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A new method for the synthesis of monodisperse-porous titania microbeads by using polymethacrylate microbeads as template

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Monodisperse-porous titanium dioxide (TiO_2) particles have attracted much attention due to its usability in different research areas such as photocatalysis, energy storage, sensor applications, catalysis, dye-sensitive solar cells and chromatography. In this study, a new synthesis protocol was established to obtain monodisperse-porous titania beads with different sizes and different porous characteristics.

Monodisperse-porous titania microbeads were synthesized by sol–gel templating method by using a new type of polymethacrylate microbeads as template. Monodisperse-porous poly(3-chloro-2-hydroxypropyl methacrylate-co-ethylene dimethacrylate), poly(HPMA-Cl-co-EDMA) microbeads 5.4 µm in size were used as starting material for the preparation of new template. Strong cation exchanger -SO_3Na groups were generated on the selected polymethacrylate template via the reaction between chloropropyl groups of template and sodium bisulfite. -SO_3Na functionalized-polymethacrylate microbeads were treated with the precursor, $TiCl_4$ in an aqueous medium and subsequently treated with ammonia solution to obtain titania-polymer composite microbeads. The composite microbeads were then calcined at 450 ºC to have monodisperse-porous titania microbeads.

Monodisperse-porous titania microbeads in the size range of 3.0-5.0 µm with crater-like or fine porous structures with specific surface areas ranging between 50-91 m^2/g were obtained by changing the concentration, crosslinking density of the template beads and the calcination temperature. The selection of a polymethacrylate template decomposed at lower temperatures with respect to poly(styrene-co-divinylbenzene) type templates, commonly used for synthesis of porous titania microbeads, allowed to perform the calcination of titania-polymer composite microbeads at lower temperatures. Monodisperse-porous titania microbeads with higher specific surface area and a crystalline structure with higher percent of anatase phase could be obtained by performing calcination at lower temperatures. The photocatalytic activity of monodisperse-porous titania microbeads was investigated using an anionic azo-dye, Remazol Black 5 (RB5) in batch-fashion. Higher photodegradation rates were observed with the monodisperse-porous titania microbeads in the acidic pH region.

Keywords: Titania microbead; Sol-gel template synthesis; Photocatalysis; Dye degradation.