Editorial

Perovskite Solar Cells Research in Switzerland

Energy needs and environmental sustainability are intimately linked and pose significant challenges to humankind. Presently, over 85% of the World's energy requirements are satisfied by fossil fuels with devastating consequences on health and the environment. Energy demand is predicted to increase by almost 30% during the next 20 years due largely to population growth and, consequently, solar photovoltaics are considered as the ultimate source of clean, renewable electricity.[1] In recent years the performance of solar photovoltaics has rapidly improved and, at the same time, their cost has reduced significantly. The cost reduction is mainly due to technological improvements which allow the use of thinner silicon wafers and higher efficiencies of 25.6%.[2] The competitive crystalline single junction GaAs solar cell efficiency is 27.5%, and the thin-film photovoltaics such as $Cu(In,Ga)Se_2$ (CIGS) and CdTe exhibit 22.3% and 22.1%, respectively.[3] Though these technologies are operational, they are facing difficulties in large-scale production due to supply limitations of In, Ga, and Te. The GaAs and CIGS need a few micrometers thick layer to absorb solar radiation due to their direct bandgap, the crystalline silicon absorber, which has an indirect bandgap, requires about a 150 micrometers thick layer.

Organic/inorganic lead triiodide perovskite materials pioneered by Mitzi in 2001 are used in various optoelectronic applications.[4] The ease with which these hybrid perovskite materials can be prepared and processed from solution has made them attractive for photovoltaic applications.[5] Following the pioneering work of Miyasaka and co-workers in 2009, where they replaced the dye in a dye-sensitized solar cell by a perovskite absorber using iodine/triiodide based liquid electrolyte,[6] the performance of solid-state perovskite solar cells has improved enormously with power conversion efficiencies now reaching 22.1%.[7] Perovskite materials exhibit direct bandgaps with tunable band energy depending on the perovskite cation/anion composition, and high absorption coefficient. The high absorption of perovskite materials enables the use of ultrathin absorber 400–600 nm in which photo generated carriers do not have to travel far before they are collected and, consequently, leads to a low non-radiative recombination rate. The other pertinent properties of perovskite materials are low exciton binding energy, good charge carrier mobility, and long charge carrier diffusion lengths. The versatility of perovskite materials, different device architectures and processing methodologies has triggered the tremendous advancement of perovskite-based solar cells technology and has opened up a plethora of new possible applications in optoelectronics.[8]

One of the major challenges in the field stemmed from the low stability of perovskite solar cells, however, by integrating 2D/3D metal halide perovskites solar cells with an efficiency of 12.9% and stability exceeding 10000 hours under AM 1.5 sunlight was obtained and the product is now sold by Solaronix SA (Fig. 1).[9] Indeed, Swiss researchers and companies are leading the way and at EPFL alone a dozen research groups are involved, some of whom have provided articles for this issue.

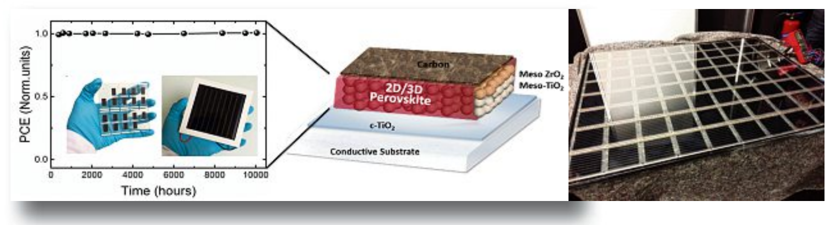

Fig. 1. Typical module stability test under 1 sun AM 1.5 G conditions for 10000 h. The device architecture with mixed 2D/3D perovskite. A picture of perovskite module size 100 X 120 cm developed at Solaronix SA, Aubonne.

Mohammad Khaja Nazeeruddin
Institute of Chemical Sciences and Engineering
École Polytechnique Fédérale de Lausanne, Switzerland
E-mail: mdkhaja.nazeeruddin@epfl.ch

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