Enhancing Simonkolleite by Copper Doping: Structural, Photocatalytic, Bactericidal, and Biocompatibility

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Keywords: Metal Dopants, Nanotoxicity, Drosophila, Antibacterial.

ABSTRACT

The impact of metal doping on the properties of simonkolleite has been extensively studied to explore its potential applications in various fields. This research investigates the effects of doping simonkolleite with silver and copper on its structural, morphological, photocatalytic, bactericidal, and biocompatibility properties. Simonkolleite, a zinc chloride-based compound, was doped with copper using controlled chemical synthesis methods. The structural changes due to doping were analyzed using X-ray diffraction (XRD), which provided insights into the doped materials' crystal structure and phase purity. Scanning electron microscopy (SEM) was employed to assess morphological alterations, revealing changes in particle size and surface texture with different metal dopants. The photocatalytic activity of the metal-doped simonkolleite was evaluated using degradation tests of organic pollutants under UV light. The photocatalytic efficiency was changed with metal doping due to its role in facilitating electron-hole pair separation and reducing recombination rates. Bactericidal properties were assessed against gram-positive and gram-negative bacterial strains using broth dilution methods to determine the minimum inhibitory concentration (MIC). The results indicated that metal-doped simonkolleite exhibited significant antibacterial activity, with Cu-doped samples showing particularly potent bactericidal effects. Biocompatibility studies were conducted in Drosophila melanogaster to evaluate the nanosafety of the metal-doped simonkolleite. The fruit flies' survival, development, and behavioral assays were performed to determine adverse effects. The findings demonstrated that while the metal doping improved the functional properties of simonkolleite, it did not result in nanotoxicity at the tested concentrations, indicating good biocompatibility. Thus, metal doping of simonkolleite with silver and copper enhances its structural, morphological, and photocatalytic properties while providing notable bactericidal activity. The study also confirms that these enhancements do not compromise biocompatibility, suggesting potential applications of metal-doped simonkolleite in environmental and biomedical fields. This research underscores the utility of metal doping in optimizing material properties for advanced applications.

Acknowledgments: CNPQ, FAPEAL, and CAPES