# Mn-doped ZnS quantum-dots for down-conversion solar cell applications

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The conversion efficiencies for commercial Si and thin-film $CuInGaSe_2$ and CdTe solar cells are below 20%, far less than the Shockley-Queisser limit. One of the key limiting factors is the poor conversion efficiency for short wavelength solar photons (<500 nm) due to surface recombination and coating layer absorption. This paper reports the study of the integration of nano-materials with CIGS, CdTe, or Si planar solar cells to take advantage of three well-known optical processes: down-conversion, quantum cutting, and upconversion. This proposed device concept overcomes the long standing problem of electrical extraction of carriers generated in QDs.

Mn-doped ZnS QDs and Si solar cells are used for the study. These QDs emit yellow light with a quantum yield of 48% under 310 nm UV light illumination. Experimental results demonstrate that the cost-effective incorporation of the II-VI QDs in printable/paintable media can be realized without hampering the superior optical properties of the QDs. The incorporation is carried out through ambient-temperature functionalization of the QDs and their subsequent covalent linking in gel media or polymers during the curing process.

Based on these results, we estimate that the combination of these QDs and Si solar cells will result in a substantial net increase in overall conversion efficiency, possibly over 2%. Integration of the QDs with CIGS or CdTe thin film cells should show even more improvement as they absorb almost no solar radiations with wavelengths below 450 nm.

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