# Boron and Cobalt co-doped silicate-based bioactive glass scaffolds fabrication via Digital Light Processing (DLP): Optimization of the printing parameters

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## ABSTRACT

Therapeutic ions such as boron (B) and cobalt (Co), incorporated into bioactive glass, are capable of regulating genes responsible for new blood vessel formation (e.g. VEGF) through different signalling pathways [1]. In addition, B could act as the reinforcement element improving the mechanical properties of bioactive glass. Additive manufacturing (AM) combined with co-doped bioactive glass systems is of great interest for the scaffold fabrication applicable to bone tissue engineering. AM techniques, particularly digital light processing (DLP), make it possible to transform digital objects into tangible biomedical substitutes. The study investigated the production of 3D scaffolds using UV light-curable slurry composed of undoped (un-BG), B and Co co-doped silicate-based bioactive glass (co-BG). The suspension optimization and 3D printing of Kagome [2] bioactive scaffolds were carried out by keeping the solid loading constant at 40% vol. The slurry was fine-tuned with an un-BG, based on the 45S5 Bioglass®, where the effect of particle size distribution and dispersant ratio on cure depth and rheological behaviour were examined. During the thermal treatment of scaffolds, the influence of the therapeutic ions described above was investigated for its effect on the crystallization tendency of the scaffolds in connection with bioactivity and mechanical properties. As the dispersant ratio increases, the polymerization of relatively low-viscosity slurry (0.4 Pa·s at $30 \cdot s^{-1}$) begins at shorter exposure times. The reduction in the particle size distribution (Dv(90) = 10 ±2 μm) ensured acquiring a specific curing thickness at longer curing times, thereby maximizing the total energy utilized per layer during printing. The 3D scaffolds with Kagome structure were printed at a wavelength of 385 nm with a layer thickness of 10 μm, an exposure intensity of 14.65 mW/cm2, and an exposure time of 2.2 s. It has been demonstrated that co-BG, despite changing colour in the presence of Co, is appropriate for DLP printing at a 385 nm wavelength without requiring extended curing periods. This resulted in the production of 3D scaffolds with exceptional dimensional precision, which were subsequently studied as a possible implant material for bone replacement.

**Keywords:** Co-doped bioactive glass, 3D Scaffolds, Bone tissue engineering, Digital Light-Processing, Suspension characteristics

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