Power Up the Future with Clean Energy

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Energy, in the past and coming centuries, is the most important challenges for all over the world.1 Coal, gas, oil and electricity are critical in our everyday life. Currently, most of the world’s energy requirement is obtained from oil, coal and natural gas, which in turn cause global warming and lots of pollution. However, due to the explosive growth of global economy and population, the demand of energy exhausting for fossil fuel supply is exponential as well. About 13 terawatts (TW) of energy is needed to sustain the current lifestyle worldwide. By 2050, additional 10 TW of clean energy is needed to maintain the predicted lifestyle.2 Obtaining CO2-free sources of energy is urgent.3,4

Photovoltaics (PV) is the conversion of light into electricity using semiconducting materials that exhibit the photovoltaic effect. In 1954, Bell Laboratories invented the first crystalline silicon (c-Si) PV devices. For the past decades, with the depreciation of non-renewable sources of energy the material science research is greatly focusing on designing and manufacturing lightweight, flexible, and highly efficient solar cells. Solar cells can be classified into first generation: wafer based containing crystalline silicon; second-generation: cadmium telluride (CdTe) and copper indium gallium selenide (CIGS), which demonstrate PCE of 19.6% for 1 cm² cells;5 third generation: thin film solar cells, such as dye sensitized solar cell,5 halide perovskite solar cells, organic solar cell and so on.7-10 Apart from this, there are materials involved in photochemistry such as water splitting(hydrogen production), which convert solar energy directly into chemical energy in the form of hydrogen or other organic compounds.11 Efforts are being made for the continued improvements in energy storage,12 efficiency, durability and cost for market viability. These domains of materials are of great impetus as development in this era will serve not only towards humankind but also towards all inhabitants of our planet leading to the reduction of pollution and safe clean environment. Thermal metamaterials are an emerging technology, which is now recently being acknowledged and developed by the microelectronics and material sciences community. Thermal metamaterials are materials composed of engineered, microscopic structures that exhibit unique thermal performance characteristics based on their physical structures and patterning, rather than their chemical composition or bulk material properties. This special issue is aimed at bringing out an overview of the latest advances in the field of photoelectrochemical materials with special emphasis on synthesis and applications highlighting greater strides in the field.

Fig. 1 (a) Hierarchical structure of a typical C3 leaf; (b) Schematic diagram of a perovskite solar cell with biomimetic leaf-type hierarchical nanostructure (in this issue DOI: 10.30919/esee8c728).

The present issue covers a review by Supek et al. dealing with different techniques used for the deposition of CdTe/ CdS thin films and various parameters affecting on performance of solar cells. Liang et al. reported the design of biomimetic leaf-type hierarchical nanostructure for enhancing the solar energy harvesting of ultra-thin perovskite solar cells (Fig. 1). The work by Alshehri et al. shows solar-thermal energy conversion...
performance of a selective multilayer metal film absorber with excellent thermal stability.

The heat transfer performance factors of the thermal metamaterial are such that similar performance cannot be obtained using conventional materials or compounds. In conjunction with these newly emerged materials, we have included two articles by Han et al. and by Chen et al. The invisibility cloaks which constitute the thermal metamaterials, have been attracting more and more attention due to their powerful manipulation on heat transfer. Han et al. have designed a diamond shaped thermal cloak based on linear transformation thermotics. The next article by Chen et al. demonstrates the generalized "Slope method" of the 3ω analysis to measure the thermal conductivity and heat capacity of solids. 3-state thermal switch that employs combination of layers with different metal–insulator transition temperatures of W-doped and undoped VO_2 has been explained in the article by Zhou et al. They further demonstrate that the introduction of two-dimensional(2D) materials can effectively improve the resolution of discrete thermal signals. The issue furthers uncovers XTe (X = Ge, Sn, Pb) Monolayers as promising thermoelectric materials with ultralow lattice thermal conductivity and high-power factor.

References: