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Silicon nitride ceramics with SiO2, SrO and Al2O3 additions for bone replacements

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The excellent mechanical properties of silicon nitride ceramics combined with their osseointegration ability and good image characteristics have increased their application potential as orthopedic and dental implants. In this work, we investigated the densification, microstructure and mechanical properties of silicon nitride with SiO2, SrO and Al2O3 additions (90Si3N4-6SiO2-4SrO, 90Si3N4-6SiO2-3.86SrO-0.14Al2O3, 80Si3N4-10SiO2-10SrO, 80-Si3N4-10SiO2-9.625SrO-0.375Al2O3, 80Si3N4-12SiO2-8SrO, 80-Si3N4-12SiO2-7.7SrO-0.3Al2O3, in wt.%). This oxides combination should aid the sintering process and promote an intergranular phase with great in vivo reactivity in view of its importance in the new bone formation process. Hence, six different compositions were prepared by the conventional sintering method. Samples were ground, pressed and sintering at 1815o C for 1 hour under nitrogen atmosphere. The apparent density, phase and grain distributions as well as the hardness and fracture toughness were determined by means of Archimedes' method, scanning electron microscopy (SEM), X-ray powder diffraction (XRD) and Vickers' method. Also, in vitro test of cytotoxicity was performed for a preliminary biological evaluation. The results shown that samples reached ca. 97% of theoretical density and total beta-Si3N4 transformation. Hardness and fracture toughness values of 10 GPa and 7 MPa.m1/2, respectively, were obtained for all samples which were non-cytotoxic, suggesting their great potential for bone replacements in orthopedic surgeries and implantology.