Hind Ahmed et al., Int J Mater Sci Res. 2017
http://dx.doi.org/10.18689/2638-1559.a1.002

madridge CONFERENCES
International Conference on
Materials Science and Research
November 16-18, 2017 Dubai, UAE

Advanced Plasmonic Luminescent Solar Devices

Hind Ahmed*, Subhash Chandra and **Sarah Mc Cormack**
Department of Civil, Structural & Environmental Engineering, Trinity College, The University of Dublin, Ireland

Spectral losses due to limited spectral response represent a fundamental limit to the maximum efficiency achievable by the solar cell. Low energy photons are not absorbed by the solar cell, while high energy photons are not used efficiently and energy is lost via thermalization. Also the dependency on direct normal irradiance (DNI) limits the application of photovoltaic technology in building integrated photovoltaic (BIPV) for climate where diffuse solar radiation is dominate. The potential exists to increase solar cell efficiency by making better use of short wavelength light and concentrating solar radiation using static concentrator. One way to do this is to use a luminescent materials to down shift high energy photons to lower energy photons through energy downshifting and simultaneously concentrating solar radiation. The conversion of the high energy photons to lower energy phones before they interact with the solar cell refer to as luminescent down shifting layer (LDS) and when the energy downshifting combined with solar energy concentration, it's known as Luminescent Solar Concentrators (LSC). The LSCs were proposed with the potential of reducing the cost of solar electrical power generation and LDS with the potential of increasing the solar cell efficiency. LSC and LDS suffer from self-absorption, escape cone losses, and scattering losses at higher concentrations of luminescent species hence undermining the efficiency of the device. Some of these losses could be significantly reduced if it were possible to guide the emission directionally and decrease the luminescent species concentration without compromising the total emission in device. A novel approach was proposed to utilize metal nanoparticles with the objective of counteracting these optical loss mechanisms. In this technology, plasmonic coupling between luminescent species and metal nanoparticles has been exploited, resulting in significant enhancement in absorption and fluorescence emission of luminescent species. First, the optimum luminescence species concentration in polymer was established. Subsequently, plasmonic coupling with MNP was introduced and optimum plasmonic coupling determined. The plasmonic interaction was manipulated through variation of the spacing between the luminescence species and MNP and of the surface plasmon resonance (SPR) frequency of MNP. The spacing was controlled by the relative concentration distribution of luminescence species and MNPs. The SPR resonance was determined by controlling the size and shape of the MNPs. Optimised plasmonically enhanced luminescence devices were fabricated and the performance of these devices was experimentally tested on different PV solar cells through optical and electrical characterization. The results have shown significant enhancement in absorption, fluorescence emission and electrical output of PV/plasmonic devices.

Biography:

Dr. Hind Ahmed is a graduate of the prestigious Graduate Studies Program at the Singularity University, NASA AMES, California, USA. She has a strong background in Mathematics, Physics and Engineering with the focus in the area of solar energy research. She holds an Honour's degree in Physics, a Postgraduate Diploma in Mathematical Sciences, a Master degree in Material Physics, a Professional Master in Micro/Nano Electromechanical System and a PhD in Physics. She is currently working as a senior research fellow in the Solar Energy Applications group in Trinity College Dublin under ERC Starter grant ''Plasmonic Enhancement and Directionality of Emission for Advanced Luminescent Solar Devices (PEDAL)'' which involves the design, development, characterisation and fabrication of large scale plasmonic luminescent down shifting devices for enhancing the efficiency of solar cells.