Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2017.20477

67 (2017) 300–308
March

Photocatalytic activity of synthesized titanate nanotubes and nanoribbons vs. commercial TiO_2 under artificial solar and visible irradiation using 17β-estradiol as model micropollutant

Ivana Grčić[a,*], Ivan Brnardić[b], Dragana Mutavdžić Pavlović[a], Vilko Mandić[a], Sanja Papić[a]

[a]*Faculty of Chemical Engineering and Technology, University of Zagreb, Marulićev trg 19, 10000 Zagreb, Croatia, Tel. 0038514597124; email: igrcic@fkit.hr*
[b]*Faculty of Metallurgy, University of Zagreb, Aleja narodnih heroja 3, 44103 Sisak, Croatia*

Received 16 September 2016; Accepted 20 December 2016

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 (λ_{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 (ζ_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

* Corresponding author.