Photocatalytic Cr(VI) Reduction by ZnTi Layered Double Hydroxide/Montmorillonite Composite

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Nowadays, two-dimensional/two-dimensional (2D/2D) composites have received considerable attention for photocatalytic applications because they have high electron–hole mobility across the heterojunction interface, which can impede the electron–hole recombination rate [1].

In this work, ZnTi layered double hydroxide/montmorillonite composites (ZTL@MT) were prepared via a hydrothermal method by varying the weigh percent of MT (10 %, 20 % and 30 %). The as-prepared samples were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy energy-dispersive X-ray spectroscopy (TEM-EDS), thermogravimetric analysis (TGA), UV-Vis diffuse reflectance spectroscopy (DRS) and photoluminescence spectroscopy (PL). The photocatalytic activity of the obtained samples was investigated by reduction of Cr(VI) under UV light irradiation.

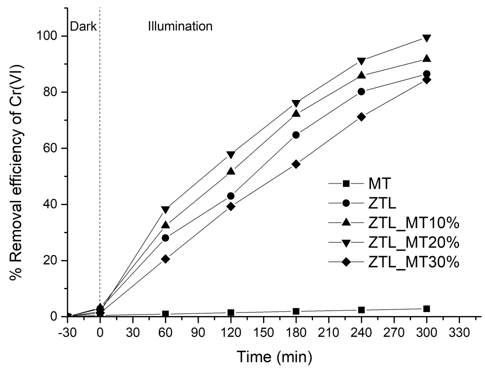

Figure 1. Photocatalytic reduction of aqueous Cr(VI) (intitial concentration of Cr(VI) = 10 ppm, pH = 3, catalyst loading = 1g/L, temperature = 25 °C)

In comparison, the photocatalytic performance of ZTL@MT composites displayed higher than pristine samples of ZnTi layered double hydroxide (ZTL) and montmorillonite (MT) and ZTL@MT20% exhibited the highest photocatalytic efficiency (Figure 1). The improved photocatalytic activity of the ZTL@MT composites could be attributed to improve light absorption ability and reduced the energy gap of the composites.

In addition, the composites had shown a synergistic effect of ZTL and MT, which lead to suppressing the recombination of photogenerated electron–hole pairs. The reusability of the composite were investigated in detail.

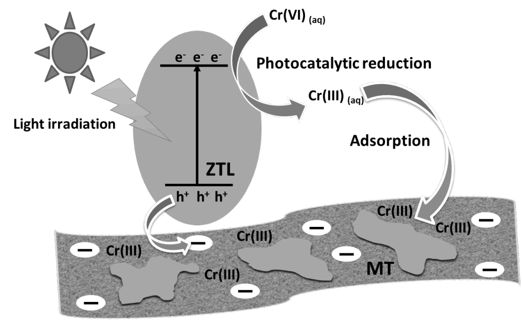

Figure 2. Schematic illustration of photocatalytic mechanism of ZTL@MT composites for Cr(VI) removal

The photocatalytic mechanism for Cr(VI) reduction over the ZTL@MT composites was proposed as illustrated in Figure 2. Under visible light illumination, the valence band (VB) electrons (e^-) of ZTL in the composite can be easily excited to the conduction band (CB) by photons, resulting in the formation of holes (h^+) in the VB of ZTL. The Cr(VI) was reduced to Cr(III) by reacting with e^- in the CB of ZTL. Hence, the Cr(III) can be intercalated between the layers of MT which can be eliminated from wastewater.

In addition, the probability of electron-hole recombination in ZTL@MT composites could be significantly decreased because of the formation of a interfacial combination between ZTL and MT via the electrosatatic interaction [2]. The ZTL@MT composites can be potential catalysts for removal of heavy metal pollutants in wastewater.

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