Journal of Nanosciences: Current Research

Journal of Nanosciences: Current Research
ISSN 2572-0813

2020
Vol.5 No.4

Inorganic charge transport materials for hybrid perovskite solar cells

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Abstract

Organic–inorganic metal halide perovskite materials are the new class of hybrid semiconductors with the general formula ABX3, where 'A' and 'B' are organic and inorganic cations and 'X' (Cl, Br and I) is the halide anion, respectively. The exceptional physical properties of hybrid perovskite materials like a tuneable band, high absorption coefficient, and long-range charge transport with high mobilities have brought about a surge of interest in the optoelectronic device community to seek hybrid perovskite materials as potential candidates for solar cell fabrication. A typical hybrid perovskite solar cell (PSC) device consists of the following six layers:

(i) FTO (fluorine-doped tin oxide) as transparent electrode,

(ii) c-TiO2 as electron transport material (ETM), which can additionally block the hole from reaching FTO,

(iii) Mesoporous TiO2 (mp-TiO2) to infiltrate light harvester and to extract electrons from it,

(iv) Hybrid perovskite material as light harvester,

(v) Hole transport material (HTM) to extract holes from perovskite and

(vi) Metal Au as back electrode.

The currently used HTM, Spiro-OMe-TAD slowly degrades the perovskite and also the material's cost is significant. The alternative organic HTM is PEDOT:PSS which also has the stability challenges in ambient conditions. Therefore, there is a need to find a stable HTM. In terms of improved stability at low cost use of inorganic materials as HTM is a good choice.

In this current work, nanoparticles of inorganic oxide material, NiO is synthesized and characterized XRD and SEM, TEM to confirm the phase purity and morphology, respectively carry out the structural and microstructural characterization. Low temperature annealed Ni1-xO appears black in colour and absorbs a fraction of light in the visible region. With high temperature annealing optically transparent near stoichiometric NiO nanoparticles are obtained with a direct band gap of 3.81 eV. For the transparent near stoichiometric NiO nanoparticles a complete energy band diagram is determined and realized a suitable valence band edge to fabricated hybrid perovskite solar cells. By employing as prepared optically transparent NiO as HTM working semi-transparent perovskite solar cells are fabricated with a demonstrated photo conversion efficiency of 3.46%.

Biography:

Dr.I.V.Subba Reddy, Department of Physics, School of Technology, GITAM (Deemed to be University, he worked on Synthesis and characterisation of optically transparent nickel oxide nanoparticles as a hole transport material for hybrid perovskite solar cells.

Speaker Publications:

1. Kalpana Deevi, Venkata Subba Reddy ImmaReddy (2019) Synthesis and characterisation of optically transparent nickel oxide nanoparticles as a hole transport material for hybrid perovskite solar cells, Journal of Materials Science: Materials in Electronics, Vol. 30(6) : 6242–6248.
2. Bhavani P, Ramamanohar Reddy N, Venkata Subba Reddy I (2017) Synthesis and Physical Characterization of γ-Fe2O3 and (α+γ)-Fe2O3 Nanoparticles, Journal of the Korean Physical Society, 70(2) : 150-154.
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5. Palagiri Bhavani , Chintaparty Rajababu , Arif M.D, Venkata Subba Reddy I, Ramamanohar Reddy N (2016) Synthesis and characterization of iron oxide nanoparticles prepared hydrothermally at different reaction temperatures and pH International Journal of Materials Research,107 (10) : 942-947.

10th World Congress on Biopolymers & Bioplastics, Zurich Switzerland, August 03-04, 2020.

Abstract Citation:

Kalpana Deevi, I.V Subba Reddy, Inorganic charge transport materials for hybrid perovskite solar cells, Biopolymers 2020, 10th World Congress on Biopolymers & Bioplastics, Zurich Switzerland, August 03-04, 2020.

https://biopolymers.insightconferences.com/speaker/2020/dr-i-v-subba-reddy-department-of-physics-school-of-technology-gitam