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Digital light processing 3D printing of multifunctional nanocomposites: manufacturing and applications

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Additive manufacturing (AM) or 3D-printing has gained significant research interest in the industrial sector. The processing by Digital Light Processing (DLP) 3D-printing allows manufacturing materials with good quality and accuracy at a low cost. In addition, the industry demands the development of new multifunctional materials, that is, materials with good structural behavior and several functionalities at the same time. For these reasons, in this work, 3D printing techniques based on digital light processing has been used to manufactured objects and circuits of polymer nanocomposites. The ink of the circuits and nanocomposites materials has been done with a mixture of photocurable resin with different nanoparticles (MWCNTs, GNPs and, BN). The nanoparticles contents, and their mixtures, and the parameters of the 3D-printing technique have been optimized to reach materials and circuits with optimal properties as a function of their application. The inks have been used to development circuits for use in applications that require an electrically conductive system and/or with heating capacities such as electronic circuits, heated rear windows, and anti-icing and de-icing systems (ADIS). In other case, have been optimized parameters of DLP printing technology for manufactured materials with UV-curing resin doped with BN nanoparticles for application in injection molds and with MWCNTs for self-sensing materials for structural health monitoring (SHM) purposes. The results of this study, have been demonstrated high efficiency of the circuits, with MWCNT and GNP, as an anti-icing and de-icing system (ADIS). The maximum temperature reached of the 3D printed nanocomposites circuits was superior to reach by the thermal rear window of a commercialized vehicle. Also, nanocomposites were successfully manufactured by DLP with contents up to 0.15 wt.% and sensitivity, obtained in tensile tests, was in the same range of the one presented by conventional metallic gauges.