USE OF SUPERCRITICAL CARBON DIOXIDE FOR THE PREPARATION OF HIGHLY CHARGED POLYMER/CLAY NANOCOMPOSITES AND EXTRUSION FOAMING OF POLY(STYRENE-*CO*-ACRYLONITRILE)

Urbanczyk L.[1], Calberg C.[2], Stassin, F.[1], Alexandre M.[1], Bourbigot S.[3], Espuche E.[4], Jérôme, R.[1], Jérôme C.[1], Detrembleur C.[1]

[1]Center for Education and Research on Macromolecules (CERM), University of Liège, Sart-Tilman B6a, 4000 Liège, Belgium

[2]Department of Applied Chemistry, University of Liège

[3]Laboratoire des Matériaux Polymères et des Biomatériaux, UMR 5223, Université Claude Bernard Lyon 1

[4]Equipe Procédés d'Elaboration de Revêtements Fonctionnels, LSPES UMR-CNRS 8008, ENSCL

Recently, supercritical CO_2 has become an attractive green solvent for materials synthesis and processing because of environmental concern [1]. It is also a unique solvent with a wide range of interesting properties. We have exploited these advantages by using $scCO_2$ as a polymerization medium for polymer/clay masterbatch preparation and also as a physical foaming agent to prepare polymer foams.

Pre-exfoliated nanoclays were prepared through a masterbatch process using supercritical carbon dioxide as solvent [2]. *In situ* intercalative ring-opening polymerization of ε-caprolactone in the presence of a large amount of clay was conducted to obtain these easily dispersible nanoclays (poly(ε-caprolactone)/clay masterbatches), collected as a dry and fine powder after reaction. These masterbatches can be easily redispersed in commercial polymer matrices for the preparation of polymer/clay nanocomposites.

After redispersion of the PCL/clay masterbatches into poly(styrene-*co*-acrylonitrile) (SAN), we have also used supercritical CO_2 as a physical blowing agent for the continuous SAN foaming in a single screw extruder. In the supercritical state, this gas can dissolve into the molten polymer and create a single-phase solution. When the pressure is released, the gas generates a large quantity of bubbles which grow until the foam is frozen (when $T \ll T_g$) or when the overall quantity of CO_2 available for cell growth is used [3]. Several parameters have been varied and the effect of nanoclay addition on the foam morphology has also been investigated.

This study has shown the superiority of masterbatch-redispersed clay over directly mixed commercial organoclay in term of clay delamination efficiency into SAN. This clay exfoliation results in an important improvement of the thermal stability and gas permeability of the nanocomposite.

(1) S. P. Nalawade, F. Picchioni, L. P. B. M. Janssen, Supercritical carbon dioxide as a green solvent for processing polymer melts: processing aspects and applications, Progress in Polymer Science, 31, 19 (2006).
(2) L. Urbanczyk, C. Calberg, F. Stassin, M. Alexandre, R. Jérôme, C. Jérôme, C. Detrembleur, Synthesis of PCL/clay masterbatches in supercritical carbon dioxide, Polymer, Accepted.
(3) C. B. Park, A. H. Behravesh, R. D. Venter, Low density microcellular foam processing in extrusion using CO_2, Polymer Engineering and Science, 38, 1812 (1998).