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Sonochemical Synthesis of Copper Nanomaterials from 3D Printing Waste

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Additive manufacturing (AM) waste high in copper was employed as an eco-friendly precursor in this study for the formation of luminescent copper-containing nanomaterials. The sonochemical process using a bath-type ultrasonic reactor (40 minutes, 99% power) was applied to convert 3D-printing metallic waste into nanostructures based on oxides using acoustic cavitation. Three different additive systems, namely polyvinylpyrrolidone (PVP), barium peroxide (BaO2), and iminodiacetic acid (IDA), were screened for regulating nucleation, oxidation, and stabilization. Morphological analysis by Scanning Electron Microscopy (SEM) revealed a transition from micrometer-sized spherical grains to densely packed, homogeneous nanofibers, consistent with additive complexity. Energy Dispersive X-ray Spectroscopy (EDS) confirmed near-stoichiometric Cu:O ratios. Photoluminescence (PL) spectroscopy under excitation with 370 nm and 400 nm wavelengths exhibited strong broad blue emission with a maximum at approximately 424-430 nm. All these effects can be attributed to redox-mediated cavitation. The increased PL, nanoscale tunability, and compositional tunability indicate high promise for optoelectronic and photocatalytic uses. Ultrasonic irradiation, as an acoustic wave-based method to tune nanoscale morphology, enhance photoluminescence, and compositional control suggest promising applications in optoelectronics and photocatalysis.

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