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Carbon, Nitrogen Doped TiO2 Macro/Mesoporous Monoliths with High Visible Light Absorption for Photocatalytic Wastewater Treatment

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Abstract : TiO2 based monoliths with hierarchical macropores and mesopores have been synthesized following a novel one pot sol-gel synthesis method. Taking advantage of spinodal separation that occurs between titanium isopropoxide and an acidic solution in presence of polyethylene oxide polymer, monoliths with homogeneous interconnected macropres of 3 µm in diameter and mesopores of ca. 6 nm (surface area 150 m2/g) are obtained. Furthermore, these monoliths present some carbon and nitrogen (as shown by XPS and elemental analysis), which considerably reduce titanium oxide energy gap and enable light to be absorbed up to 700 nm wavelength. XRD shows that anatase is the dominant phase with a small amount of brookite. Enhanced light absorption and high porosity of the monoliths are responsible for a remarkable photocatalytic activity. Wastewater treatment has been performed in closed reactor under sunlight using orange G dye as target molecule. Glass reactors guarantee that most of UV radiations (to almost 300 nm) of solar spectrum are excluded. TiO2 nanoparticles P25 (usually used in photocatalysis under UV) and un-doped TiO2 monoliths with similar porosity were used as comparison. C,N-doped TiO2 monolith allowed a complete colorant degradation in less than 1 hour, whereas 10 h are necessary for 40% colorant degradation with P25 and un-doped monolith. Experiment performed in the dark shows that only 3% of molecules have been adsorbed in the C,N-doped TiO2 monolith within 1 hour. The much higher efficiency of C,N-doped TiO2 monolith in comparison to P25 and un-doped monolith, proves that doping TiO2 is an essential issue and that nitrogen and carbon are effective dopants. Monoliths offer multiples advantages in respect to nanometric powders: sample can be easily removed from batch (no needs to filter or to centrifuge). Moreover flow reactions can be set up with cylindrical or flat monoliths by simple sheathing or by locking them with O-rings.

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