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The ILs-assisted solvothermal synthesis of TiO_2 spheres: The effect of ionic liquids on morphology and photoactivity of TiO_2

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In recent years, photocatalytic processes have been intensively investigated for destruction of pollutants, hydrogen evolution, disinfection of water, air and surfaces, for the construction of self-cleaning materials (tiles, glass, fibers, etc.). Titanium dioxide (TiO_2) is the most popular material used in heterogeneous photocatalysis due to its excellent properties, such as high stability, chemical inertness, non-toxicity and low cost. It is well known that morphology and microstructure of TiO_2 significantly influence the photocatalytic activity. These characteristics as well as other physical and structural properties of photocatalysts, i.e., specific surface area or density of crystalline defects, could be controlled by preparation route. In this regard, TiO_2 particles can be obtained by sol-gel, hydrothermal, sonochemical methods, chemical vapor deposition and alternatively, by ionothermal synthesis using ionic liquids (ILs). In the TiO_2 particles synthesis, ILs may play a role of a solvent, soft template, reagent, and agent promoting reduction of the precursor or particles stabilizer during synthesis of inorganic materials. Ionic liquids (ILs) are widely applied to prepare metal nanoparticles and 3D semiconductor microparticles. Generally, they serve as a structuring agent or reaction medium (solvent); however, it was also demonstrated that ILs can play a role of a co-solvent, metal precursor, reducing as well as surface modifying agent. Based on the literature data and preliminary own investigation, it could be concluded that application of ionic liquids in semiconductors synthesis provide a modification of the morphology and enhanced the photocatalytic activity of obtained structures. In this regard, ionic liquids may play a role of a solvent, soft template, reagent, and agent promoting reduction of the precursor or particles stabilizer during preparation of inorganic material. In addition, presence of the IL on the TiO_2 surface probably results in absorption of the photons and excitation of the electrons from HOMO to LUMO orbitals. Mechanism of the photo excitation could be therefore related with transfer of the electron from the LUMO level of IL to the TiO_2 semiconductor conduction band. In this work, the effect of selected ILs structure and amount, as well as conditions of hydrothermal synthesis on the morphology and photoactivity of TiO_2 is presented. The preparation of TiO_2 microparticles with spherical structure was successfully achieved by solvothermal method, using tetra-tert-butyl orthotitanate (TBOT) as the precursor. Various molar ratios of all ILs to TBOT (IL:TBOT) were chosen. For comparison, reference TiO_2 was prepared using the same method without IL addition. Scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), Brunauer-Emmett-Teller surface area (BET), NCHS analysis, and FTIR spectroscopy were used to characterize the surface properties of the samples. The photocatalytic activity of IL-assisted TiO_2 photocatalysts was estimated by measuring the rate of phenol decomposition in aqueous solution as well as formation of hydroxyl radicals based on detection of fluorescent product of coumarin hydroxylation. Phenol was selected as a model contaminant because it is a non-volatile and common organic pollutant found in various types of industrial wastewater.

Biography

Ewelina Grabowska has her expertise in “Heterogeneous photocatalysis, preparations of nanoparticles and nanomaterials, nanotechnology, functional materials, photocatalytic oxidation in presence of titanium dioxide, water and wastewater treatment, remediation technology and chemical technology evaluation”.

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