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C-doped TiO_2 powder characterization via XRD-analysis and Photo-Electrochemical experiments

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Research towards the establishment of photo-electro-catalytic oxidation of organics as an advanced oxidation method for the degradation of organic pollutants, sometimes coupled with the production of hydrogen or electric energy, is timely. Special emphasis is given to its applicability under visible light illumination and to that direction photoanode materials that show visible light activity are highly demanded. These can be classified as single component semiconductors, bi-component semiconductors and modified TiO_2-materials. The latter include non-metal-doped (e.g. C-, N-, S-doped) as well as metal-decorated (e.g. Pt-, Au-, Ag-decorated) TiO_2 oxide powders or nanotubes. The aim of this study has been to produce C-doped TiO_2 nanopowders as visible-active photocatalytic materials. Catalyst preparation has been carried out by mixing TiO_2 (P25-Degussa) and carbon (Vulcan X) powders in ethanol, followed by drying and calcination at various temperatures in an inert or ambient atmosphere. Structure characterization was performed by powder XRD diffraction pattern analysis and photoelectrocatalytic testing towards water oxidation via cyclic voltammetry and chronoamperometry. XRD-analysis and 2θ-peak-indexing were accompanied by statistical analysis of the calculated crystal unit's dimensions. Photoelectrochemical experiments were carried out in a three-electrode cell by means of a potentiostat. Sample illumination by visible or UV light was achieved by appropriate lamps. Photocatalytic activity extended from the UV to visible range was recorded for certain samples. A direct correlation between variation of lattice parameters and photocatalytic activity, indicating that carbon enters the lattice of TiO_2 has not been observed. It is assumed that the beneficial effect of carbon is due to the creation of appropriate hetero-junctions at the catalyst surface rather than a change of its crystallographic structure.