Synopsis of Original Research Paper

Generation and Control of Active Oxygen Species by the UV irradiation on Semiconductor Particles

Tsugio Sato

Institute of Multidisciplinary Research for Advanced Materials

Fine powders of semiconductors such as TiO_2, ZnO and CeO_2 possessing band gap energy ca. 3eV are of potential interest as an UV radiation blocking material in personal care products to cut off UV ray less than 400nm of wavelength. However, it is suspected that active oxygen species such as singlet oxygen and oxygen radicals are formed by UV irradiation on semiconductors and cause damages to the human health. The goal of the present study was to find a way to overcome this problem and to develop a safe and stable inorganic sunscreen with excellent UV absorption capability. In order to reduce the generation of active oxygen species, semiconductor particles were coated with amorphous silica by seeded polymerization method using sodium silicate and tetraethylorthosilicate as the silica sources.

White nanoparticles of calcia doped ceria were prepared by reacting $CeCl_3$-$CaCl_2$ mixed solution with NaOH solution at pH12 followed by the oxidation with hydrogen peroxide solution at 40˚C. Then the samples were calcined at 700˚C for 1 h to prepare white ceria nanopowder. After that calcia doped ceria was coated with amorphous silica by means of seeded polymerization technique using hydrolysis of tetraethylorthosilicate (TEOS) or acid hydrolysis of sodium silicate. The silica shell is confirmed by TEM, XPS and FT-IR. It is confirmed that calcia-doped ceria showed much lower photocatalytic activity as well as lower generation of singlet oxygen under UV light irradiation than those with titania and zinc oxide. The silica coating by seeded polymerization with TEOS was much more efficient for the reduction of the catalytic activity of ceria for the oxidation of organic materials without loss of UV-shielding ability than that by acid hydrolysis of sodium silicate.