In situ non-hydrolytic sol-gel synthesis of new polyolefin-based nanocomposites by reactive extrusion

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Polymer nanocomposites have drawn considerable attention due to the improvement of structural and functional properties of polymer based systems. The common way to elaborate nanocomposites is the "top-down" approach, i.e. the dispersion of fillers into the polymer. However, the agglomeration of nanofillers in the polymer and the increasing concerns about the manipulation of nanoobjects are the main issues of this technique. To overcome these problems, a "bottom-up" approach has been found combining reactive extrusion and sol-gel chemistry [1]. However the limit of this approach is the difference of nature between hydrophobic polyolefin and fillers synthesized by hydrolytic sol-gel process. Actually, water is required and the surface of such inorganic phases presents hydroxyl groups.

The aim of the project is to use non-hydrolytic sol-gel (NHSG) reactions to generate nanoparticles by reactive extrusion. The specificity of NHSG is the use of an organic oxygen donor instead of water and the ability to control the shape and the size of nanoparticles [2]. First experiments were made in model medium at the ICGM-Montpellier (ANR partner) in order to evaluate the kinetics and to select the best candidates for the transfert to reactive extrusion. Then the reactions were carried in molten polymer and nanocomposites were characterized by electronic microscopy, TDA-GC-MS coupling, rheology and spectroscopy. One of the objectives is to synthesize lamellar nanoparticles in order to improve barrier properties of the material. The synthesis of titanium phosphonates seems to be an interesting way for the obtaining of the desired morphology.

[1] V. Bounor-Legaré, P. Cassagnau, Prog. Polym. Sci. ***39****, 1473–1497 (2014)*

[2] P.H. Mutin, A. Vioux, J. Mater. Chem. A. ***1****, 11504 (2013)*