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3D printing by vat photopolymerization of nanocomposites based on dimethacrylated PCL, ZnO nanoparticles and bioactive glass

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Biomimetic scaffolds are essential in tissue engineering, providing structural support and bioactive environments for cell growth. Vat photopolymerization (VP) enables high-resolution 3D printing of complex scaffolds, but its success depends on bioink properties. This study focuses on developing photopolymerizable nanocomposites using dimethacrylated poly(ε-caprolactone) (PCLDMA) as the polymer matrix, incorporating zinc oxide nanoparticles (ZnO-NPs) and bioactive glass (BG). PCLdiol was chemically modified with methacrylate groups to obtain PCLDMA, allowing efficient photocrosslinking [1]. ZnO-NPs were synthesized via the Pechini method and functionalized with 3-aminopropyltrimethoxysilane (APTES) to enhance dispersion and interaction within the polymer matrix. These nanoparticles serve as additives to replace conventional photoabsorbers, preventing overexposure and preserving dimensional accuracy [2]. Additionally, 45S5 BG particles were incorporated to enhance the scaffold's bioactivity [3]. Nanocomposites with varying concentrations of ZnO-NPs and BG were characterized using UV-Vis, FTIR, XRD, and SEM, and their mechanical properties were evaluated. Optimized printing parameters allowed the fabrication of scaffolds with high dimensional accuracy, reproducibility, and printability. These findings demonstrate the potential of these nanocomposites for developing patient-specific scaffolds in regenerative medicine.

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