Simple preparation method of Ag and Cu doped TiO₂

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Recently developed TiO₂ supported Ag nanoparticles [1,2] is promising catalytic material for removal of nitrates from potable water. In this reaction silver enhances photocatalytic activity of titania promoting charge separation and inhibiting recombination of electron–hole pairs, while sacrificial electron donors (hole scavengers) are essential for the reduction of NO₃⁻. However, it is still desirable to find out an appropriate procedure for the catalyst preparation and optimal reaction conditions to produce a quality standard for drinking water.

In this study, the influence of preparation mode potentially effecting photocatalytic behaviour of Ag/TiO₂ and Cu/TiO₂ materials in nitrate reduction was investigated.

The catalysts were prepared using different modifications of TiO₂ by a triblock copolymer induced reduction of ammine complexes of Ag and Cu in ethanol [2] under visible light illumination. The metal content was varied between 0.5-2.5 wt %. The catalysts were characterized by means of ICP, X-ray diffraction, X-ray photoelectron spectroscopy, UV-ViS spectroscopy and transmission electron microscopy. Photocatalytic reaction was carried out as described in Ref. [1] with initial concentration of nitrate anions 23 mg N l⁻¹ (calculated by nitrogen weight). Over all catalysts under study, no nitrate reduction was observed without a hole scavenger. The use of formic acid as sacrificial electron donor greatly improved both the reaction rate and selectivity for nitrogen avoiding formation of undesirable nitrite and ammonium ions. The amount of HCOOH equal to 0.04 mol l⁻¹ was sufficient to reduce nitrate totally. The highest catalytic activity was observed for the catalysts derived from TiO₂ with mixed anatase-rutile composition. This fact indicates importance of hetero- junction existed in multiphase nanocomposite for enhancement of its photocatalytic activity.

The preparation procedure significantly affects catalyst efficiency towards nitrate reduction. Depending on the carrier structure, composition, grain size and metal loading. Enhanced dispersion of strongly anchored silver nanoparticles to the surface of TiO₂ can be considered as a possible explanation for this finding. By repeating the visible light radiation, the deactivated catalysts could be regenerated again. The catalyst regeneration efficiency depends on both the titania composition and duration of illumination. The most active catalyst is Ag/TiO₂ but Cu/TiO₂ shows better stability and selectivity. All these results showed the impact of studied aspects on denitrification properties of Ag/TiO₂ and Cu/TiO₂ nanocomposite catalyst.