Copper oxide for low cost and stable perovskite solar cells

To date, numerous attempts have been carried out to provide energy from natural resources. As the petroleum related fuels produce large amount of pollution which had been reported as a big threat to creature life, employing green technique in providing the energy turned to an inevitable approach. Solar energy attracted much attention in reaching green and sustainable energy from natural resources. Emerging photovoltaic properties of materials has introduced an easy and green technique in generating the electricity from sunlight which is an abundant resource worldwide.

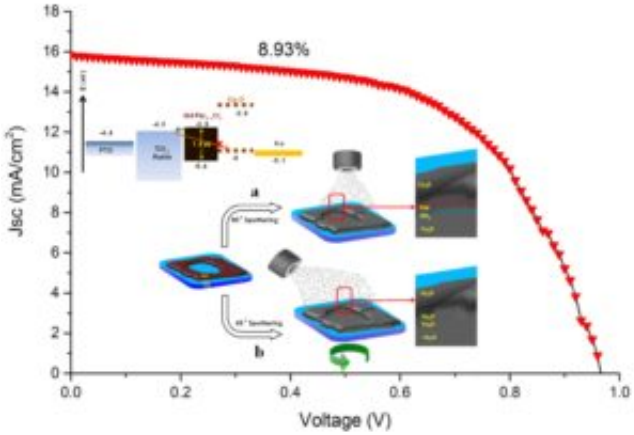

Fig. 1.

Perovskite solar cells emerged as an efficient and low cost solar cell which attracted much attention in absorbing a large portion of sun light to generate electricity. Organometal halide perovskite is an interesting photovoltaic material with an approximate direct optical band gap, which has numerous advantages like broad range of light absorption from the visible to near infrared spectra with high extinction coefficient and long diffusion length. To date, the certified power conversion efficiency reached to 20.3%. Material selection and engineering for electron transport material (ETM) and hole transport material (HTM) for extracting electron and hole, respectively, from organometal trihalide perovskite absorber has a high impact on perovskite solar cells efficiency. By now, despite the large number of valuable works conducted on improving the perovskite solar cells performance and resolving some challenges such as durability against moisture, the production cost of these devices is high due to the use of some expensive materials (such as Spiro-OMeTAD) in device structures. Hence, in addition of device stability, replacing the expensive materials in fabrication of perovskite solar cells would facilitate reaching these efficient solar cells to market and human life.

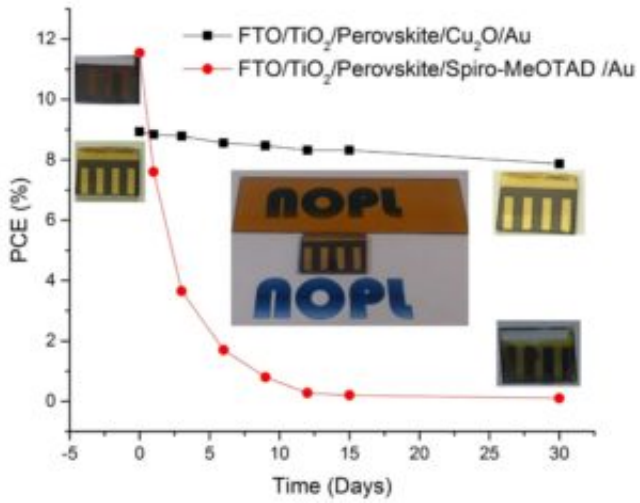

Fig. 2.

Copper based hole transport materials such as CuI and CuSCN attract much attention in fabrication of perovskite solar cells because of their high hole mobility and low cost fabrication methods and materials.

Using metal oxides as both n-type and p-type materials for perovskite solar cells is a future vision and appeal considering their robust behavior, long-term durability, low cost, and importantly environment and market friendly characteristics. Cuprous oxide (Cu_2O) with narrow band gap is promising and environmental-friendly p-type material for absorbing and hole transporting in p-n junction solar cells. Moreover, the respective hole mobility and diffusion length is reported for cuprous oxide structure making this as an appropriate inorganic and low cost HTM for perovskite solar cells.

Here, Cu_2O thin film is introduced as a potential new hole transport materials for durable perovskite solar cells (Fig. 1.). Considering the fact that copper oxide is highly sensitive to the mixture of perovskite precursors and their solvents, we proposed an engineered technique of reactive magnetron sputtering in this work. A rotational angular deposition of copper oxide shows a well surface coverage of perovskite layer for high rate of charge extraction (Fig. 1.). Deposition of Cu_2O layer on the pinhole-free perovskite layer shows the maximum power conversion efficiency of 8.93% (Fig.1). More than 30 days stability of these kinds of perovskite solar cells (Fig. 2.) provides a new vision in enhancing and developing the perovskite solar cells employing cuprous oxide as an inorganic hole transport material.

Bahram Abdollahi Nejand[1]***, Saba Gharibzadeh***[2]***, Vahid Ahmadi***[3] *and* ***Hamid Reza Shahverdi***[1]
[1]*Nanomaterials Group, Dept. of Materials Engineering, Tarbiat Modares University, Tehran-Iran*
[2]*Department of Physics, Tarbiat Modares University, Tehran-Iran*

[3]*School of Electrical and Computer Engineering, Tarbiat Modares University*

Publication

Cuprous Oxide as a Potential Low-Cost Hole-Transport Material for Stable Perovskite Solar Cells.
Nejand BA, Ahmadi V, Gharibzadeh S, Shahverdi HR.
ChemSusChem. 2016 Feb