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Opinion

The Problem of Commercial Application of Perovskite Solar Cells

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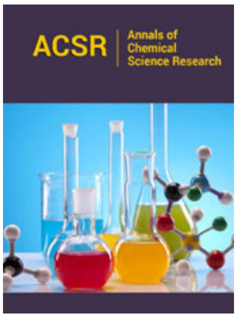

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Abstract

Despite the power conversion efficiency (PCE) in organometal halide perovskite solar cells (PCSs) has achieved 23.7%, the prospect commercial application is not optimistic. The stability and repeatability of conversion efficiency from small-area devices to large-area devices are the main reasons for preventing commercialization. Here, we will discuss these two aspects in detail.

Keywords: Perovskite solar cell; Commercial application; Stability; Repeatability; Large area

Opinion

In the last couple of years, solar cells based on organic-inorganic hybrid perovskite poly-crystallites have experienced a skyrocketing increase in the PCE, which enables their applications in generating the electricity with low-temperature process and earth-abundant materials [1-7]. The record-certified PCE of PSCs has recently risen to 23.7% [8] for a small-area device whose active area is well below that of standard commercial crystalline silicon solar cells. The first certified PCE of 16.63% for large area (20.77cm^2) is from Chen's group of Huazhong University of Science and Technology [9]. Compared with mature single crystal silicon solar cells (recorded at 26.7%, area 79cm^2), there are still significant differences in large area and high efficiency. In addition, stability is also a problem that perovskite solar cells need to overcome for commercial applications. The perovskite solar cells exhibited acceptable stability in thermal stability tests at 80 °C to 100 °C for 2160h comparing the life of a silicon solar cell with 25 years [10]. Therefore, the stability and repeatability of conversion efficiency from small-area devices to large-area devices are the main reasons for preventing commercialization.

For the stability, the lifetime of perovskite solar cells is affected by many factors and can be divided into two categories: external (environmental) and intrinsic. Good encapsulation can solve environmental factors, such as moisture and oxygen. The composition of the perovskite structure itself is an intrinsic factor. For example, the organic methylammonium cation (MA^+) easily absorbs water and causes decomposition of the perovskite. Many researchers have improved their stability by partially replacing or completely replacing MA^+ with inorganic cations (Cs^+, K^+, Na^+) [11-13], and have achieved good results. The internal factors affecting the stability of the perovskite solar cells are still being studied, but it is clear that the interface between the perovskite and the contact layers has a great influence on the stability of the solar cells.

Another problem is that the PCE of devices cannot be repeated when a small-area device is expanded to a large area. Due to the large number of defects in large-area perovskite films, the PCE of large-area perovskite solar cells is far less than that of small-area devices in the laboratory. In recent years, researchers have improved the quality of large-area perovskite films through blade coating, CVD method, sequential desopition and screen-printing technology [14-18]. For example, In June 2014, Seo and co-workers for the first time demonstrated a solution-processing method for the fabrication of a 10 cm×10 cm (active area of 60cm^2) p–i–n perovskite solar module, which exhibited a PCE of 8.7% [17]. Deng et al. [14] fabricated 1-inch^2 area perovskite films by using the modified doctor-blading method and got an exciting efficiency of 15.1% [13]. The PCE of large-area modules of perovskite solar cells has made great progress, but there is still no industrial production.

In summary, perovskite solar cells as a promising candidate for the next generation of photovoltaic technologies have recently gained much attention both from the scientific and industrial community. However, even though the performance of PSCs exhibits a dramatic improvement, the difficulty on scaling-up becomes a bottleneck of industrialization. The efficiency from area enlargement and stability issues are urgent to be concerned and solved.

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