# Transition metal Ion Assisted Enhancement of Photoconversion Efficiencies of Quantum Dot Sensitized Solar Cells

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Several charge recombination processes in quantum dots (QDs) hinder the increment of power conversion efficiency (PCE) of QD sensitized solar cells (QDSSCs). One of the strategies to boost the efficiency of QDSSCs is to dope the QDs with optically active $Mn^{2+}$ ions to create long-lived charge carriers and reduce the electron-hole recombination.[1] The *in situ* deposition of QDs although offers good surface coverage and better charge separation; in "doped" QDSSCs the type of doping responsible for higher PCE was seldom ascertained. In the electrophoretically deposited Mn:CdS QDSSCs, lattice doping of $Mn^{2+}$ ions in pre-synthesized CdS QDs resulted in the highest PCE of 2.08%, whereas exchange coupled $Mn^{2+}$-$Mn^{2+}$ pairs increases non-radiative electron-hole recombination and decreases the PCE.[2] With Mn:Cd at% of 1.44, the PCE of CdS QDSSCs was enhanced by 66.4% due to slower charge recombination in the photoanode and the electrolyte interface and higher electron lifetime in the doped QDSSCs.

On the other hand, alloying QDs with suitable metal ions is another efficient tool to enhance the PCE of QDSSCs. Ternary $AgInX_2$ (X = S, Se) based liquid-junction QDSSCs have low PCEs due to presence of defect states at internal atom vacancies. However, $Zn^{2+}$ diffusion at these vacant sites can improve carrier mobility of the QDs. The QDSSCs with $Zn^{2+}$-diffused $AgInSe_2$ (ZAISE) QDs have a broad light harvesting range up to near-infrared (NIR) region. PCE was increased from a merely 1.67% for undoped $AgInSe_2$ QDs (AISE) to 3.07% for ZAISE with Zn/(Ag+In) ratio of 48.2%, aided by an optimized ZnS passivating layer on the photoanode. The device efficiency was further improved to 3.57% by applying dual passivation of amorphous $TiO_2$ and $SiO_2$ layers.[3] This approach could effectively suppress the recombination pathways at QD surface and thereby minimize back electron transfer from photoexcited electrons of QDs and from the conduction band of $TiO_2$ to the polysulfide electrolyte. The combined strategy of alloying with $Zn^{2+}$ and inorganic passivation could achieve the highest ever PCE of environmentally friendly $AgInX_2$ based QDSSCs.

***References*:**

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