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Editorial: Oriented Nanostructures for Energy Conversion and Storage

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Editorial on the Research Topic

Oriented Nanostructures for Energy Conversion and Storage

Oriented nanostructures demonstrate promising properties for energy harvesting, conversion, and storage. Because of the importance of material structure in applications, a common fundamental challenge is to improve the generation and transport of electrons and ions although the applications differ from field to field. Instead of seeking new materials, the majority of scientific attempts are made in promoting performance via high surface area to maximize surface activity and focusing on the importance of optimum dimension and architecture, controlled pore channels, and alignment of the nanocrystalline phase to optimize the transport of electrons and ions. All these strategies are effective to improve performance in energy and environmental applications. Meeting our expectations, this Research Topic has strengthened the fundamental and advanced knowledge of materials design and gathered related research on oriented nanostructures and improvements made for advanced energy conversion, energy storage, and environmental catalyst materials.

The Research Topic has collected eight manuscripts contributed from 42 authors and attracted 12 institutes in total. These data unequivocally illustrate the impact and popularity of nanostructured materials in energy conversion, energy storage, and environmental catalysis. The six research articles highlight the versatility of oriented nanostructures in a plethora of applications associated with energy conversion, energy storage, and environmental catalysis. Hu et al. demonstrated that the hierarchical structure $TiNb_2O_7$ wrapped further by graphene oxide nanosheets is beneficial to the final electrochemical performance in electrochemical energy storage fields. This study not only provided a general approach for the design of novel 2D nanomaterials wrapped by graphene because of the advantage of esterification reaction and flocculation reaction but also improved the electronic and ionic conductivity simultaneously. Niu et al. utilized nanoporous silica to understand the storage and transformation processes of organic hydrocarbons under the nanopore-confinement effect. This study showed that the interaction between the inorganic nanoporous silica and organic long-chain alkyl quaternary ammonium bromide (C_nTAB, n = 12, 14) has a significant effect on the pyrolysis of C_nTAB. Zhang et al. revealed that the existence of ZnO as a dopant led to the decrease of conduction activation energy and the deterioration of energy storage behavior, while the appropriate introduction of ZnO as an intergranular phase increased the conduction activation energy and the optimization of energy storage performance. Zhang et al. prepared Mn/Mg/Ce ternary catalyst and performed the ozone catalytic oxidation treatment of actual and simulated printing and dyeing wastewater to study the performance of four different carrier catalysts, namely, molecular sieve (MS), silica gel (SG), attapulgite (ATP), and nano alumina (Al_2O_3), by simulated dynamic test. This study provided a new choice of ozone catalyst for the degradation of printing and dyeing wastewaters in the future. Cheng et al. fabricated WO_3/Mo/CrNi/TiO_2 composite film and analyzed the complementary

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effect of these different film thicknesses. The microstructure characterization proves that the self-cleaning function of the composite film is determined by the photocatalytic properties and superhydrophilic properties of the TiO_2. Wen et al. investigated the band structure and density of the state of $NiMoO_4$ bulks with different concentrations of oxygen vacancy by the first-principles calculation. The results demonstrated that introducing oxygen vacancies can improve the conductive property of $NiMoO_4$.

Apart from six original articles, two mini-review articles briefly introduced the oriented nanostructured materials in thermoelectrics, optoelectronics, and electronics. Hao et al. discussed two of the latest strategies to improve the thermoelectric properties of PbTe-based materials, including modulation of doping to improve the thermoelectric figure of merit and manipulation on phonon to reduce lattice thermal conductivity. Compatible PbTe thermoelectric semiconductor materials are the key components of thermoelectric devices for renewable energy sources. Wang et al. summarized various approaches that induced adjustability of 2D van der Waals (vdW) layered heterojunctions, mainly including composition and thickness modulations, strain, and electric fields. 2D semiconductors and their heterojunctions would be a hot topic in future research and can potentially have broad applications.

In the future perspective, the nanostructure design and performance achievement is not the only challenge in energy conversion and storage. Mastering the energy and information on the nanoscale to create materials and technologies with capabilities rivaling those of living systems is a long-term target.

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