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Polymerization kinetics of acrylic photopolymer loaded with graphene-based nanomaterials for additive manufacturing

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Abstract-

Graphene-based nanomaterials (GBN) can provide attractive properties to photocurable resins used in 3D printing technologies such as improved mechanical properties, electrical and thermal conductivity, and biological capabilities. However, the presence of GBN can affect the printing process (e.g., polymerization, dimensional stability, or accuracy), as well as compromising the quality of structures. In this study an acrylic photocurable resin was reinforced with GBN, using methyl methacrylate (MMA) to favor homogenous dispersion of the nanomaterials. The objective was to investigate the influence that the incorporation of GBN and MMA has on polymerization kinetics by Differential Scanning Calorimetry using Model Free Kinetics, ultra-violet (UV) and thermal triggered polymerization. It was found that MMA catalyzed polymerization reaction by increasing the chain’s mobility. In the case of GBNs, graphene demonstrated to inhibit both, thermally and UV triggered polymerization, whilst graphene oxide showed a double effect: it chemically inhibited the polymerization reaction during the initialization stage, but during the propagation stage it promoted the reaction. This study demonstrated that MMA can be used to achieve photocurable nanocomposites with homogenously dispersed GBN, and that the presence of GBN significantly modified the polymerization mechanism while an adaptation of the printing parameters is necessary in order to allow the printability of these nanocomposites.

Index Terms- Vat Photopolymerization; polymerization kinetics; graphene-based nanomaterials; acrylic-based resin

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