Novel hierarchical TiO_2 superstructures as efficient photocatalysts for dye removal

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Novel hierarchical nanostructured TiO_2 were successfully synthesized by the simple hydrothermal process. Different geometries, including interconnected carnation petal-, rose bridal bouquet- and humming-top-like superstructures, were easily tuned by varying the hydrothermal treatment temperature at 120º, 160º and 200ºC. The band gap energies were estimated approximately 3.83, 3.65 and 3.40 eV corresponding to the temperature increment. The gradual transformation from layered titanate to brookite phase was well coincident with the growth mechanism of the hierarchical morphologies. The three-dimensional flower bouquets built from the bunches of roses with surrounding fern fronds displayed the best adsorptivity and completely degraded methylene blue within 60 minutes under UV irradiation. Accordingly, the fastest apparent reaction rate constant was obtained, 61.8×10^{-3} min^{-1}, which was 10% greater than that of carnation petal-shaped nanosheets. The humming-top geometry composed of anisotropically elongated spindle-like crystallites was detrimental to the dye photodegradation.