**RESEARCH HIGHLIGHTS**

Editors’ selection of papers from China’s academic journals

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**PHYSICS**

2D gallium oxide memristors for neuromorphic computing

Synapse emulation is very important for realizing neuromorphic computing, which could overcome the energy and throughput limitations of today’s computing architectures. Recently, a research team led by Guangyu Zhang at the Institute of Physics, Chinese Academy of Sciences (CAS), reported the realization of the synaptic function in memristor based on a vertical structure of graphene/ultrathin-gallium-oxide/Ag (see Fig. 1). The ultra-thin gallium oxide film is produced by a squeegee approach. The synaptic weight of the memristor could be tuned by the applied voltage pulse, number, width and frequency. Such ultra-thin synaptic devices provide a promising platform for developing neuromorphic computers with low energy consumption and high-efficiency. [Wang S et al. Chin Phys B 2019; 28: 017304]

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**CHEMISTRY**

C(sp²)–H phosphorylation for direct construction of aminophosphonic acid precursors

Construction of organophosphorus compounds is of great significance in pharmaceuticals, agrochemicals and material sciences. However, the efficient phosphorylation of alkeny C(sp²)–H bonds remains a huge challenge. Recently, Jun-An Ma, Fa-Guang Zhang and co-workers from Tianjin University reported a Pd-catalysed direct and efficient phosphorylation of enamido C(sp²)–H bonds to access a considerably wide range of β-amidovinylphosphonates without the need for additional ligands or directing groups. The novel method provides a practical, general and applicable route to the formation of C–P bonds and may find wide applications in relevant fields. [Qiao B et al. Chin J Chem 2018; 36: 809–14]

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**AGRICULTURAL SCIENCES**

Evolution of drought resistance in rice: from theoretical research to breeding practice

It is essential to learn the evolutionary process of drought resistance in rice for breeding drought-resistant rice. The recently published work by Lijun Luo’s group from Shanghai Agrobiological Gene Center discloses the mode of bi-directional selection in upland rice for both drought resistance and productivity, which makes it adaptively differentiated from lowland rice in drought resistance (see Fig. 2). The bi-directional selection retains great genetic biodiversity of drought resistance in upland rice. Some upland-specific recombination events can overcome the tradeoff between drought resistance and productivity. By
applying the bi-directional selection, the drought-resistant and water-saving rice derived from upland × lowland rice obtains advantages in both drought resistance and productivity. [Xia H et al. Mol Plant 2019; 12: 170–84]

**NEUROSCIENCE**

Revealing molecular landscapes of cerebellar development through single-cell transcriptome analysis

The cerebellum is critical for controlling motor and non-motor functions via a cerebellar circuit that is composed of defined cell types, which approximately account for more than half of neurons in mammals, whereas the molecular mechanisms governing cerebellar neuronal fate determination and maturation remain not completely understood. Recently, a study led by Zhen-Ge Luo at the Institute of Neuroscience, CAS, and ShanghaiTech University, analysed transcriptome profiles of 21 119 single cells of the postnatal mouse cerebellum and revealed trajectory hierarchies of various cerebellar cell types. The datasets implied roles of mitochondrion and ATPases in the maturation of Purkinje cells (PCs), the sole output cells of the cerebellar cortex, and found enriched expression of ataxia-related genes in PCs. This study will expedite the understanding of mechanisms of cerebellum development and accelerate the understanding of molecular and cellular mechanisms of cerebellar diseases. [Peng J et al. J Mol Cell Biol; doi: 10.1093/jmcb/mjy089]

**MATERIALS SCIENCE**

A nanoreactor of hierarchically hollow spheres as metal-free oxygen-reduction electrocatalysts

The creation of hierarchical structures in cathodic electrocatalysts could provide increased density of active sites and faster mass transfer, thus greatly improving the reactivity. Recently, Jiacheng Wang and Qian Liu at Shanghai Institute of Ceramics, CAS, prepared N-doped hollow carbon spheres via CO₂ activation, showing unique triple hierarchical micro-mesoporous structures and large surface areas (see Fig. 3). The optimized catalyst demonstrated comparable oxygen-reduction reaction (ORR) activity but superior methanol tolerance and long-term durability to commercial Pt/C with a 4e⁻-dominant transfer pathway, indicating its great potential as a cathodic electrocatalyst in fuel-cell applications. [Xing R et al. Nano-Micro Lett 2018; 10: 3]
MATERIALS SCIENCE

Sb$_2$S$_3$ hollow microspheres as anode materials for lithium/sodium-ion batteries

The design and synthesis of electrode materials with 3D hierarchical architectures have attracted considerable attention. Recently, Li Liu and co-workers at Xiangtan University fabricated Sb$_2$S$_3$ hollow microspheres by a simple hydrothermal reaction using SbCl$_3$ and Lcysteine as raw materials without adding any surfactants. The novel architecture combines the merits of nanometer size, hollow interior and 3D hierarchical structure. The material presents remarkable cycling performance and outstanding rate capability in lithium-ion batteries and also exhibits superior sodium-storage capabilities in sodium-ion batteries. [Xie J et al. Nano-Micro Lett 2018; 10: 12]

INFORMATION SCIENCE

Deep learning helps to discover the creation era of Dunhuang murals

Dating the creation era of ancient paintings is very important in archaeology. Some murals at Dunhuang, China, are hard to date due to the lack of reference materials. Recently, Qingquan Li (Shenzhen University), Qin Zou (Wuhan University) and co-workers formulated the problem of mural-painting dating into a problem of drawing-style classification and developed a novel dating method that encodes drawing styles with visual codes learned through deep learning.

This new method successfully uncovered the creation era of six mural paintings at Mogao Grottoes (see Fig. 4). [Li Q et al. Sci China Inf Sci 2018; 61: 092105]

Edited by Yuan Gao