Foaming of polymer blends designed for nano foams in supercritical CO_2

Margaux HAURAT[a], Michel DUMON[a], Fabien BAILLON[b], Martial SAUCEAU[b], Jacques FAGES[b]

[a] LCPO - ENSCBP, Université de Bordeaux, 16 Avenue Pey Berland Bat. A, 33607 Pessac, France
[b] Université de Toulouse, IMT Mines Albi, CNRS, centre RAPSODEE, 81013 Albi, France

Organic polymer foams are obtained by various processes, one of which is an expansion process (namely "foaming") in liquid or solid states, induced by "foaming agents" (chemical agents vs physical agents –inert gases). As a consequence of the REACH regulation, many chemical foaming agents (CBA) that can decompose chemically upon temperature, have been,or will be soon, banned because of the toxicity of some released molecules. Knowing that supercritical carbon dioxide ($scCO_2$) is a green solvent, we have selected it in order to replace some chemical foaming agents.
Although CO_2 expansion is already used in polymer foaming, reducing both the size of the foam pores and the density is a great challenge in the field of plastics and porous (cellular) polymer materials. The final products will have both reduced weight and interesting superior properties (greater thermal insulation, high mechanical strength, high toughness). One ultimate challenge is to reduce both specific mass (e.g. < 0.2 $g.cm^{-3}$) and cell size (e.g. average pore diameter < 80 nm). These features are not achievable if a single polymer is used (whatever the polymer or the process).

Regarding the physical CO_2-expansion processes, either discontinuous (batch foaming) or continuous ($scCO_2$ extrusion) processes can be used. They consist in saturating the polymer in $scCO_2$ before decreasing the pressure to create a thermodynamic instability that leads to the creation of cells or voids in the matrix. The work is intended to compare both polymers and processes, aiming at getting nanostructured foams in a continuous process.

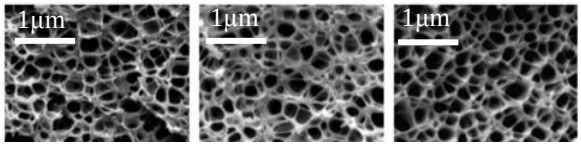

Figure 1:SEM micrographs of scCO2-blown acrylic foams

Block copolymers are introduced into a matrix to provide a nanostructured polymer that "helps" the nano foaming. We present different works on polymer foaming by a batch discontinuous process or a continuous extrusion process. By selecting the matrix and a polymeric additive, we expect to develop a continuous feed method for producing porous polymeric materials for better thermal insulation or high mechanical damping.

This work is financed by ANR, Agence Nationale de la Recherche, AAP 2018-19, projet *edyFICE*