Solid State Tuning of TiO2 Morphology, Crystal Phase, and Size through Metal Macromolecular Complexes and Its Significance in the Photocatalytic Response

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A solid-state phase control of TiO2 by the use of different macromolecular complex precursors is reported for the first time. During the formation of TiO2 nanoparticles, chitosan and poly(styrene-co-4-vinylpyridine) polymers can act as solid-state template producing areas after carbonization, where the TiO2 nucleates. It seems that the location of metal centers through the polymeric chain (i.e., the distance between the metal centers) strongly influences the morphology and particle size of the photocatalyst. To demonstrate the application value of our different TiO2 structures, the photocatalytic behavior was explored. The efficient photocatalytic decoloration of methylene blue on different polymorphic forms of nanostructured TiO2 is confirmed. The best photocatalyst achieved a 98% discoloration rate in only 25 min when the pH of the solution was 9.5, improving the efficiency of the standard photocatalyst Degussa P25 without the addition of other phases or dopants. The novelty of the present work is that, by means of an appropriate synthesis, the three main factors (morphology, size, and crystalline phase) that allow modulating the photocatalytic response of titania material can be tuned simultaneously. This control has allowed an advance in the properties of the material, managing to increase the photoresponse in a short time.

morphology

photocatalysis

size and crystal phase

solid-state synthesis

TiO2 nanoparticles

Carbonization

Chromium compounds

Dyes

Macromolecules

Morphology

Nanoparticles

Particle size

Photocatalysis

Polymers

Silicon compounds

Styrene

Synthesis (chemical)

Titanium dioxide

Crystal phase

Crystalline phase

Macromolecular complexes

Nano-structured TiO2

Photocatalytic behaviors

Polymeric chain

Polymorphic forms

Solid-state synthesis

TiO2 nanoparticles