Inverse opal TiO$_2$ supposes to surpass the efficiency of conventional TiO$_2$ solar cell due to its large interconnected pores, which enables better penetration of dye sensitizers. Indeed, it also exhibits photonic band gap that may cause a significant change in dye absorbance by adjusting the position of photonic band gap to the position of dye absorption. Semiconductor quantum dots (QDs) have attracted attention as dye substitute due to its quantum confinement effect.

TiO$_2$ photonic crystal has been successfully fabricated by a simple method wherein the voids in the artificial opal latex are filled with nanosized TiO$_2$ by dropping TiCl$_4$ into the latex matrix, hydrolyzing and heating at 80 °C for 10 min. This filling process is repeated three times and finally calcination of the template and annealing of TiO$_2$ were conducted at 450 °C. The resulted TiO$_2$ photonic crystal was then sensitized with CdSe QDs by chemical deposition for various times. The optical absorption and the incident photon to current conversion efficiency (IPCE) properties were characterized using photoacoustic (PA) and photoelectrochemical methods.

The red shift of the PA spectra can be clearly seen with increasing deposition time. The optical absorption shoulders in PA spectra of CdSe deposited samples show blue shift relative to the band gap energy of 1.73 eV for bulk CdSe indicating the occurrence of quantum confinement effect in CdSe particles. Increase in IPCE value and clear shift to visible region are observed with the increasing deposition times, indicating photosensitization of CdSe QDs. All CdSe sensitized samples show two peaks at ~ 3.0 and 2.2 eV. The peak at ~3.0 eV may indicate the enhancement of light absorption due to photonic band gap. On the other hand, the peak at 2.2 eV corresponds to the first excitation of CdSe QDs. Recently, it was found that increasing deposition temperature may cause fast growth and rapid deposition of CdSe QDs.