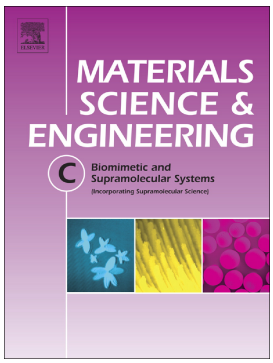

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Stiff, porous scaffolds from magnetized alumina particles aligned by magnetic freeze casting

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ABSTRACT

Bone consists of a hard mineral phase and a compliant biopolymer phase resulting in a composite material that is both lightweight and strong. Osteoporosis that degrades spongy bone preferentially over time leads to bone brittleness in the elderly. A porous ceramic material that can mimic spongy bone for a one-time implant provides a potential solution for the future needs of an aging population. Scaffolds made by magnetic freeze casting resemble the aligned porosity of spongy bone. A magnetic field applied throughout freezing induces particle chaining and alignment of lamellae structures between growing ice crystals. After freeze drying to extract the ice and sintering to strengthen the scaffold, cubes from the scaffold center are mechanically compressed along longitudinal (*z*-axis, ice growth direction) and transverse (*y*-axis, magnetic field direction) axes. The best alignment of lamellar walls in the scaffold center occurs when applying magnetic freeze casting with the largest particles (350 nm) at an intermediate magnetic field strength (75 mT), which also agrees with stiffness enhancement results in both *z* and *y*-axes. Magnetic moments of different sized magnetized alumina particles help determine the ideal magnetic field strength needed to induce alignment in the scaffold center rather than just at the poles.

KEYWORDS: freeze casting, ferrofluid, magnetic alignment, ceramic scaffold, mechanical properties