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PROMOTING MAGNETOSTRICTION IN GRAIN BOUNDARIES OF NANOSTRUCTURATED TiO2 FILMS SUPPORTED ON STAINLESS STEEL ELECTRODES FOR CONTROLLING THE PHOTOGENERATION OF HOLES AND HYDROXYL RADICALS

The study of ferromagnetism (FM) in non-cubic semiconductor oxides such as defective TiO2 is attractive due to their applications in photocatalysis. FM can be activated in TiO2 nanomaterials by promoting oxygen vacancies (VO) located in paramagnetic defected sites Ti3+VOTi4+. In this context, the VO can induce in Ti3+-doped TiO2 structures remarkable magnetic anisotropy energy (MAE) of 6.51x106 erg/cm3, thus indicating the magnetic saturation should be achieved at magnetic fields (MFs) of ⩾425 gauss. Therefore, magnetostriction can be observed in ferromagnetic TiO2 films as a phenomenon in which their dimensions and shapes are changed when they are magnetized. In this work, stainless steel mesh electrodes (ss) were modified by nanoparticulate TiO2 films (ssTiO2) enriched by Ti3+VOTi4+ sites, to gain an understanding of the effects of magnetostriction on the photocatalytic properties of ferromagnetic TiO2 electrodes. MFs having intensities (H) of 125, 250, 500, 1000, and 2000 gauss were applied to the ssTiO2 electrodes for 80 min under UV light illumination for increasing the number of Ti3+VOTi4+ sites. Our results revealed that the magnetic lines promoted compression in the grain boundaries of the TiO2 structure when achieving pressures p>4.67 GPa for H>425 gauss (equation p=1/2(MAE/4⍰ gauss2)H2 describes the relationship between p and H). Consequently, the proportion of TiO2(anatase)/TiO2(beta) and the photogeneration of trapped holes (h+) and hydroxyl radicals (•OH) were simultaneously controlled as a function of the MFs intensities. In this way, it was observed a significant increase of h+ able to carry out the direct photocatalytic oxidation of aqueous orange G (without electron scavenger's assistance, e.g. gaseous O2) at the lowest H values, whereas the photogeneration of •OH radicals decreased at the highest H values. Finally, it was also interesting to observe that the Hinshelwood-Langmuir kinetics constants for the orange G oxidation were improved as H was increased.

Keywords

ferromagnetic TiO2, magnetostriction, photocatalysis.

Reference

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Author approval

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