NOVEL 3D PRINTING FILAMENTS: PLA AND ZINC CARBONATE BASIC COMPOSITES FOR LASER-ASSISTED THERMAL DECOMPOSITION

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Additive manufacturing (AM), also known as 3D printing, has revolutionized the production of complex geometric structures across various industries. This study presents an innovative approach by integrating zinc carbonate basic (ZCB) precursor with polylactic acid (PLA) to develop composite filaments for fused deposition modeling (FDM) 3D printers. The resulting filaments undergo surface transformation into zinc oxide (ZnO) through high-power laser irradiation. Thermal analysis (TGA-DSC) and Fourier-transform infrared spectroscopy (FTIR) were used to confirm the decomposition of ZCB ($[ZnCO_3]_2 \cdot [Zn(OH)_2]_3$) into ZnO during the thermal decomposition stages. The study successfully extruded a composite filament containing 10% of ZCB, which worked adequately in 3D printing. The printed parts were analyzed through tensile tests (based on ASTM D638-5 standard), showing a notable difference in mechanical behavior between the commercial filament PLA and the composite filament (PLAC10). Laser irradiation of these samples facilitated a targeted conversion to ZnO, verified through scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), X-ray diffraction (XRD), and X-ray photoelectron spectroscopy (XPS). The integration of zinc oxide within the printed structures enhances structural stability and provides surfaces enriched with ZnO, a metal oxide with widely reported applications. Furthermore, an irradiated 3D-printed sample demonstrated chemo-resistive properties upon carbon monoxide (CO) exposure, underlining its potential as a gas sensor and confirming its semiconductor nature. This approach provides a cost-effective and efficient way to develop innovative devices with integrated functional materials.

Keywords: additive manufacturing, CO gas sensor, Zinc basic carbonate

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