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Mechanical Reliability and Biocompatibility of Graphene-Modified Photocurable Resins for Additive Manufacturing: Implications for Potential Biomedical Use

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Abstract-

Additive manufacturing using stereolithography enables the fabrication of intricate small-scale parts, making it ideal for biomedical applications such as prostheses and scaffolds. This study evaluates the mechanical reliability and biocompatibility of photocurable acrylic resins modified with graphene-based nanomaterials, graphene (G) and graphene oxide (GO), to address limitations in their use for biomedical products, where high reliability and predictable performance under mechanical stress are critical to ensuring safety and functionality. Through mechanical testing and Weibull distribution modeling, it was found that GO significantly enhances the characteristic strength (σθ) of the resin, improving its performance under mechanical stress; however, the reliability of this strength decreased as evidenced by a reduction in the Weibull modulus (m). Postprinting washing, aimed at reducing cytotoxic leaching, improved biocompatibility with cell viability exceeding 90%, though it slightly decreased the compression strength and increased the variability. GO-modified resins exhibited enhanced mechanical and biocompatibility profiles compared to G-modified resins, which showed limited interaction with the resin matrix. These findings offer important insights for optimizing mechanical reliability and biocompatibility, advancing the development of materials suitable for safe and reliable human-body contact in regenerative medicine.

Index Terms- 3D Printing; Biocompatibility; Organic Polymers; Toxicity; Two Dimensional Materials

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