Due to ever increasing petroleum prices and growing evidence connecting the effects of CO\(_2\) levels to global climate change, the pressure for sustainable alternative energy (SAE) production has grown. Hydrogen production via light driven water splitting (photolysis) is a promising field of research which can offset the need for methane reforming and nuclear power driven electrolysis for hydrogen generation. ZnO PEC cells produced by pulsed laser deposition (PLD), oblique angle deposition (OAD), and glancing angle (GLAD) were characterized by HRSEM, XRD, UV-vis and PEC techniques. Water splitting efficiency of the PLD ZnO samples was shown to achieve a photon-to-hydrogen efficiency of 0.92% with a 1 V potential bias. Solar harvesting using photovoltaic (PV) devices is also a widely investigated technology, and here we combined for the first time the use of nitrogen doped nanocrystalline TiO\(_2\) with CdSe nanoparticle sensitization.

The thin film TiO\(_2\):N/CdSe devices had a nitrogen doping level of 0.8%, a fill factor (FF) of 27%, and a power conversion efficiency of 0.84%. We believe the addition of the nitrogen level may aid in the recombination of photo generated holes in the valence band of theCdSe QDs leading to higher efficiencies.

**Photo Driven Water Splitting**

The splitting of water on n-type metal oxide PEC cells occurs due to the photogeneration of electrons and holes (exciton). In our setup, the oxidation of water to produce O\(_2\) resides at the photoanode and the reduction of protons to hydrogen gas (H\(_2\)) occurs at a Pt coiled cathode. After photoexcitation electrons migrate into the bulk of the ZnO PEC cell, while the holes migrate to the surface. Electrons that diffuse to the back contact are then collected as photocurrent, and holes act as oxidizing centers for adsorbed water molecules. Reduction of recombination pathways such as surface traps, electron scavenging by dissolved oxygen and photocorrosion, should be minimized to increase efficiency. Fundamental PEC characteristics are collected here to compare and further understand the differences in the three deposition techniques examined.

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\text{hv} + \text{H}_2\text{O} \rightarrow \frac{1}{2}\text{O}_2 + 2\text{H}_2
\]

**SEM and HRSEM: Morphological Comparison**

**Nitrogen Doped Nanocrystalline TiO\(_2\) Sensitized with CdSe QDs for PV devices**

Hexamethyldisilazane (HMT) was the nitrogen precursor source of the TiO\(_2\) and achieved a 0.8% doping level. CdSe QDs were bound to the TiO\(_2\) and achieved a 0.8% doping level. CdSe QDs were bound to the TiO\(_2\) through a ligand exchange of tetradecylphosphonic acid (TDPA) for pyridine should increase light harvesting efficiencies.

**PEC: Linear Sweep, Mott-Schottky and IPCE Measurements**

**AFM images of nanocrystalline TiO\(_2\) thin films before (left) and after (right) incorporation of 3.5 nm CdSe QDs via the linking molecule TGA.**

**SEM and HRSEM images of PLD (top), OAD (bottom) and GLAD ZnO PEC cells**

**AFM images of nanocrystalline TiO\(_2\) thin films before (left) and after (right) incorporation of 3.5 nm CdSe QDs via the linking molecule TGA.**

**Incident-photon-to-current-conversion efficiency (IPCE) action spectra of a 500 nm thick ZnO OAD PEC cell. On/Off light cycles at AM 1.5 of a ZnO PLD PEC cell at 1V showing enhanced photocurrent and a decrease in Ip at off time revealing an increase in electron-hole recombination after initial illumination.**

**Schematic energy level diagram versus the normal hydrogen electrode (NHE) of TiO\(_2\):N with a sensitizing 3.5 nm CdSe QD.**

We believe the increase in power conversion efficiency of the simultaneously doped and sensitized system could be due to an enhanced electron-hole recombination from the nitrogen doping level (TiO\(_2\):N) to the valence band in CdSe.