Mechanical properties and biological activity of 3D printed silicon nitride materials

ABSTRACT

Silicon nitride (Si3N4) is a very promising biomedical material. Customization and reliability requirements are one of the prerequisites for achieving widespread application of Si3N4 materials. This research used 3D printing method to achieve customized molding and gas pressure sintering to prepare dense Si3N4 ceramic material, and investigated their mechanical properties and biological activity. Compared with Ti-alloy, Al2O3, and PEEK, 3D printed Si3N4 materials have significant advantages in mechanical properties: bending strength of 803 MPa, fracture toughness of 8.86 MPa m1/2, vickers hardness of 15.1 GPa, compressive strength of 2725 MPa. Meanwhile, Si3N4 have more stable and excellent biocompatibility than other biomedical materials, and have obvious advantages in antibacterial performance, with an antibacterial rate of 94.6 %. On the surface of Si3N4 materials, cells have good morphology, normal migration, and are more conducive to cell spreading, adhesion, and crosslinking. Research has shown that the melting deposition filling characteristics of the 3D printing method, the crystal-oriented growth microstructure characteristics of 3D printed Si3N4 materials, and the beneficial effects of Silicon and Nitrogen elements are the main reasons for achieving these advantages.