Title: QDSSC's infrared response for enhancing the efficiency upto 13.2%

Abstract: To harness the solar energy, Silicon (Si) solar cells are commercially available in market at large scale. As per theoretical calculations, conventional Si solar cells can achieve maximum efficiency limited to 33.7% which is calculated by Shockley and Queisser. The manufacturing cost of these first generation solar cells is very high.Si solar cells require bulky and high cost installation exercise. Alternatively, thin film solar cells can be technological solution for short-comings of conventional Si solar cells. Thin film solar cells include dye sensitized solar cell (DSSC), organic solar cell, quantum dot sensitized solar cell (QDSSC), solid state quantum dot solar cell and perovskite solar cell. These type of solar cells are flexible in nature and have low cost fabrication with potential to achieve power conversion efficiency up to 44.7% which is superior to conventional Si solar cells. In 1991, DSSC with optically active sensitizing material such as Ru based dye was first introduced to achieve low cost and efficient solar cells. Later on, dyes were replaced by new type of light absorbing material i.e. quantum dots (QDs) for designing QDSSC. Due to quantum confinement, QDs have unique opto-electronic characteristics such as size dependent tunable energy band gap and carrier multiplication (i.e. multiple exciton generation effect-MEG).Cd and Pbbased chalcogenide QDs are commonly used sensitizing materials in QDSSCs. But, due to highly toxicity of Cd or Pb materials, 'Green' QDs are being explored for application in QDSSC. Green QDmainly includes I–III–VI2 group compounds

such as CuInS2 (CIS), CuInSe2 (CISe), CuInSeS (CISeS), core shell structure of CIS-ZnS (CIS-Z) etc. In QDSSCs, the highest reported efficiency is 12.75% as per our best of knowledge.

Interfacial charge transfer processes in QDSSCs suffers fromvarious recombination losses due to insufficient charge transfer and mismatch of charge transfer rate. In this talk, an insight on QDSSC along with interfacial charge transfer mechanism is presented. Different fabrication techniques related to QDSSCs have been described. The talk focuses on recent advances in QD sensitized solar cells. Various aspects related to photoanode, counter electrode, barrier layer, electrolyte and redox process have been incorporated. Issues related to photoanode corrosion and stability are discussed. Limitations and future perspectives have been presented to fabricate efficient and stableQDSSC.

The idea of QDSSC configuration originates from the conventional DSSC. A typical QDSSC is assembled using two different electrodes, named as sensitized photo-anode and counter electrode with suitable electrolyte. The sensitized photo-anode is fabricated on transparent conductive substrate (Fluorine doped tin oxide – FTO or Indium doped tin oxide - ITO or PET-ITO) by the deposition of wide band-gap semiconductor and subsequently the deposition of a layer of QD sensitizer over semiconductor deposited electrode. In QDSSC, Cu2S is widely used as counter electrode with polysulfide liquid electrolyte.

QDSSC is superior to other p-n junction solar cells as it does not require highly pure and defect-free semiconductor but it has limited efficiency because of poor spectral absorption, various recombination losses at interfaces and also has low thermal and long-term stability. To improve the performance of QDSSCs, sensitized photoanode with suitable passivation and counter electrode are required to be optimized. Overall performance of solar cell can be enhanced by maximizing absorption of solar spectral energy (i.e. minimizing re-flection losses of solar spectrum), maximizing exciton generation, transportation and collection and, minimizing recombination losses at different interface in solar cell through proper material selection and engineering.

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She is founder and in-charge of Research Lab for Energy Systems at Department of Physics. Her research interest is Solar Energy Materials and Solar Energy Utilization, Development of Nano-structured thin film Solar cells and Characterization of Energy Materials for Device Applications.

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She has delivered several invited lectures/talks related to Solar Energy Technologies in various educational and research institutions as well as in various national or international conferences and workshops and part of the panel discussions. She has also chaired or co-chaired several sessions in various National or International conferences.