Abstract

This research is focused on the production of structures of biomedical interest using supercritical assisted processes: Supercritical freeze extraction, Supercritical gel drying and Supercritical phase separation. These processes have been selected to overcome the limitations of the traditional ones used in this field; indeed, they produce structures with a disordered microporosity, without an organization at nanometric level, with poor mechanical properties and with potential cytotoxic effect due to the residues of organic solvents and crosslinking agents. These problems reduce the efficiency of the cells culture on these structures in terms of adhesion, proliferation and differentiation in the tissue that it would to regenerate.

Therefore, during the experimentation, several polymers, of natural and synthetic origin, were tested for bone, tendon and vascular applications. In particular, in this thesis:

- synthetic and natural structures characterized by a micrometric porosity and wrinkled pore walls were produced by Supercritical freeze extraction process,
- in the case of polymer/drug composite structures, a homogeneous distribution and controlled release of the active compound was assured,
- aerogels starting from natural polymers, that mimic the tissue extracellular matrix at nanometric level were produced by Supercritical gel drying,
- bioactive materials were tested; in particular, graphene oxide exfoliation and purification, during the formation of cellulose acetate nanocomposites, was obtained by Supercritical phase separation,
- FEM Modeling was developed, confirming that mechanical properties of aerogels depend on how the nanofibrous network is connected in the space and that bending is the major mode of deformation of the network.