# Supercritical gel-foaming: an optimized process for PCL-based scaffolds production

Mariangela Guastaferro, Lucia Baldino, Stefano Cardea, Ernesto Reverchon

Department of Industrial Engineering, University of Salerno, Via Giovanni Paolo II, 132, 84084, Fisciano (SA), Italy

Polycaprolactone (PCL) is frequently used as bone scaffold material due to its biocompatibility, non-cytotoxic degradation products, and hydrophobicity that extends its *in vivo* degradation. However, its slow degradation may be a problem for an efficient bone tissue regeneration. In order to address this limitation, PCL blends with polyethylene glycol (PEG) are investigated, since PEG is able to tailor PCL degradation kinetics.

In this work, PCL based scaffolds, characterized by a well-controlled pore structure, were produced combining two supercritical $CO_2$ (SC-$CO_2$) processes, i.e.: SC-$CO_2$ gel drying and SC-$CO_2$ foaming. PCL at increasing concentration values (from 10 wt% to 30 wt%) and PEG (10 wt% and 50 wt% with respect to PCL) were blended by dissolution in dimethylsulfoxide (DMSO), forming a physically cross-linked gel. SC-$CO_2$ drying was then performed, operating at 200 bar, 40 °C for 8 h. In this context, also a SC-$CO_2$ foaming occurred due to the slow release of $CO_2$ from PCL polymeric chains that favored nucleation and bubble growth during the depressurization step. PCL scaffolds showed open and interconnected pores, that were characterized by a pore size distribution ranging from 50 µm to 500 µm. PEG addition favored the generation of a further homogenous porosity along the scaffold structure, with an average pore size of about 10 µm. IR spectroscopy demonstrated an effective interaction between these biopolymers after processing, since a new chemical bond was detected.

**Graphical abstract**