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Eco-friendly, facile preparation of carbon nitride/titanium dioxide nanocomposites for catalytic applications.

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Graphitic carbon nitride (g-C_3N_4) is a widely used and versatile catalytic material [1]. Catalytic properties of g-C_3N_4 are enhanced when it forms nanocomposites with titanium dioxide (TiO_2) due to the complementary electronic properties of these two materials [2]. In previously reported works [3], g-C_3N_4/TiO_2 nanocomposites were prepared at relatively high temperatures (550–600 °C), which is connected to increased energy consumption.

We report a novel synthetic strategy for the preparation of g-C_3N_4/TiO_2 nanocomposites. TiO_2 nanoparticles were prepared via the sol-gel technique according to the procedure described in [4]. Urea or melamine were added directly to the TiO_2 hydrosol. The mixtures were lyophilized and subjected to annealing in air at 200, 300, 450, and 600 °C. For comparison, pure urea, melamine, and TiO_2 hydrosol were subjected to the same treatment. The resulting materials were characterized using X-ray photoelectron spectroscopy (XPS), X-ray diffraction analysis (XRD), scanning electron microscopy (SEM), and diffuse reflectance spectroscopy (DRS).

According to XPS and XRD analyses, g-C_3N_4 with a high degree of crystallinity was formed from both urea and melamine at 600 °C. Thermal treatment below 500 °C did not result in the formation of the g-C_3N_4 phase. The mixture of urea with TiO_2 exhibited contrasting behavior. More specifically, the g-C_3N_4 phase was evident even after heating to 200 or 300 °C, although with relatively poor crystallinity. After thermal treatment at 450 or 600 °C, no g-C_3N_4 phase was detected. These data indicate that TiO_2 efficiently catalyzes the polymerization of urea thus allowing us to obtain the g-C_3N_4 phase at drastically lower temperatures. Surprisingly, we were unable to obtain the g-C_3N_4 phase from the mixture of melamine with TiO_2. SEM micrographs revealed mesoporous morphology with high specific area of the prepared g-C_3N_4/TiO_2 nanocomposites. DRS spectra confirmed the presence of both TiO_2 and g-C_3N_4 phases.

To summarize, a new method to prepare g-C_3N_4/TiO_2 nanocomposites was reported. The nanocomposites were formed at 200 and 300 °C, in contrast to previously reported methods that required heating to ~600 °C. The nanocomposites exhibited highly developed surface and diffuse reflectance extended to the visible spectral region. These materials will be used for a variety of catalytic applications.

REFERENCES

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