One-pot room temperature synthesis of yellow-orange TiO_2: high photocatalytic activity under visible light

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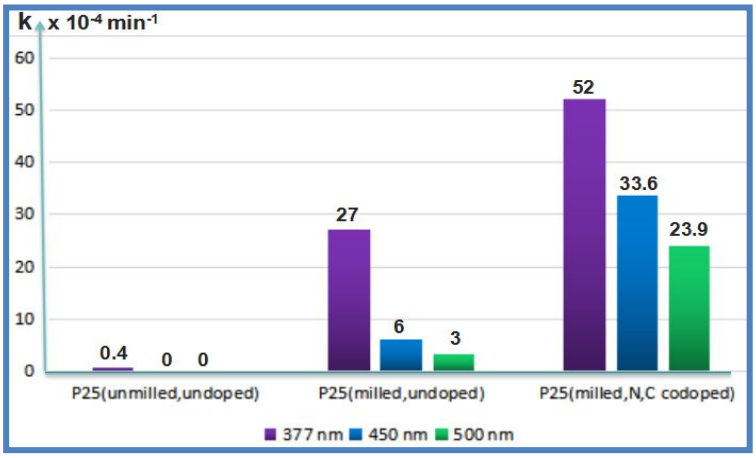
Titanium dioxide (TiO_2) has been the most popular photocatalyst and is used for the degradation of organic pollutants, self-cleaning, and water-splitting reaction [1-3]. TiO_2 photocatalyst is activated by UV light due to its wide band gap (3.2 eV, $\lambda \leq 387.5$ nm)[2]. Visible-light activated TiO_2 has attracted much attention using metal-ion or non-metal doping. However, almost all synthesis methods have required specific experimental conditions, such as ion-implantation facilities, vacuum, and high temperatures up to 400-800 °C for several hours[5-6]. High-energy ball milling has attracted considerable attention as a physical synthesis method [5-6], because large amount of particles can be easily obtained by simply grinding solid materials in a milling vessel with milling balls, i.e., one-pot facile synthesis at room temperature.

In the present study, nitrogen (N) and carbon (C) co-doped TiO_2 particles were synthesized at room temperature by high-energy milling. The TiO_2 and source used for N and C atoms were P25 and organic molecule, respectively. The product powder was bright yellow-orange colored, which was investigated using diffuse reflection spectroscopy, elemental analysis, dynamic light scattering, X-ray diffraction, and X-ray photoelectron spectroscopy. The photocatalytic activity was evaluated before and after milling according to the decomposition reaction of a methylene blue aqueous solution under visible and UV light. As a result, the milling significantly enhanced the photocatalytic activity and the activity at the visible light (450 nm) was 1.3 time higher than that at the UV light (377 nm under the solar light condition (AM 1.5).



(x10-2)	377 nm	450 nm	500 nm
k_n(min-1mW-1)	1.3	0.746	0.478
E_{solar}(mW)	0.685	1.528	1.946
k_{solar}(min-1)	0.89	1.14	0.93

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