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Gold nanoparticle/rutile titanium (IV) oxide plasmon photocatalyst as environmental catalyts: Removal of phenol derivatives

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Phenol derivatives are used for the synthesis of many industrial chemical products, e.g., p-cresol for an antiseptic substance, bisphenol A for polycarbonate, and 2-naphthol for azo dyes. Among them, nonylphenol and bisphenol A are well known endocrine disruptor, and the concentration in environmental water should be restricted below 0.1 μM. Thus, a sunlight-driven process for completely removing phenol derivatives, particularly nonylphenol and bisphenol A, from the wastewater is of great importance for environmental conservation. On the other hand, gold nanoparticles (NPs) show the strong visible light absorption due to localized surface plasmon resonance (LSPR). The LSPR-driven photocatalyst called as "plasmon photocatalyst" has recently attracted much attention as a new type of visible-light photocatalyst. In this talk, we show that visiblelight irradiation of gold nanoparticle (NP)-loaded rutile TiO_2 (Au/rutile TiO_2) plasmon photocatalyst leads to rapid and complete removal and degradation of nonylphenol from its dilute aqueous solution. Au/rutile TiO_2 exhibits much higher activity than Au/anatase TiO_2 and $BiVO_4$. Based on the results of the action spectrum analysis, the adsorption and Fourier-transformed infrared spectroscopic measurements, we show a unique reaction scheme consisting of a series of events, 1) the large adsorption and concentration of nonylphenol on the Au NP surface, 2) the successive efficient oxidation induced by the LSPR-driven interfacial electron transfer from Au NP to rutile TiO_2, and 3) the regeneration of the adsorption sites by the surface transport of the intermediates from Auto TiO_2.

Biography

Shin-ichi Naya received his BS in 1996, M.D. in 1998 and Ph.D. in 2001 in Chemistry from Waseda University. He joined the research group of Prof. M. Nitta at Waseda University as a Research Associate in 2000 and subsequently served as a postdoctoral fellow of 21COE "Practical Nanochemistry" at Waseda University in 2003. In 2006, he served as a postdoctoral fellow of 21COE "New Functional Materials for Highly Efficient Energy Systems" at Aoyama Gakuin University. In 2007, he joined the staff of Environmental Research Laboratory at Kinki University.

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