Control of photoactivities of TiO_2

Young Cheol Lee, Hoon Kim, Young Jin Jung,
Ha Yong Lee, Young Pyo Hong, Kyung Hyun Ko,
Hyun Seok Jung* and Kuk Sun Hong*

Department of Materials Science and Engineering,
Ajou University, Suwon 442-749, Korea
*School of Materials Science and Engineering,
Seoul National University, Seoul 151-742, Korea

TiO_2 has been studied far more than other semiconductor photocatalysts due to its strong oxidizing power, chemical inertness, and non-toxicity. And it has also been reported that amphiphilic surfaces have anti-fogging and self-cleaning property. In recent, sensitization of wide band gap semiconductors with organic and inorganic dyes is of great interest in solar energy conversion systems, so called dye-sensitized TiO_2 solar cell(DSC). TiO_2 semiconductor in a solar cell(DSC) play a role as an electron-hole separator due to its wide band gap. Normally, for enhancing photocatalytic reactivity, doped-TiO_2 and dye adsorbed TiO_2 are used, however it has been suggested that photoactivity is hydrophilicity requires different surface states from conventional photocatalysis regarding electron-hole trap and controlled surface state.

In this research, TiO_2 thin film was prepared by dip-coating method with polymeric sol. Additives such as Al, W, Al+W were added polymeric sol(named as AT, WT and AWT respectively). Deep levels(~Ev+2.9eV) which could act as a e-h trap were found in WT. Concerning on surface acidity, it was found that Al could suppress acidity caused by W doping. So that AWT has less acidity than WT. Also AT has an opposite tendency to WT to increase surface roughness. WT had a better photocatalytic activity than AT and AWT, while hydrophilic property has an opposite tendency. And AWT had a similar sustainability of hydrophilic surface, but better recovery rate than AT under ultra-violet irradiation. These results mean that different mechanism exists in photocatalysis and hydrophilicity. Hydrophilicity of TiO_2 thin film is highly dependent on surface acidity and roughness. Especially it seems that recovery from hydrophobic to hydrophilic state needs e-h trap such as deep levels. Meanwhile, for sustainability of hydrophilic state, it seems that dopant such as Al which can provide low acidity and high roughness is needed. However, it was turned out that in photocatalytic reaction only an existence of deep traps from W was useful.