3D-Printed Polymer-Infiltrated Ceramic Network: mechanical properties and biocompatibility

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ABSTRACT

The current study focuses on the manufacture and characterization of emerging polymer-infiltrated ceramic networks (PICN) produced by 3D-printing technologies, which show a potential to be used as dental implant material. The advantage in comparison with currently used materials is the combination of organic and inorganic phases and therefore similarity to natural teeth. Porous zirconia (3Y-TZP) scaffolds with 50 % infill and cubic geometry were designed. Samples were extruded from 30:70 Pluronic® hydrogel and 3Y-TZP powder paste through 800 µm nozzle employing robocasting technique. Following the sintering process the scaffolds were infiltrated with a copolymer mixture of bisphenol A glycerolate dimethacrylate (Bis-GMA) and tri(ethylenglycol) dimethacrylate (TEGDMA) in 40:60 ratio and copolymerized in vacuum to avoid the formation of bubbles. To ensure proper infiltration and the attachment of copolymer to zirconia surface the samples were functionalized with 3-(trimethoxysilyl)propyl methacrylate (γ-MPS). As the material is predetermined to be used as biomaterial, the chemical, microstructural, mechanical, and cytotoxic properties were evaluated. The adherence of copolymer to zirconia surface was supported by x-ray photoelectron spectroscopy analysis and visualized by scanning electron microscopy. To observe the mechanical performance of PICN, the crack resistance of the material under compression stress was characterized and recorded by Vic 2D^{TM} camera. The novel composite also shows a reduction of proliferation of 2 lines of bacteria, Gram-negative Escherichia coli and Gram-positive Streptococcus salivarius, and the MG-63 cell viability assays confirmed the biocompatibility of the composite material. [1] [2]

[1] Ľ. Hodásová *et al.*, "Polymer infiltrated ceramic networks with biocompatible adhesive and 3D-printed highly porous scaffolds," *Addit. Manuf.*, vol. 39, no. November 2020, 2021.
[2] Ľ. Hodásová, C. Alemán, L. J. Del Valle, L. Llanes, G. Fargas, and E. Armelin, "3D-printed polymer-infiltrated ceramic network with biocompatible adhesive to potentiate dental implant applications," *Materials (Basel).*, vol. 14, no. 19, pp. 1–14, 2021.