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编者按：2024浦江创新论坛——未来材料论坛以“交叉创新与可持续发展”为主题，与会嘉宾围绕未来信息、未来能源、未来生物医药等领域的新材料研究展开深度研讨。本期专报对未来材料论坛嘉宾观点进行梳理，供参考。

Editor's note: With the theme of "Cross Innovation and Sustainable Development", the attendees to the 2024 Pujiang Innovation Forum - Future Materials Forum conducted in-depth discussions on new materials research in fields such as future information, future energy, and future biomedicine. This special report synthesizes the viewpoints of the guests at the Future Materials Forum for your information.

2024 浦江创新论坛专报之十四

Special Report 14 of the 2024 Pujiang Innovation Forum

加速未来材料交叉创新　筑牢未来产业发展基础

Accelerate the Cross Innovation of Future Materials, and Lay A Solid Foundation for the Development of Future Industries

新材料是高新技术发展的基本资源，也是国际竞争的重点领域之一。近年来，随着科技创新和产业转型升级的推进，新材料产业在我国呈现出快速发展的态势，但也面临如关键原材料供应不足、核心技术受制于人、产业集聚效应不明显等挑战。**与会嘉宾一致认为，材料科学发展已经进入全新阶段，跨学科交叉融合、仿生创新成为最重要的特征，未来材料研发将进一步突破传统理论瓶颈，向智能化、绿色化方向加速演进，需要进一步加强政策引导和支持，提升产业创新能力和竞争力。**

New materials are a fundamental resource for the development of high-tech and one of the key areas of international competition. In recent years, with the advancement of scientific and technological innovation and industrial transformation and upgrading, the new materials industry in China has exhibited a rapid development trend, but it also faces challenges such as insufficient supply of key raw materials, depend on others for core technologies, and insignificant

industrial agglomeration effects. **The guests present unanimously agreed that the development of materials science has entered a new stage, with interdisciplinary cross-integration and biomimetic innovation becoming the most important features. The research and development of future materials will further break through traditional theoretical bottlenecks and accelerate towards intelligent and green directions. It is necessary to further strengthen policy guidance and support, and enhance industrial innovation capabilities and competitiveness.**

一、加速未来材料研发创新的重要意义

1. The importance of accelerating the R&D and innovation of future materials

一是新材料研发直接推动各领域技术进步和产业升级。新材料与大数据、云计算和人工智能等新一代信息技术深度融合，直接催生了智能制造、智能传感等新模式创新，促进了制造业向高端化、精细化发展。**中国科学院院士、北京科技大学教授张跃**指出，中国“3060 目标”能否实现取决于钢铁行业能否从碳还原体系切换到氢还原体系，其中高效率的催化电极材料开发起到至关重要作用。**上海交通大学李政道研究所长聘教授 Vadim Grinenko** 指出，新超导材料的开发推动了核磁共振技术的发展，使得医学界能够更精确地诊断疾病。**清华大学教授宋成**强调，基于 20°Y-X $LiNbO_3$ 声表面波谐振器制备的大带宽磁电天线支撑新一代通信

技术的发展，使得普通手机能够直接与卫星连接，开启通信新时代。

Firstly, the research and development of new materials directly promotes technological progress and industrial upgrading in various fields. The in-depth integration of new materials with new-generation information technologies such as big data, cloud computing and artificial intelligence has directly given rise to new model innovations such as smart manufacturing and smart sensing, and made the manufacturing sector higher-end and better targeted. **Zhang Yue, Member of the Chinese Academy of Sciences and Professor of Beijing University of Science and Technology,** pointed out that whether China's goals to peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060 (China's "3060 Goals") can be achieved depends on whether the steel industry can be switched from the carbon reduction system to the hydrogen reduction system, in which the development of high-efficiency catalytic electrode materials plays a crucial role. **Vadim Grinenko, Tenured Professor of the Tsung-Dao Lee Institute (TDLI) at Shanghai Jiao Tong University,** pointed out that the development of new superconducting materials has promoted the development of nuclear magnetic resonance (NMR) technology, enabling the medical community to diagnose diseases more accurately. **Professor Song Cheng from Tsinghua University**

emphasized that the large bandwidth magneto-electric (ME) antenna manufactured based on the 20 ° Y-X LiNbO3 surface acoustic wave resonator supports the development of next-generation communication technology, enabling ordinary mobile phones to directly connect with satellites, thereby ushering in a new era of communication.

二是国家总体安全要求加快推进新材料的自主研发。中国科学院院士、上海交通大学教授张荻指出，上海交通大学长期聚焦空间新材料自主研发，为航天器结构与关键部件提供保障，支撑天宫一号、嫦娥探测器等外太空任务稳定运行。**中国科学技术大学教授余彦**认为，新兴电化学储能技术的开发，如钠离子电池，使得我国电池体系核心技术掌握在自己手中，不受制于人。

Secondly, for the purpose of overall national security, it is required to accelerate the independent research and development of new materials. Zhang Di, Member of the Chinese Academy of Sciences and Professor of Shanghai Jiao Tong University, pointed out that Shanghai Jiao Tong University has long focused on independent research and development of new space materials, providing support for spacecraft structures and key components, and supporting the stable operation of Tiangong-1, Chang'e probe and other outer space missions. **Professor Yu Yan from the University of Science and Technology of China** believes that the development of emerging electrochemical energy storage

technologies, such as sodium ion batteries, has enabled us to hold the core technologies of China's battery system in our hands, not subject to others.

二、未来材料重点布局方向：交叉融合、智能化与绿色化

2. Key layout directions for future materials: cross-integration, smart, and eco-friendly

一是聚焦交叉融合，重视跨学科、跨领域合作研发实现高价值新材料的设计与制备。张荻指出，结合铝基材料与碳纳米管，能够生产出比强度高、比模量大的复合材料，将其应用于关键传力结构的设计，将极大惠及军事、经济和社会效益。**宋成**指出，通过电磁学与声学耦合，研发磁电天线、磁敏传感器，加速实现微波器件小型化。同时，注重从大自然获取灵感开展仿生创新。**中国科学院金属研究所研究员刘岗**指出，借鉴农业种植中的植物套种策略，如玉米+花生，将随机无序组装的光催化氧化、光催化还原材料颗粒进行图案化有序组装，能够极大提升光催化全解水的效率。**张荻**强调，复合材料研发已经从材质复合发展到构型复合的高阶阶段，例如模拟自然蝶翅精细结构开发的“蝶翅”构型复合材料，能够产生光增益偶和效应，用于开发更高效的太阳光吸收材料。

The first is to focus on cross-integration, and attach importance to interdisciplinary and cross-field collaborative

research and development to achieve the design and preparation of high-value new materials. Zhang Di pointed out that by combining aluminum-based materials with carbon nanotubes, we can manufacture composite materials with high specific strength and large specific modulus. Applying such composite materials to the design of key force-transmitting structures will give rise to significant military, economic and social benefits. **Song Cheng** pointed out that through the coupling electromagnetism and acoustics as well as the research and development of magneto-electric antennas and magneto-dependent sensors, we can achieve the miniaturization of microwave devices at a faster pace. At the same time, we should attach great importance to drawing inspiration from nature and carrying out bionic innovation. **Liu Gang, Research Fellow of the Institute of Metal Research (IMR) of the Chinese Academy of Sciences,** pointed out that drawing on the plant inter-planting strategy in agricultural planting, such as corn + peanut, we can conduct patterned and orderly assembly of the randomly disordered photocatalytic oxidation and photocatalytic reduction material particles, thereby greatly improving the efficiency of photocatalytic total water splitting. **Zhang Di** emphasized that the research and development of composite materials has progressed from material quality composite to the advanced stage of configuration composite. For example, the "butterfly wing"

configuration composite material developed by simulating the fine structure of natural butterfly wings can generate light gain coupling and effects, which can be used to develop more efficient solar light absorbing materials.

二是聚焦智能化，开发具备感知功能、自我修复功能和智能响应外部环境功能的智能材料，实现功能精准调控。德国科学院院士、工程院院士、明斯特大学教授 Harald Fuchs 介绍了其在表面在位精准化学方面研究的最新进展，展示了特定的表面化学分子如何通过自组织的方式重构铜金属表面原子结构。**德国工程院院士、开姆尼茨工业大学教授 Oliver G. Schmidt** 指出，实现自我维持、自给自足、自我再生产是新型材料发展的重要方向，如由柔性材料、太阳能电池、光学感应以及微型马达组装而成的微型折纸机器人“智子”，能够感应环境，与同伴进行接驳和自组装形成各种形态，用以执行特定任务。

The second is to focus on intelligence and develop smart materials with the functions of perception, self-repair and intelligent response to the external environment to achieve precise functional control. Harald Fuchs, Member of the German National Academy of Sciences and Engineering and Professor the University of Münster, introduced the latest progress in his research on surface in-situ precision chemistry, demonstrating how specific surface chemical molecules can reconstruct the atomic structure of copper metal surfaces through self-organization. **Oliver**

G. Schmidt, the German Academy of Science and Engineering and Professor of Chemnitz University of Technology, pointed out that achieving the self-sustainability, self-sufficiency, and self-reproduction is an important direction for the development of new materials. For example, the micro origami robot "ZhiZi" assembled from flexible materials, solar cells, optical induction, and micro motors can sense the environment, connect with its peers, and form various forms through self-assembling, and it can be used to perform specific tasks.

三是聚焦绿色化，开发绿色、可循环和低碳的高性能材料，推进可持续高质量发展。世界工业技术研究组织协会主席、伊斯坦布尔科技大学校长 Hasan Mandal 指出，为实现 2050 年地球平均气温涨幅控制在 1.8°C 以内的目标，需要大力推动新电池技术与可再生能源技术，都离不开新材料应用。**李岗**研制的植入式光催化材料 $BiVO_4$ 薄膜展现出可规模化、通用、柔性和可回收等诸多优势。**宋成**基于材料创新开发的天线波束成形技术，成功保障了低功耗高效能的卫星通信。

The third is to focus on eco-friendly, develop green, recyclable and low-carbon high-performance materials, and promote sustainable and high-quality development. Hasan Mandal, President of the World Association of Industrial and Technological Research Organizations (WAITRO) and Rector of Istanbul Technical University, pointed out that in order to achieve

the goal of controlling the average temperature rise of the Earth within 1.8 ° C by 2050, it is necessary to vigorously promote new battery technology and renewable energy technology, both of which cannot be separated from the application of new materials. The implantable photocatalytic material BiVO4 thin film developed by **Li Gang** exhibits many advantages such as scalability, versatility, flexibility, and recyclability. The antenna beamforming technology developed by Song Cheng based on material innovation has successfully ensured low-power and high-performance satellite communication.

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