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Photocatalytic wastewater purification under visible light irradiation using multi-doped TiO_2/rGO cross-linked 3D aerogel; Mechanistic catalytic experiments and cytotoxicity assessment

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In this work, the 3D Ga, N and F multi-doped TiO_2@rGO aerogels as an efficient visible-light activated and easily separable catalyst have been successfully prepared trough simple one-pot hydrothermal method using ascorbic acid as the cross-linker and reducing agent. It can be seen that multi-doping and coupling with GO decrease the growth of TiO_2 crystals. The band gap of TiO_2 was reduced from 3.21 eV to 2.73 eV with the use of 1 mol.% of Ga and 3 mol.% of NF. SEM images indicated an interconnected porous 3D network structure contain of 2D graphene oxide sheets, with uniform dispersion of TiO_2 nanoparticles on the rGO plane. The reduction of GO was clearly confirmed based on the results from FT-IR and Raman spectroscopy analysis. 3D porous structure of prepared aerogels resulted in large specific surface area and high pore volume and present good adsorption capacity as well as excellent photocatalytic activity for the degradation of ATZ molecules. Mixed-doped TGA sample showed higher photocatalytic activity than mono-doped and un-doped samples under visible light irradiation. The 100% degradation and 77% mineralization of 40 mg/L ATZ was attained in the PCO process within 60 min using Ga_1NF_3@TGA sample. The enhanced photocatalytic activity of the Ga_1NF_3@TGA is due to the synergic effect of high visible light absorption, short band gap (Ga and N doping), surface acidity (F doping), ATZ adsorption (electrostatic attraction), efficient charge excitation and transfer (mid bands/defect levels/vacancies) and generation of more hydroxyl and superoxide radicals for the photocatalytic degradation of ATZ. The degradation studies using various scavengers showed that hydroxyl radical was the main active species contributed in the photocatalytic degradation of ATZ under the selected conditions. The cytotoxicity of the fresh and photocatalytic-treated (under optimum conditions) ATZ solutions was evaluated as skin fibroblast cells (Hu02) viability. The results indicated that excellent detoxification of ATZ upon photocatlytic treating under visible light irradiation. Accordingly, GaNF@TGA sample prepared at this work could be an excellent visible-light photocatalyst for degradation, mineralization and detoxification of organochlorine pesticides in the contaminated water.

Keywords: TiO_2 modification, nanocomposie, aerogel, cytotoxicity.

References

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