Inorganic-organic halide perovskites for new photovoltaic technology

November 7 2017

Perovskite solar cells (PSCs) have received worldwide attention due to excellent power-to-electricity conversion efficiency (PCE). Currently, 22.1 percent certified PCE has been achieved compared to those of CIGS and CdTe solar cells. However, there are still some critical issues to be solved in order to promote PSC commercialization.

Perovskite metal halide materials, such as $CH_3NH_3PbI_3$, have attracted wide interest in the field of photoelectric conversion, detecting and luminescence. As an emerging semiconductor, this type of material has distinct advantages of high light absorption coefficient, long carrier lifetime, low defect density and exciton binding energy, and low fabrication cost. The energy conversion efficiency of the perovskite solar cell (PSCs) has been exceeding 22 percent, even higher than that of multicrystalline silicon cells, implying its potential commercial application. In the development process of PSCs, Chinese scientists have made contributions in developing efficient hole transport material-free PSCs, exploring new materials with photoelectric and luminescence properties, regulating the material fabrication, integrating large-area devices, and investigating the stability issue of the cell.

Here, Meng's group from Institute of Physics, Chinese Academy of Sciences, reviews the latest advance from the perspective of material structure, fabrication technology to the critical physics properties. Especially for the physics properties, the doping, defects, carriers, junction and electric field, ion transportation and their influence on the semiconductor properties are discussed.

The carrier property of ternary perovskite is closely related to the self-doping, and the carrier control can also be experimentally realized by regulating the physics-chemistry process behind the material fabrication. Meanwhile, impurity atoms could be an alternative for the carrier adjustment. Due to the p-type doping, a single heterojunction at the TiO2/perovskite interface was observed in the cell, where the heterojunction is mainly located in the perovskite region. Interestingly, no obvious junction was found at the perovskite/hole transporting layer interface, which implies that the cell may be not a p-i-n cell. For the defect properties, some works have been reported. The defect density of these low-temperature solution-processed perovskites is as low as 10^{15} cm^{-3}, which thus contributes to the long carrier lifetime. Recently, significant ion transport in the material has been found, which would redistribute the doping and defect in the cell, thus affecting the photoelectric behavior and stability.

These physics properties play essential roles in the operation of the cell and need to be understood thoroughly. For the cell, the low stability is the key limitation to its further development, and the physics stability has the critical effect. It is believed that, with substantial effort toward developing new hybrid perovskite materials and new fabrication techniques, a reliable perovskite photovoltaic technology can be realized in the future.

More information: Dongmei Li et al, Inorganic–organic halide perovskites for new photovoltaic technology, *National Science Review* (2017). DOI: 10.1093/nsr/nwx100

Provided by Science China Press

7) retrieved 2 May 2024 from
https://phys.org/news/2017-11-inorganic-organic-halide-perovskites-photovoltaic-technology.html