Sustainable copper extraction from chalcopyrite using deep eutectic solvent for sample dissolution, electrodeposition, and adsorbent modification

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Chalcopyrite is a copper ore with a crystalline structure that forms strong atomic bonds, making it difficult to break using conventional solvents. As a solution, we propose using deep eutectic solvents (DES) based on methanesulfonic acid and choline salts as green leaching agents to extract copper from chalcopyrite and then directly electrodeposit it. We investigated the leaching efficiency by varying the anion forming the choline salt, the solid-liquid ratio, and the water content in the DES. After direct copper electrodeposition, we combined the remaining solution with agro-industrial biomass waste to create a high-performance material for removing herbicides. We found that using DES formed with choline chloride and 30 % water and a solid/liquid ratio of 0.04 g g^{-1} resulted in the dissolution of 75 % of the copper from chalcopyrite. We investigated the redox mechanism of the dissolved copper in DES using cyclic voltammetry. Under the best electrochemical conditions, we were able to recover copper by electrodeposition as metallic copper with a purity of 98.5 %. The advanced material obtained had a high removal capacity for 2,4-dichlorophenoxyacetic acid, with an adsorption capacity of 170 mg g^{-1}. Using DES, we streamlined the copper recovery process and obtained high-purity copper. The co-products from electrodeposition were utilized to produce new advanced material, completing the cycle of extraction and purification of copper. This sustainable process is efficient and aligns with circular hydrometallurgy.

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