole density of 1.49 × 1014 per square centimeter, which is about five times the conventional dielectric limit.

Differential absorption of circularly polarized light by a centrosymmetric crystal

中心对称晶体对圆偏振光的差分吸收

▲ 作者：KATHERINE A. PARRISH, ANDREW SALIJ, KENDALL R. KAMP, EVAN SMITH, AND ROEL TEMPELAAR

▲链接：

https://www.science.org/doi/10.1126/science.adr5478

▲摘要：

晶体固体受其对称性决定的普适结构—性能关系所支配，衍生出关于材料可能或不可能展现哪些性能的范式规则。一个长期公认的结构—性能关系是：中心对称晶体不可能对圆偏振光产生差分吸收。

研究者通过设计、合成和表征中心对称材料Li2Co3（SeO3）4，打破了这一认知。该材料并非通过违背对称性选择定则，而是利用一种此前在晶体固体中未被表征的光物理过程实现了这一突破。

该过程源于线性二色性（LD）与线性双折射（LB）的干涉效应（简称LD-LB效应），可产生强手性光学信号，且信号会随样品翻转发生反转。这一发现不仅实现了中心对称体系下的手性光学响应，更为基于晶体固体的光子工程开辟了新途径。

▲ Abstract：

Crystalline solids are governed by universal structure-property relationships derived from their crystal symmetry, leading to paradigmatic rules on what properties they can and cannot exhibit. A long-held structure-property relationship is that centrosymmetric crystals cannot differentially absorb circularly polarized light. In this study, we demonstrate the design, synthesis, and characterization of the centrosymmetric material Li2Co3（SeO3）4, which violates this relationship not by defying symmetry-imposed selection rules but by invoking a photophysical process not previously characterized for crystalline solids. This process originates from an interference between linear dichroism and linear birefringence, referred to as LD-LB, and involves strong chiroptical signals that invert upon sample flipping. In addition to enabling a chiroptical response under centrosymmetry, this process opens up photonic engineering opportunities based on crystalline solids.

生态学Ecology

Global importance of nitrogen fixation across inland and coastal waters

内陆与沿海水域固氮作用的全球重要性

▲ 作者：ROBINSON W. FULWEILER, SHELBY RINEHART, JASON TAYLOR, MICHELLE C. KELLY, MEGAN E. BERBERICH, NICHOLAS E. RAY, AUTUMN OCZKOWSKI, SAWYER BALINT,

MAR BENAVIDES, AND AMY M. MARCARELLI

▲链接：

https://www.science.org/doi/10.1126/science.adt1511

▲摘要：

生物固氮，即将氮气转化为生物可利用的固定氮的过程，已在陆地和开阔海洋系统中得到广泛研究，但人们对其在内陆和沿海水域中的作用知之甚少。

研究者发现，内陆和沿海地区的固氮速率极高。尽管这些栖息地占地球表面积不足10%，却贡献了陆地和海洋中约20%的固氮量。

▲ Abstract：

Biological nitrogen fixation, which converts nitrogen gas into biologically available fixed nitrogen, has been studied extensively in terrestrial and open ocean systems, but less is known about this process in inland and coastal waters. Fulweiler et al. found that inland and coastal regions fix nitrogen at prodigious rates. Although these habitats occupy less than 10% of Earth ’ s surface, they are responsible for approximately 20% of the nitrogen fixation occurring on land and in the ocean.

Observed trend in Earth energy imbalance may provide a constraint for low climate sensitivity models

地球能量失衡的观测趋势可为低气候敏感性模型提供约束

▲ 作者：GUNNAR MYHRE, IVIND HODNEBROG, NORMAN LOEB , AND PIERS M. FORSTER

▲链接：

https://www.science.org/doi/10.1126/science.adt0647

▲摘要：

气候变暖或变冷取决于地球大气顶层的净能量通量——当入射太阳辐射通量大于或小于出射长波辐射通量时，气候相应变暖或变冷。卫星数据显示，2001年至2023年间，导致气候变暖的能量失衡现象已加剧。

研究者发现，低气候敏感性的气候模型无法重现地球能量失衡的这一趋势。他们的研究表明，大气温室气体浓度的持续升高可能导致比当前多数模型预测更为剧烈的变暖。

▲ Abstract：

Climate warms or cools depending on whether the net energy flux from incoming solar radiation is

respectively greater or less than that of outgoing long-wave radiation at the top of Earth’s atmosphere. Satellite data have shown that an energy imbalance producing warming has strengthened between 2001 and 2023. Myhre et al. show that climate models with low climate sensitivity do not reproduce that trend in Earth energy imbalance. Their finding means that increasing concentrations of atmospheric greenhouse gases likely will cause even more warming than most current models predict.

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