The effect of rare earth dopants on the structure, surface texture and photocatalytic properties of TiO$_2$–SiO$_2$ prepared by sol–gel method

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ABSTRACT

The sol–gel method was successfully used to prepare a series of TiO$_2$–SiO$_2$ and rare earth (RE) (La$^{3+}$, Nd$^{3+}$, Sm$^{3+}$, Gd$^{3+}$)-doped TiO$_2$–SiO$_2$ nanoparticles at a doping level of 3 atomic percent. The structural features of parent TiO$_2$–SiO$_2$ and RE–TiO$_2$–SiO$_2$ fired at 550°C have been investigated by XRD, UV-diffuse reflection, SEM and nitrogen adsorption measurements at $-$196°C. XRD data verified the formation of typical characteristic anatase form in all the prepared RE-doped TiO$_2$–SiO$_2$ samples. In comparison with the pure TiO$_2$–SiO$_2$ samples (ca. 35 nm in diameter), the RE–TiO$_2$–SiO$_2$ samples have relatively small particle size indicating that the doping with RE metal ions can improve the particle morphology, and retard the grain growth of TiO$_2$–SiO$_2$ during heat treatment. The results indicated that Gd$^{3+}$ doped TiO$_2$–SiO$_2$ has the lowest bandgap and particle size compared with pure TiO$_2$–SiO$_2$ and other nanoparticles of RE-doped TiO$_2$–SiO$_2$. The highest surface area ($S_{BET}$) and pore volume ($V_p$) values were recorded for Gd–TiO$_2$–SiO$_2$ as well. The effect of doping on the photoactivity was evaluated by the photocatalytic degradation of EDTA as a probe reaction. Among all the pure and RE-doped TiO$_2$–SiO$_2$, Gd$^{3+}$–TiO$_2$–SiO$_2$ performed the highest catalytic activity towards the tested reaction. That might be due to its special characteristics of particle size, surface texture and bandgap properties. Details of the synthesis procedure and results of the characterization studies of the produced RE–TiO$_2$–SiO$_2$ are presented in this paper.