Highlights

RESEARCH AREA 1 - Superconductors and Innovative materials for Energy and Environment - 2024

Ball–milled TiO_2/biochar hybrid system as a heterogeneous photocatalyst for tannery dyes removal in aqueous solution

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In this study, a biochar/TiO_2 photocatalytic hybrid system has been prepared, for the first time, by ball-milling approach, a simple, green, and cost-effective method. The new material is proposed for the removal of tannery dyes from aqueous solutions under UV light. Enhancement in degradation and removal efficiency of pollutants has been tried by combining an adsorbent material with a photocatalyst. TiO_2 has been selected as the photocatalyst because it is economical, non-toxic, and has proven effective in the degradation of a wide range of different aquifer pollutants; biochar acts as the support, being a porous carbonaceous solid derived from conversion of biomass waste; Acid Blue 7 and Amaranth Red dye are chosen as target organic dyes to assess the efficacy of the photocatalytic hybrid system since acid and azo dyes are the most commonly used dyestuff in the leather industry. The physicochemical, thermal and structural characteristics of the hybrid system $(C/TiO_2)_{BM}$ prepared by ball-milling confirmed the effective coupling of the biochar with TiO_2 particles. The surface morphology revealed well-dispersed TiO_2 particles in the biochar without agglomeration (Fig. 1). The photocatalytic activity results showed that the $(C/TiO_2)_{BM}$ system exhibited a good adsorption ability and higher photocatalytic performance than the system prepared by manual mixing, pristine biochar (C) and bare TiO_2 (Fig. 2), revealing a synergistic effect of biochar and TiO_2 working together. After five reuse cycles, decrease in removal efficiency was negligible and elemental composition (investigated by EDX) of the hybrid photocatalyst did not significantly change, thus evidencing reusability and stability of the prepared system, as well as the absence of TiO_2 particles leaching phenomena.

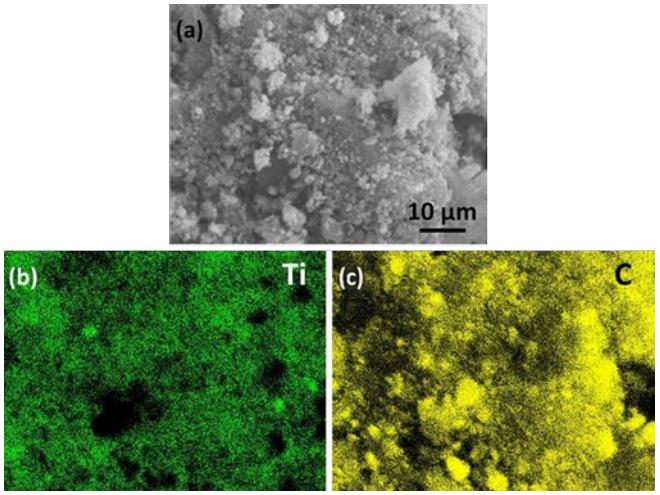

Fig. 1: SEM image (a) and corresponding EDX elemental maps of titanium (from TiO_2) (b), and carbon (from biochar) (c) for the surface of the as-prepared $(C/TiO_2)_{BM}$ system.

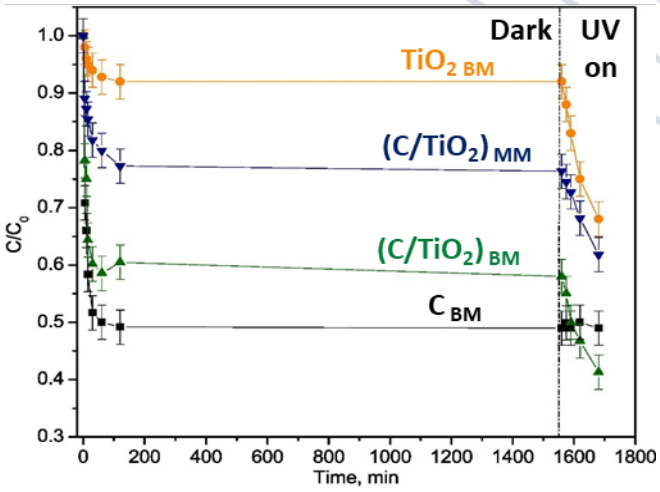

Fig. 2: Acid Blue 7 relative concentration (C/C_0) in aqueous solution as a function of run time, in presence of ball-milled TiO_2 **($TiO_{2\ BM}$)**, manual mixing TiO_2/biochar **$(C/TiO_2)_{MM}$**, ball-milled TiO_2/biochar **$(C/TiO_2)_{BM}$** or ball-milled biochar **(C_{BM}).**

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