ABSTRACT - ORAL

DIW-Fabricated Porous Ce-ZrO_2 Structures

Mia Kovač[1], Erin Koos[2], Bart Van Meerbeek[3], Jef Vleugels[1], Annabel Braem[1]
[1] KU Leuven, Department of Materials Engineering, Leuven, Belgium
[2] KU Leuven, Department of Chemical Engineering, Leuven, Belgium
[3] KU Leuven, Department of Oral Health Sciences, Leuven, Belgium

The replacement of metal implants with ceramic alternatives is becoming increasingly feasible. Among ceramics, 3Y-TZP stands out as the most promising option for dental implants due to its excellent mechanical strength and aesthetic properties. However, its susceptibility to low-temperature degradation (LTD), particularly in the wet oral environment, poses a challenge. This issue is worsened by porosity introduced to enhance osseointegration through a porous surface. To mitigate the risk of LTD-related failure, ceria-stabilized zirconia (12Ce-TZP) emerges as a hydrothermally stable alternative.

Direct ink writing (DIW) is an additive manufacturing (AM) process involving the micro-extrusion of highly concentrated zirconia pastes through a narrow nozzle, depositing material as a spatially controlled filament in a layer-by-layer fashion. DIW pastes must exhibit shear-thinning flow and specific viscoelastic properties to ensure smooth extrusion and adequate yield stress for layer stacking during printing. Successful fabrication requires defect-free printing, followed by proper drying, debinding, and sintering to produce monolithic prints.

In this study, a water-based hydrogel (Pluronic F-127) was utilized as a carrier for ceria-stabilized zirconia powder to optimize paste rheology while maintaining colloidal stability. Two methods for creating a porous network were explored: incorporating a pore-forming agent (e.g., starch) into the ink formulation and leveraging model design with optimized printing parameters to fabricate scaffold-like structures. The sintered Ce-TZP samples were evaluated for printing and thermal treatment defects using scanning electron microscopy, micro-computed tomography, and density measurements. Biaxial flexure testing and hardness measurements were conducted to assess the mechanical properties of high-density printed Ce-TZP discs.