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Effect of graphene and graphene oxide addition in crosslinking and mechanical properties of photocurable resins for stereolithography

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Abstract-

The mechanical properties of the resins used in stereolithography are often inadequate, prompting studies on their enhancement with nanofillers such as graphene-based nanomaterials (GBNs). GBNs hold promise for enhancing the mechanical performance of photocurable resins, yet their incorporation often leads to unexpected alterations that impact the final nanocomposite. The full spectrum of GBN effects on these resins remains incompletely understood, with many studies reporting suboptimal improvements. This study aims to elucidate the influence of graphene (G) and graphene oxide (GO) on the mechanical properties and polymer structure of an acrylic photocurable resin used in stereolithography. The novelty of this research lies in examining how GBNs affect the polymer structure during polymerization and the degree of crosslinking—parameters that have not been sufficiently explored—and correlating these effects with photopolymerization outcomes. Stereolithography is particularly valuable in biomedicine thanks to its exceptional precision in creating patient-specific models, functional parts, implant devices or scaffolds for tissue engineering, but also various other innovative uses across different industries. Through comprehensive tensile tests, DMTA, DSC, FTIR, and microscopy analyses, it was found that GO enhances tensile strength but reduces the crosslinking degree, thus hindering overall improvements. These findings highlight the critical roles of nanomaterial dispersion, matrix-polymer interaction, and reinforcement in affecting proper crosslinking. Future studies should investigate the impact of varying nanoparticle sizes on crosslinking to further validate these hypotheses.

Index Terms- Graphene-Based Nanomaterials; Photocurable Resin; Stereolithography; DMTA; Crosslinking

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