Microwave-Assisted Flow Synthesis of Nano-confined Pt in Titania Nanotubes (Pt-TiNT) photocalysts

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Pt-TiNT with PtO nanoparticles dispersed within the lumen and interlayer spaces of titania nanotubes (TiNT) were prepared by a new process involving titania nanosheets (TiNS) synthesis in an optimised microwave-assisted flow reactor, followed by ion-exchange with a Pt precursor, before triggering the titanate layer rolling to trap the Pt precursor clusters inside the titanium nanotubes, and thermal treatment. TEM, XRD and Raman analyses confirm the total conversion of TiO_2 into TiNS in 15 min at 120°C and 4 bar, and TiNS transformation into 181 nm-long TiNT with 10 and 6 nm outer and inner diameter, respectively. The 2% Pt-TiNT comprises PtO clusters (according to XPS) of 0.7 nm diameter, causing slight distortions of the interlayer spaces while some larger 2-3 nm Pt clusters reside within the lumen. Pt-TiNT is 14-fold more active than TiNT for visible light photocatalytic oxidation of diclofenac and more than 1000-fold better than the uncatalyzed photoconversion reaction. Nano-confinement of PtO clusters narrowed the bandgap of the TiNT, which combined with its excellent absorptivity to harvest light allowed a large spectral range of photon energies to activate the photocatalyst.

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