Journal of Industrial and Engineering Chemistry
Volume 95, 25 March 2021, Pages 203-214

Industrial and environmental significance of photonic zirconia nanoflakes: Influence of boron doping on structure and band states

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Abstract

A unique zirconia nanomorphology possessing an enhanced photocatalytic efficiency was developed utilizing a convenient single-sol synthesis process which involved in-situ doping of zirconia by boron. The boron-doped zirconia exhibited a flake morphology as opposed to the spherical pure form and subsequent crystallographic investigations implied the phase conversion from binary to single-phase along with the shape due to the doping. Optical characterization indicated a modified band structure with newly generated isolated impurity states within the principle zirconia band edges. As per the X-ray spectroscopy data, boron was detected as chemically bound to oxygen while electron paramagnetic resonance indicated the presence of an adsorbed oxygen lattice. During UV and simulated solar irradiation trials, respective removal capabilities of 90% and 93% of the model compound were accomplished, hence the effectiveness of the photocatalyst was confirmed. The enhanced photoactivity observed in the UV region was attributed to combined effects

of the boron-induced isolated impurity states within principle band edges of zirconia, the defect-rich planer morphology, favorable interfacial interactions and the greater availability of oxygen on the lattice. Developed nanoflakes are stable, inert, and efficient hence exhibiting compelling suitability in the remediation of harmful industrial organic compounds.

Keywords

Doping
Zirconia
Boron
Bandgap
Environmental remediation