Highly porous TiO_2 nanofibers by humid-electrospinning with enhanced photocatalytic properties

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ABSTRACT

Development of porous TiO_2 nanostructures with high surface area and porosity is an active area of research due to their versatile properties for diverse applications. Owing to the large aspect ratio of nanofibers (NFs) and their impressive properties, electrospinning has been a widely adopted technology for developing TiO_2 nanofibers. Conventionally, porous electrospun ceramic nanostructures are produced by using sacrificial materials and post-sintering secondary chemical treatments. In this work, we demonstrate that porous TiO_2nanofibers (NFs) could be synthesized by optimizing the humidity in the electrospinning chamber without any post-sintering treatments and the porous TiO_2 nanofibers thereby produced show high catalytic activities. Three other TiO_2 structures are used as benchmark materials in this work: (i) solid TiO_2NFs, (ii) TiO_2 NFs obtained by the removal of glycerin and (iii) TiO_2 NFs obtained by etching TiO_2/ZnO composite nanofibers. The BET surface area of the materials (ii) and (iii) did not differ much (~60–63 m^2/g); however, the porous TiO_2 NFs produced in high humidity nearly thrice surface area (~128 m^2/g) than (i). To demonstrate the variation of properties of the four types of TiO_2 NFs, photocatalytic degradation of methylene blue (MB) is demonstrated. Over 70% of the MB could be degraded by the materials produced by high humidity in 30 min whereas it was 30% for the benchmark materials. The strategy presented here could be adopted for synthesizing highly porous TiO_2 NFs for a range of applications.

KEYWORDS

TiO_2 nanofibers; Electrospinning; Highly porous nanofibers; Photocatalytic activity