Colloidal Synthesis of $MoSe_2$ Nanosheets and Its Applications as Electrocatalyst in Hydrogen Evolution Reaction and as Counter electrode in Dye Sensitized Solar Cell

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We have synthesized 2H-$MoSe_2$ nanosheets by colloidal synthetic route and the thickness of sheet was controlled by varying the amount of long alkyl chain coordinating solvent. We observed solvent dilution effects play a crucial role to control the thickness of $MoSe_2$ nanosheets and this type of phenomena has not been reported till date in $MoSe_2$ nanosheets. Our as-prepared $MoSe_2$ nanosheets possess pristine absorption peaks[1] with thickness dependent band transitions with a large surface area as observed from transmission electron microscopic (TEM) images. $MoSe_2$ nanosheets are soluble in different organic solvents making them suitable for thin-film based device applications. We fabricated CEs using $MoSe_2$ nanosheets in a very simple procedure and used it in dye sensitized solar cells (DSSCs)[2] with power conversion efficiency of 7.20 % which is comparable with Pt CE (7.94 %). In the time of CEs fabrication, after depositing $MoSe_2$ nanosheet on FTO, we annealed it in inert atmosphere to remove the insulating capping ligands. Because of better contact of electrolyte and CE the efficiency is increased from 5 % to 7.20 % and FF improved from 43 % to 60 %. $MoSe_2$ nanosheets also exhibited thickness dependent electrocatalytic HER performances with a low onset overpotential (130-135 mV) and a small Tafel slope (55-75 mV/decade).[3]These $MoSe_2$ nanosheets show stability towards both in DSSCs and HER, making it advantageous for practical applications.

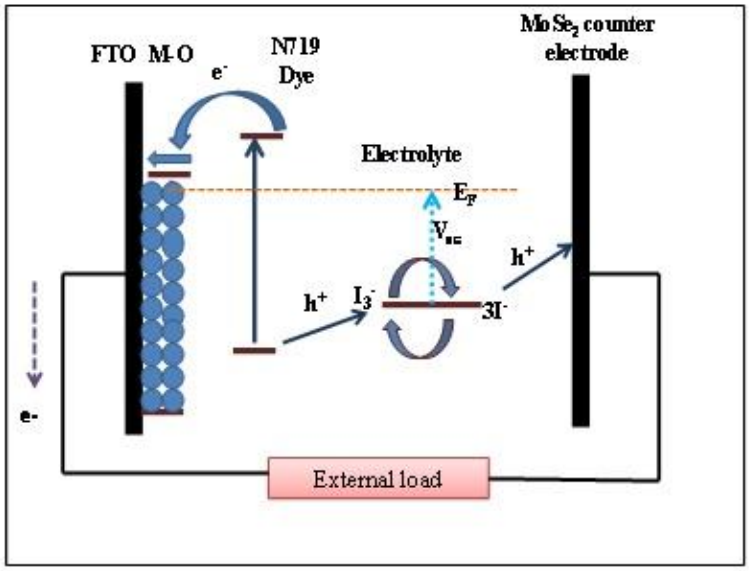

Fig. 1 Schematic representation of the working principle of a DSSC using $MoSe_2$ nanosheet.

1) Cheon et al., *J. Am. Chem. Soc.* **2015**, *137* (23), 7266–7269.
2) Gra¨tzel et al., Nature Chemistry, **2014, 6,** 242-247
3) Chhowalla et al., *Advanced Materials, **2016**,28, 6197-6206*