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3D Printing of Biomimetic Functional Nanocomposites based on dimethacrylated PCL and ZnO nanoparticles via Vat Photopolymerization for Tissue Engineering Scaffolds

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Biomimetic design and manufacturing have long garnered extensive attention in the biomedical field. However, progress has been hindered by the limitations of conventional techniques to reproduce microscopically complex structures and the lack of functional materials [1]. This study aims to develop photopolymerizable nanocomposites based on dimethacrylated Polycaprolactone (PCLDMA) and Zinc Oxide nanoparticles (ZnO-NPs) to produce tissue engineering scaffolds via vat photopolymerization 3D printing. PCLDMA synthesis involved the functionalizing PCLdiol with methacrylate groups, while ZnO-NPs were synthed using the Pechini method and further functionalized with 3-aminopropyltrimethoxysilane (APTES) to enhance nanoparticles dispersion and interaction within the polymer matrix. Moreover, the ZnO-NPs act as additives substituting photoabsorbers to control overexposure that causes loss in dimensional accuracy. The influence of ZnO-NPs addition was evaluated by developing nanocomposites with different concentrations of modified ZnO-NPs (1.0, 2.5, and 5.0 wt.%). The photopolymerizable nanocomposites were characterized using UV-vis, FTIR, DRX, and SEM, and the mechanical properties were evaluated. Scaffolds with biomimetic designs were fabricated by optimizing printing parameters, resulting in scaffolds with good dimensional accuracy reproducibility, and printability. These findings offer significant implications for the development of promising biomaterials for the creation of patient-specific scaffolds adapted to individual needs using an advanced 3D-printing technique.

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References:

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