Photocatalytic activity of synthesized titanate nanotubes and nanoribbons vs. commercial TiO$_2$ under artificial solar and visible irradiation using 17β-estradiol as model micropollutant

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ABSTRACT

The aim of this study was to compare photocatalytic activity of protonated titanate nanotubes (HTiNT) and nanoribbons (HTiNR) vs. TiO$_2$ P25 under different irradiation conditions for degradation of selected water micropollutant (17β-estradiol, E2). HTiNT and HTiNR were prepared according to previously published method, hereby confirmed by means of the scanning electron microscopy and powder X-ray diffraction (XRD). In order to check the extent of photocatalytic activity at high E2 photolysis rates due to its absorption maximum ($\lambda_{\text{max}} = 278$ nm), reaction cell was exposed to the source of artificial solar light with enhanced UVB irradiation. HTiNT, HTiNR and commercial TiO$_2$ were active under both visible light and solar irradiation. In each irradiation regime, the E2 degradation followed pseudo-first-order kinetics with respect to both irradiation time and energy. The rate constant decreased with the decreasing catalyst load while increased with the increasing irradiation energy for the emissions below 400 nm. On behalf of achieved nanostructural arrays the wider bandgaps were shown for HTiNT and HTiNR. Compared with TiO$_2$ P25 almost three times lower rate constants for E2 degradation under visible irradiation were observed on behalf of band alignment effect of the P25. The photonic efficiencies ($\zeta_0$) were calculated and used for quantitative comparison of HTiNT, HTiNR and TiO$_2$ photocatalytic activity regardless the irradiation conditions. The respective values decreased with the higher irradiation energy as related to an excess of photons available for simultaneous photolysis of E2 and its degradation intermediates.

Keywords: 17β-estradiol; Photocatalysis; Nanotubes; Nanoribbons; Photonic efficiency

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