ADVANCED ADDITIVE MANUFACTURING OF FUNCTIONAL BIOGLASS-CARBON NANOCOMPOSITE SCAFFOLDS FROM NOVEL SILICONE-BASED LIQUID FEEDSTOCKS

Diamanti, Valeria[1]; Elsayed, Hamada[2]; Stabile, Franco M.[3]; Bernardo, Enrico[1]

1. Department of Industrial Engineering, University of Padova, Padova, Italy.

2. Department of Industrial Engineering, University of Padova, Padova, Padova, Italy.

3. Department of Chemical Engineering, Univesidad Nacional de La Plata, La Plata, Argentina.

70S30C (70 mol% SiO2, 30 % CaO) bioglass is one of the most promising results of sol-gel processing of ceramics for bone tissue engineering. We discuss the feasibility of this material directly from silicone-based blends, used as feedstock for additive manufacturing of highly porous scaffolds (porosity >80 %). These scaffolds are first shaped, by vat photopolymerization or direct ink writing, and later ceramized by firing at only 700 °C, in flowing nitrogen or in air. A uniform SiO2/CaO distribution is achieved according to an emulsification step: droplets of molten hydrated calcium nitrate or of concentrated calcium nitrate solutions, in water, are homogeneously dispersed in blends of H44 commercial polysiloxane and photocurable acrylate resin, with the help of surfactants. Vat photopolymerization is adopted for scaffolds with complex geometry, offering a distrinctive control of the porosity (practically identical to that of reference geometrical models). Photopolymerization is exploited also for direct ink writing, as a way to consolidate reticulated scaffolds, soon after extrusion, based on water-containing blends. The water component is useful as 'templating' agent, since it favours the obtainament of spongy struts. In all cases, the obtained scaffolds feature a remarkable strength-to-density; preliminary cell tests confirm both biocompatibility and bioactivity.