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Influence of Nitrogen Doping and Surface Modification on Photocatalytic Activity of TiO_2 Under Visible Light

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We made attempts to improve photocatalytic activity of TiO_2 nanoparticles under visible light exposure by combining two additional treatments. N-doping of TiO_2 by ammonia gas treatment at 600°C increased absorbance of visible light. By coating thin film of polydimethylsiloxane (PDMS), and subsequent vacuum-annealing at 800°C, TiO_2, became more hydrophilic, thereby enhancing photocatalytic activity of TiO_2. Four types of TiO_2 samples were prepared, bare-TiO_2, hydrophilic-modified TiO_2 (h-PDMS/TiO_2), N-doped TiO_2 (N/TiO_2) and hydrophilic-modified and N-doped TiO_2 (h-PDMS/N/TiO_2). Adsorption capability was evaluated under dark condition and photocatalytic activity of TiO_2 was evaluated by photodegradation of MB under blue LED ($400\ nm < \lambda$) irradiation. N-doping on TiO_2 was characterized using XPS and hydrophilic modification of TiO_2 surface was analyzed by FT-IR spectrometer. It was found that N-doping and hydrophilic modification both had positive effect on enhancing adsorption capability and photocatalytic activity of TiO_2 at the same time. Particularly, N-doping enhanced visible light absorption of TiO_2, whereas hydrophilic surface modification increased MB adsorption capacity. By combining these two strategies, photocatalytic acitivity under visible light irradiation became the sum of individual effects of N-doping and hydrophilic modification.

Keywords: Visible light responsive photocatalyst, Methylene blue degradation, Nitrogen doped TiO2, Hydrophilic surface modification

S-008

Large-Area Synthesis of High-Quality Graphene Films with Controllable Thickness by Rapid Thermal Annealing

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Today, chemical vapor deposition (CVD) of hydrocarbon gases has been demonstrated as an attractive method to synthesize large-area graphene layers. However, special care should be taken to precisely control the resulting graphene layers in CVD due to its sensitivity to various process parameters. Therefore, a facile synthesis to grow graphene layers with high controllability will have great advantages for scalable practical applications. In order to simplify and create efficiency in graphene synthesis, the graphene growth by thermal annealing process has been discussed by several groups. However, the study on growth mechanism and the detailed structural and optoelectronic properties in the resulting graphene films have not been reported yet, which will be of particular interest to explore for the practical application of graphene. In this study, we report the growth of few-layer, large-area graphene films using rapid thermal annealing (RTA) without the use of intentional carbon-containing precursor. The instability of nickel films in air facilitates the spontaneous formation of ultrathin ($<2\sim3$ nm) carbon- and oxygen-containing compounds on a nickel surface and high-temperature annealing of the nickel samples results in the formation of few-layer graphene films with high crystallinity. From annealing temperature and ambient studies during RTA, it was found that the evaporation of oxygen atoms from the surface is the dominant factor affecting the formation of graphene films. The thickness of the graphene layers is strongly dependent on the RTA temperature and time and the resulting films have a limited thickness less than 2 nm even for an extended RTA time. The transferred films have a low sheet resistance of $\sim380\ \Omega$/sq, with $\sim93\%$ optical transparency. This simple and potentially inexpensive method of synthesizing novel 2-dimensional carbon films offers a wide choice of graphene films for various potential applications.

Keywords: graphene, RTA, CVD, annealing, segregation, few-layer graphene