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Polymer infiltrated ceramic networks produced by additive manufacturing: rheology, mechanical properties and biocompatibility

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Keynote: Zirconia ceramics have numerous applications in a wide range of industries due to their excellent mechanical properties, corrosion resistance, and biocompatibility. Components are usually shaped by molds and densified afterward through a sintering process. However, traditional ceramic manufacturing processes give rise to limitations for new applications due to long processing times, high cost, and low geometry complexity. Additive manufacturing represents a revolution and offers new possibilities for addressing novel challenges. Among the different technologies, Direct Ink Writing (DIW) builds the object by a continuous extrusion of inks through a fine nozzle with the assistance of a computer-controlled robotic deposition system, which leads to the fabrication of complex ceramic shapes. Formulation of inks with suitable rheological properties to generate complex 3D structures followed by optimal printing conditions and post-processing steps are the main key issues to achieving high-performance printed parts. In this work, zirconia scaffolds fabricated by DIW have been developed for the design of a novel Polymer-Infiltrated Ceramic Network (PICN) for dental applications. In doing so, a well-controlled scaffold arrangement by establishing a pre-fixed porosity was printed and infiltrated with a biocompatible adhesive widely used in dentistry. The novelty relies on the creation of a dental implant with superior properties, such as long lifespan, mechanical properties mimicking natural enamel and dentin to reduce mandibular bone stiffness, easy fabrication with the possibility of personalized design, and ceramic-polymer interface without bacterial growth and cell adhesion promotion.