Sol-gel synthesis of mesoporous anatase-brookite and anatase-brookite-rutile TiO_2 nanoparticles and their photocatalytic properties

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Abstract

TiO_2 photocatalysts with a mixture of different TiO_2 crystal polymorphs have customarily been synthesized hydrothermally at high temperatures using complicated and expensive equipment. In this study TiO_2 nanoparticles with a mixture of TiO_2 crystals were synthesized using a modified sol-gel method at low temperature. In order to form nanoparticles with different polymorphs a series of samples were obtained at pH 2, 4, 7 and 9. Raw samples were calcined at different temperatures ranging from 200 to 800°C to evaluate the effect of the calcination temperature on the physico-chemical properties of the samples. XRD results revealed that a mixture of anatase and brookite can be obtained in the as-synthesized samples and in those calcined up to 800°C depending on the pH used to obtain the final product. Indeed, a mixture of anatase brookite and rutile; or a sample with only rutile phase can be yielded through further calcination of the as-prepared samples at temperatures $\geq 600^0$C due to phase transformation. The photocatalytic performance of the samples with a mixture of anatase-brookite; anatase-brookite-rutile; and

anatase-rutile (Degussa P25 TiO_2) was exquisitely investigated in the degradation of methylene blue solutions. The samples obtained at pH 2 and calcined at 200^{o}C possessed the highest activity of all due to its superior properties. This study elucidates a facile method suitable for the synthesis of TiO_2 with different mixtures of TiO_2 polymorphs with desirable properties for various applications.