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## Dopant influence on the photocatalytic activity of TiO<sub>2</sub> system

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Abstract – Photocatalytic activities of  $TiO_2$  nanoparticles doped with different metals  $(Ag^+, Al^{3+}, Ce^{4+} and Nb^{5+})$  were investigated.  $TiO_2$ nanoparticles has been prepared by Pechini method and characterized by Brunauer-Emett-Teller (BET) adsorption method and X-ray diffraction (XRD). The photocatalytic degradation of the methyl orange was carried out in aqueous solution with TiO<sub>2</sub> suspension under UV irradiation. The dye degradation kinetic was investigated by UV-Vis spectrophotometry and followed a pseudo first order kinetic. The results demonstrated clearly the effect of the doping with cation of different oxidation states, which in low-amount resulted in an increase in the TiO<sub>2</sub> photocatalytic activity.

On the last 30 years, high activity heterogeneous photocatalysts have attracted considerable attention due to their environmental applications such as water purification and disinfection, air purification and hazardous waste remediation [1]. During the catalytic process, irradiated TiO<sub>2</sub> absorbs light and generates active species, which leads to the oxidation of organic compounds and the reduction of metal ions. However, its wide band-gap energy (around 3.2 eV for anatase and 3.0 eV for rutile) means that only 5% of the solar spectrum is used [2,3]. Besides, a high rate of recombination between the charge carriers (electrons and holes) leads to a low efficiency of the photocatalytic process. In this sense, doping with transition metals have been used in order to improve the photoefficiency as well as shift the absorption band to the visible part of spectrum [3].

In this work, TiO<sub>2</sub> nanoparticles doped with  $Ag^+$ ,  $AI^{3+}$ ,  $Ce^{4+}$  and  $Nb^{5+}$  in different amounts were prepared using the Pechini method. We have investigated the photocatalytic degradation of methyl orange in the aqueous suspensions of TiO<sub>2</sub> under UV light irradiation in order to evaluate the effects of the different dopants on the photocatalytic activity of the oxide.

XRD results indicate the predominance of anatase phase and formation of extensive solid solution to dopants low-concentration. Fig. 1 shows the changes on the rate constant of the methyl orange degradation reaction in function of the dopants amount. For all dopants it was observed an increase in the k value in relation to undoped material. For Al-, Ce- and Nb-doped systems the higher k value was observed to 0.05 mol% of dopant, but the k values decrease at higher doping level. For Ag-doped system the k value increases up to 1.0 mol% of Ag. Above this Ag concentration, k decreases drastically. Besides the electronic effect expected, the doping shows a secondary effect on the  $TiO_2$  particles. The BET surface area data analysis shows that initially the presence of impurity atoms leads to an increase in the grain size, however, in followed occurs a suppression effect producing an increase in the surface area. This area effect contributes also to the efficiency increase in higher dopants concentration.





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