Physico-Chemical nanomaterials science

Nano-dispersed phosphates of polyvalent metals as catalysts for pollutants degradation

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The phosphates of metals of the 4-th and 5-th groups have acidic and *red-ox* properties i.e. are bifunctional catalysts. At the same time, they are wide-gap semiconductors. Therefore, phosphates can be used as photo- as well as sono- and mechanocatalysts for pollutants degradation.

We prepared nano-dispersed titanium, zirconium, tin, cerium, vanadium niobium and tantalum phosphates using precipitation, hydrothermal, microwave and milling techniques. These phosphates were studied as photocatalysts under UV- and visible irradiation as well as mechano- and sonoctatalysts for dyes (safranin T, rhodamin B) degradation in aqueous media.

As-prepared and modified *via* milling phosphates have band gap E_g within 2.5-3.7 eV. As a result, precipitated vanadium and cerium phosphates (E_g=2.5 and 2.8 eV, respectively) are active under visible light. Besides, it has been established that milling leads to narrowing of band gap, increasing of absorption of illumination with wavelength > 380 nm for 'white' phosphates. As a consequence, the improvement of photocatalytic properties under UV and the acquisition ones under visible irradiation are observed for milled and sonicated phosphates.

Moreover, all phosphates show an even higher activity in the processes of sono- and especially mechanocatalytic degradation of pollutants. The emission of low-energy electrons during tribo- and sonoluminescence as well as dispersion of catalysts, accompanied by new surfaces formation with uncompensated chemical bonds, are possible ways of occurrence of active species necessary for the initiation of substrate oxidation. Interestingly, the second of these mechanisms makes the maximum contribution when low-dispersed phosphate catalysts are used. It should be noted that the use of insulators (including low-dispersed) as catalysts (silica, alumina) does not produce a catalytic effect. Therefore, sono- and mechanocatalysis is possible only in the presence of semiconductors.