

Cleaning of complex porous scaffolds for bone regeneration 3D printed by ceramic vat photopolymerization: effect of ultrasonic treatment, soaking time and temperature

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Vat photopolymerization has gained prominence in the bone tissue engineering owing to its ability to fabricate intricate structures that closely mimic the natural bone tissue. Thorough cleaning of uncured ceramic slurry from the as-printed structures is essential, as the presence of residue within the structure can obstruct pores during sintering. Given the limitations of conventional spray cleaning for these structures, this study seeks to investigate alternative cleaning approaches. Specifically, the efficacy of dibasic ester (DBE) and LithaSol 80, coupled with ultrasonic and soaking methods, is examined to identify optimal strategies for the thorough removal of viscous residual slurry (LithaBone HA 480).

To examine the effect of temperature on cleaning ability, printed scaffolds were soaked in the cleaning solutions at 23, 30, 40, and 50°C for 24h. Based on the results, 50°C was chosen as the temperature for further analysis in both soaking (24, 48, 72 and 96 h) and ultrasonic (5, 15 and 30 min; 1, 2, 3, and 4 h) cleaning methods. The cross-sectional image of the scaffolds showed that at least 48h and 30 min is required for effective cleaning for soaking and ultrasonic, respectively. Microstructure analysis of scaffolds cleaned with LithaSol 80 revealed smoother surfaces, while scaffolds treated with DBE showed visibly contracted pores with peeling effect, suggesting that DBE, exerts a more aggressive action on the cured slurry in contrast to LithaSol80. Notably, significant difference in mass loss was observed between scaffolds treated with LithaSol80 and DBE. The significantly lower mass loss observed with DBE suggests that it not only impacts uncured slurry but also possibly affects cured slurry. The results indicate that DBE is notably more effective in cleaning; however, LithaSol80 is more appropriate for maintaining structural integrity combined with soaking cleaning method. No significant difference was observed in compressive strength between most sintered scaffolds.