Yun Hee Lee et al., Res. Rev. J Mat. Sci. 2018, Volume 6
DOI: 10.4172/2321-6212-C5-026

Utility of camphor as diluent for lithography-based ceramic 3D printing technique

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This study demonstrates the utility of camphor as a novel type of diluents for the preparation of photo-curable ceramic slurries, which can have sufficiently low viscosities with high solid loadings (e.g., 48 vol %). These characteristics enable the use of conventional lithography-based Additive Manufacturing (AM) techniques without specifically designed feeding and recoating systems. To demonstrate this, Calcium Phosphate (CaP) ceramic objects and scaffolds were produced using various CaP slurries with different CaP contents (35 vol %, 40 vol %, 45 vol % and 48 vol %). The density and fracture strength of the samples after sintering at 1250 °C for 3 hours increased remarkably with an increase in solid loading from 35 vol % to 48 vol %. The curing behaviors (e.g., curing kinetics, cure depth and cure width) of a highly concentrated ceramic slurry (solid loading=48 vol %) were carefully characterized in order to achieve tightly controlled ceramic structures. Owing to these observations, porous CaP scaffolds with tailored porous structures could be successfully produced, where the porosity of ~54 vol %, pore size of 739.4 μm×702.5 μm in the x-y direction and wall thickness of ~1029 μm×903.7 μm were created. The porous CaP scaffolds showed the reasonably high compressive strength and modulus of ~30 MPa and ~299.45 MPa, respectively, which was attributed to the construction of highly densified CaP frameworks in a controlled periodic pattern. These findings suggest that camphor can be effectively used as the diluent, which can allow for the preparation of ceramic slurries with reasonably low viscosities and thus ceramic scaffolds with tailored porous structure can be produced using conventional lithography-based AM machine.

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