Tata Institute of Fundamental Research
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Internal Webinar

Quantum Dot based Sensitizers towards Efficient and Stable Solution Processed Solar Cells

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Inorganic semiconductor quantum dots (QDs), a few nanometer-sized zero-dimensional light harvesting particles exhibit various intrinsic advantages rendering them as suitable next-generation photo-sensitizers but the highest power conversion efficiency (PCE) achieved so far for an environmentally friendly Zn−Cu−In−S−Se QDs sensitized solar cell is 15.5%.[1] Photoactive metal oxide-based counter electrodes effectively improved the performances either by panchromatic absorption of solar radiation in tandem configuration or by self-powering smart optical response.[2,3] Metal halide perovskite solar cells have already reached a certified 25.5% efficiency from the breakthrough PCE of 3.8% in 2009 and could be the future of energy due to their unique optoelectronic features.[4] However, lead-perovskite components have limitations in terms of long-term instability and toxicity. Perovskite quantum dots (PerQDs) are a relatively new class of nano-crystals based on perovskite materials which have attractive properties comparable to or surpassing those of metal chalcogenide QDs. Through suitable engineering strategies, the aim is to fabricate PerQDs based solar cells for achieving improved PCE and environmental stability, that can also be scaled-up for niche real-time applications and later commercialization.

References:

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[2] J.Y. Kim, J.-W. Lee, H.S. Jung, H. Shin, N.-G. Park, High-efficiency perovskite solar cells, Chem. Rev. 120 (2020) 7867–7918.
[3] A. Kolay, H. Flint, E. A. Gibson, M. Deepa, Efficient Charge Separation and Transport in a Tandem Solar Cell with Photo conducting Se sub-Microtubes and AgBiS2 Quantum Dots, Chem. Eng. J. 437 (2022), 135223.
[4] A. Kolay, A. Das, P. Ghosal, M. Deepa, New Photo-electrochromic Device with Chromatic Silica/Tungsten Oxide/Copper Hybrid Film and Photovoltaic Polymer/Quantum Dot Sensitized Anode, ACS Appl. Energy Mater. 1 (2018), 4084-4095.

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