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ABSTRACT

Bio-based Smart Electrically Conductive Composites by Digital Light Processing 3D Printing

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The transition from petroleum-based polymers to bio-based alternatives is a crucial step toward achieving sustainable development and reducing environmental impact [1]. Bio-derived monomers offer a renewable and eco-friendly solution, minimizing dependence on fossil fuels while enabling high-performance materials for advanced applications.

This work explores the development of bio-based conductive composites via Digital Light Processing (DLP) 3D printing for applications in advanced smart materials. By employing bio-derived photopolymerizable monomers, combined with conductive fillers such as silver, copper, nickel powders, and mechanically recycled carbon fibers (RCF), the printed structures exhibit enhanced electrical conductivity and Joule heating capabilities. The incorporation of these fillers not only modifies the polymerization kinetics and viscosity of the formulations but also enables tailored electrical and electrothermal properties.

Characterization techniques, including Fourier Transform Infrared Spectroscopy (FT-IR), differential scanning calorimetry (photo-DSC), rheological analysis, dynamic mechanical thermal analysis (DMTA), and thermal imaging, were employed to evaluate the material properties. Results demonstrate that filler content directly impacts curing behavior, mechanical properties, and electrical performance. Specifically, formulations reinforced with silver and RCF achieved efficient Joule heating, making them suitable for applications in thermotherapy, structural health monitoring, and shape-memory devices [2].

Building upon these findings, this study extends the investigation by incorporating an alternative bio-based monomer with conductive fillers to further enhance smart functionalities. The potential of

these composites in customizable self-heating devices, responsive materials, and sustainable electronics is discussed. This research bridges additive manufacturing, sustainability, and multifunctionality, paving the way for novel eco-friendly materials with intelligent properties.

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[2] A. Cortés, X.F. Sánchez-Romate, D. Martinez-Diaz, S.G. Prolongo, A. Jimenez-Suarez, Polymers, 16, 338 (2024).