ABSTRACT

Freeze-casting is a simple shaping technique which allows generating scaffolds with a highly oriented porosity. The process consists of freezing unidirectionally a slurry before removing ice by sublimation. As a result, a lamellar structure, where the pores are a direct replica of the ice crystals, is obtained. In this thesis, fundamentals aspects related to this recent technique are firstly covered. The effects of the processing additives on the final scaffolds and on the structuration process were investigated using synchrotron X-rays tomography and radiography. On top of this, a new bidirectional freezing technique that allows further control of the ice crystal nucleation and growth was developed. The second part of this work focus on applications. Currently, one of the most important issues in bone tissue engineering is the quest for processing techniques that allows manufacturing 3-D porous scaffolds. Here, we developed a radial freeze-casting technique to prepare ceramic scaffolds with gradient channel structures that mimic the porous network of natural bone. More importantly, such scaffolds demonstrate a very unique capillary behavior that promotes the self-seeding of cells when in contact with a cell solution. Freeze-casting technique was also applied here to engineer battery electrodes. The fabricated electrodes show a three- to fourfold factor increase of the area-specific discharge capacity compared with conventional Li-ion composite electrodes. Because of their high power capability, these types of electrodes meet the performance required for electric vehicle applications.