Nanophotocatalysts for Green Synthesis and Environmental Application

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Photocatalysis is considered a green technology consenting the accomplishment of cleaner productions as a response to growing environmental regulations.

Indeed, the photocatalytic processes in general do not require much severe operating conditions, resulting in reduced cost and limited safety precautions with respect to processes carried out at high temperature and pressure. Moreover, photocatalysis could be also very selective, thus the formation of by-products is reduced. Very mall semiconductor particles have shown peculiar photocatalytic properties. Nanosized particles, with diameters ranging between 1 and 10 nm, possess properties which fall into the region of transition between the molecular and the bulk phases.

Nanostructured photocatalysts allow to improve the photoactivity since they enhance both the adsorption of reactants and the desorption of products, due to the high surface area offered by the nanostructures, and reduce the electron-hole recombination, due to the short charge transfer distance towards adsorbed species. Moreover, the use of nanomaterials as catalysts could minimize restrictions of heat or mass transfer phenomena [1].

Several nanosized titania are commercially available. To prepare nanosized photocatalysts useful for organic synthesis, wet impregnation with active phases could be performed on commercial titania. However, they are active only under UV irradiation. For environmental application that use visible light photocatalyst, actually no commercial titania are disposable. So to explore the properties of visible active photocatalysts, direct synthesis has to be performed. The principal current technologies to obtain titania dense nanoparticles are the sol–gel technique, the gas-phase decomposition process, the spray flame pyrolysis. In particular sol-gel tecnique is largely used. For instance, the optimization of the conditions of sol–gel synthesis for nitrogen doped titania powders to obtain an high visible-active surface area was conducted, decreasing the nanometer size of primary particles [2].

Irradiation by light emitting diodes (LEDs) of photocatalytic powders presents more advantages with respect to the use of lamps, since LEDs are extremely energy efficient, consume up to 90% less power than incandescent bulbs and their emission is geometrically easy to be totally direct towards the photocatalyst. Moreover the reactor configuration plays an important role in the efficiency of photocatalysis, and as a function of the applications, the photocatalysts powders could be applied with high activity in fluidized bed photoreactors, or immobilized on transparent support to be employed in fixed bed photoreactor.

Here the photocatalytic performances obtained in several photocatalytic organic synthesis and removal of aqueous contaminants on nanosized photocatalysts are reported. The transformation of cyclohexane to benzene on MoO_x/TiO_2, of cyclohexane to cyclohexene and of ethylbenzene to styrene on $MoO_x/\gamma\text{-}Al_2O_3$, of ethanol to acetaldehyde on VO_x/TiO_2, was selectively obtained. For environmental application devoted to purification of water pollutants with energy saving, nanosized nitrogen doped titania showed interesting results in the removal of several organic dyes and contaminants of emerging concern.

***References*:**

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