Inorganic Chemistry Communications. Vol. 171, 2025, Article number 113633

Adsorption efficiency and photocatalytic activity of silver sulphide-activated carbon (Ag_2S-AC) composites

Abstract

Background: This study investigates the adsorption efficiency and photocatalytic activity of silver sulphide-activated carbon (Ag_2S-AC) composites derived from ground coffee waste (GCW). Methods: In this work, GCW was preceding to carbonized at 500 ± 2°C for hours and formed biochar. Then, GCW was subjected to activation using hydrochloric acid (HCl), phosphoric acid (H_3PO_4) and potassium hydroxide (KOH). The mixture was left to soak for 24 h at room temperature, followed by carbonization at 350 and 500˚C. In the meantime, the silver sulphide (Ag_2S) was synthesized by using an ion exchange method. Sodium sulphide (Na_2S) was used as sulphur source and mixed with silver nitrate ($AgNO_3$) and sodium citrate (NaCit) for two hours, then dried in oven at 50 ± 2°C for 10 h. Next, the carbonized AC was subsequently combined with synthesized silver sulphide, resulting in the creation of Ag_2S-activated carbon composites that functioned both as adsorbent and photocatalyst. Their capabilities as adsorbents and photocatalyst were studied by using copper ions (Cu^{2+}) and methylene blue (MB) solution. Significance findings: Based on results, GCW and all the prepared activated carbons are in the amorphous phase, except for the Ag_2S-AC composites, where the Ag_2S peak reflection can be observed from the X-ray diffraction (XRD) pattern. GCW shows rough and dense surface morphology. The AC shows different pore sizes and structures depending on the chemical activators used, where AC-KOH shows the largest pore size (165.31 μm). The existence of micropores can be observed in all the activated carbon samples. For the adsorption of Cu^{2+}, all samples show more than 99 % of the removal efficiency. While for photocatalytic testing, the Ag_2S-H_3PO_4 sample shows the highest degradation rate (97.7 %) of MB solutions.

Keywords

Activated carbon; Cu^{2+} Adsorption; Ground coffee waste; Heavy metal removal; Photocatalytic Degradation; Silver sulphide-activated carbon