Indium nanoparticles for enhanced UV Photocatalysis

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The dielectric function of indium satisfies the condition for localized surface plasmon resonance in the deep ultraviolet region [1]. The surface plasmon resonance wavelength becomes promptly tailored by simply varying the deposition thickness of the indium nanoparticles using vacuum evaporation method [2]. The purpose of this research is the enhancement of UV photocatalysis using indium nanoparticles. We prepared titanium dioxide (TiO_2) thin film on a quartz substrate by spin-coating TiO_2 nanocrystals (7000 rpm for 60 seconds). Later, we fabricated indium nanoparticles on TiO_2 thin film using thermal vacuum evaporation method with monitoring the deposition thickness by quartz crystal microbalance (QCM). Methylene blue (MB) is applied onto TiO_2 thin film with and without Indium nanoparticles, and the photocatalytic properties were observed by absorption spectroscopy through UV (deuterium lamp) light illumination. Figure 1 shows the absorption spectra of the indium nanoparticles on a quartz substrate with the deposition thickness of 10nm (blue), 20nm (red) and 40nm (green) in the wavelength range from 200nm to 800 nm. By changing the deposition thickness, plasmon resonance wavelength is confirmed to be tuned from 300nm to 500nm. Figure 2 represents photocatalysis with and without In nanoparticles. It is clearly seen that photocatalytic reactions on TiO_2 is enhanced by applying In nanoparticles. We also found that a reaction rate exhibits the size dependence on photocatalytic activity, which is expected to be explained by the plasmonic property of In nanoparticles.

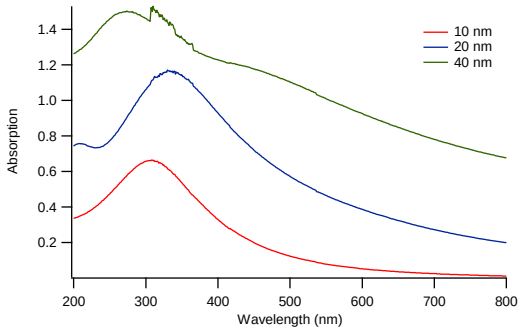

Fig. 1. Absorption spectra of In nanoparticles on a quartz substrate. The colors denote different deposition thickness of In, 10 (red), 20 (blue) and 40 nm (green).

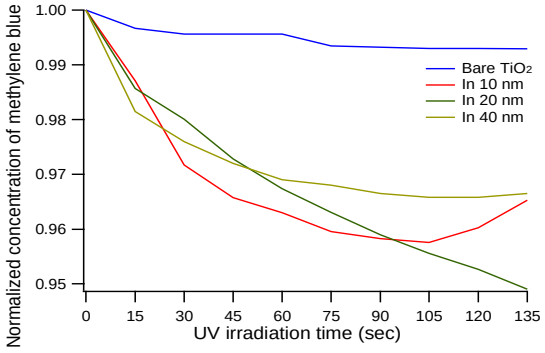

Fig. 2. Photocatalytic reactions with and without In nanoparticles. Blue curve indicates a decay curve obtained using bare TIO2 while red, green, and yellow curves are the decay curves obtained using fabrication of In nanoparticles with deposition thickness of 10 nm, 20 nm and 40 nm respectively.

References: [1] J.C. Lemonnier et al., J. Phys. C: Solid State Phys. 1975, 8, 2812−2818., [2] Y. Kumamoto et al., ACS Photonics 3014, 1, 598-603