ABSTRACT

Advanced oxidation processes represent the most appropriate solution for the treatment of wastewaters which are contaminated with non-biodegradable and toxic substances, since in this case biological treatment is not effective. With the use of hydroxyl radicals, which have one of the highest oxidation potentials, water-dissolved organic matter can be successfully converted to carbon dioxide, water, and related inorganic salts. Advanced oxidation processes were used for the treatment of bisphenol A and a landfill leachate. All catalysts were based on a promising material, TiO_2, which possesses many advanced properties, such as non-toxicity, stability and low cost. By choosing different synthesis conditions and the starting material, one can influence the morphological diversity and thus obtain a wide range of nanomaterials applicable in various fields. By applying different synthesis methods (hydrothermal synthesis, sol-gel process), we have prepared morphologically (nanotubes, nanorods, nanoparticles, humming-top structure) and structurally (anatase, rutile, brookite, nanocomposite materials anatase/ rutile, anatase/TiO_2-B and anatase/rutile/brookite) diverse materials and thus evaluated the influence of different physicochemical properties on the level of oxidation. Maximum conversion in the process of catalytic wet air oxidation can be achieved in the presence of titanate nanotubes annealed at 600 °C, which have an optimal balance between high specific surface area and the degree of crystallinity. By recycling of the liquid phase almost complete mineralization of bisphenol A was achieved. Further, impregnation with metal Ru also enabled efficient treatment of complex landfill leachate. The highest photocatalytic activity was achieved with the use of nanocomposite materials, where the specific surface area of the material does not play the crucial role; whereas the effective charge separation is crucial. Among pure polymorphs, anatase and brookite are generally more effective than rutile, due to prolonged lifetime of charge carriers. Heterogeneous photocatalytic oxidation of bisphenol A was most efficient in the presence of a nanocomposite material which contains three TiO_2 polymorphs (anatase, rutile, brookite), since complete mineralization was achieved. Due to the exceptional properties of nanocomposite materials that allow efficient charge separation and thus improved activity, we further investigated synergistic effect between physical mixtures of individual polymorphs. From the obtained results we can confirm that the physical mixture of anatase and rutile exceeds the activity of individual phases, but the overall activity of nanocomposite materials is still higher.