POLYMER/CLAY NANOCOMPOSITES OBTAINED IN AQUEOUS MEDIA

Ianchis Raluca, Donescu Dan, Ghiurea Marius, Petcu Cristian,
Serban Sever, Radovici Constantin
National R-D Institute for Chemistry and Petrochemistry - Polymer Department, Splaiul
Independenței 202, 6th district, 0600021, P.O. Box 174/35 - Bucharest, ROMANIA
ralumoc@yahoo.com

Considerable attention has been devoted over the last decade to hybrid organic-inorganic nanocomposites [1-5]. Their unique characteristics made them suitable for a lot of applications in: controlled drug delivery (cancer therapy), dental materials, membrane materials, biosensors, packaging, decontaminations, aerospace, sporting, electronic devices, etc.[6-8]. From the wide class of inorganic and organic partners, our interest is to combine layered silicate and silica from sol-gel process, with different polymers. Our aim is to join together the best properties of the layered silicates with those of silica and polymer, too.

Layered silicates, especially montmorillonite type, are commonly used in nanocomposites synthesis. Polymer-layered silicates composites are divided, generally, in three categories: conventional composites, layered silicate is acting as conventional filler; intercalated nanocomposites, the polymer is located inside the silicate sheets; exfoliated nanocomposites where the 1nm silicate sheets are dispersed in the polymer matrix [4].

There have been and there still are many studies about the incorporation of layered silicates into polymers and exfoliation of the silicate layers for the maximum performance to be reached [1,4,5]. The elemental layers of the tactoids of such layered silicate materials, like montmorillonite, are formed by aluminosilicates complexed on interlayer spaces by metallic ions, in most cases Na. Through interlayer ion hydration these sheets can be outdistance but in the same time the edge-edge bonds assure o strong interaction. For this reason, MMT aqueous dispersion contains associates and individual lamellas can be obtained only at reduced amounts. Aqueous medium nanocomposites synthesis is a very promising way due to the absence of environment problems brought mostly by organic solvents. The disadvantage of these systems is in the fact that nanoparticles synthesis proceeds in the presence of high amounts of surfactant. For this reason, the methods that use low surfactant quantities are very interesting: emulsion polymerization, miniemulsion, dispersion. Until now numerous studies regarding how these procedures are used in the presence of layered silicates have been published.

For these reasons, the paper deals with the nanocomposites obtaining possibility through microemulsion radical copolymerization of different monomers (styrene, butylacrylate, methylmetacrylate) with a sol-gel precursor which posses a vinyl group – dimethylvinylethoxysilane (DMVES) in the absence/presence of montmorillonite (sodium form - ClNa) with sodiumdodecylsulphate (SDS) as a surfactant. By alkoxysilane presence, our goal was to start a sol-gel process in order to increase the system reinforcement level. Premature hydrolysis and cross-linking reactions must be avoided to obtain stable latexes with good shelf stability. The hydrolysis of alkoxysilane was proved to be both acidic and base catalyzed [9]. In the order to avoid premature hydrolyze and condensation reactions, the polymerization process was driven at pH=7, since the minimum hydrolysis rate occurs at a neutral pH for most systems [10]. The sol-gel process took place at the end of reaction in the presence of ammonia.

Monomer and layered silicate nature influences the average diameter of the particles and the Zeta potential appeared on the particle - disperse medium interface as it was shown by DLS analysis. In order to evidence the inorganic partner's presence in the polymer matrix, FTIR, TGA respectively XRD were performed.

References:

[1] K. I. Winey, R. A. Vaia Polymer Nanocomposites, MRS. Bulletin (2007), 32, 314-322

[2] O. Becker, B. Boutevin, F. G. Pietrasanta, N. Hasegawa, M. Klapper, P. V. Kostoglodov, D. Likhatchev, K. Mullen, M. Kato, A. L. Rusanov, G. P. Simon, A. Usuki Inorganic Polymeric Nanocomposites and Membranes, Adv. Polym. Sci. (2005), 179, 29-195

[3] E. L. Bourgeat, Les Latex synthetiques (2006)

[4] M. Alexandre, P. Dubois Mat. Sci and Eng. (2000), 28, 1-63

[5] L. A. Utraki, Clay Containing Nanocomposites, (2004), Rapra Eds.

[6] V. Castelvetro, C. DeVita, Adv. Colloid Interf. Sci.(2004), 161, 108

[7] R.A. Hule, D.J. Pochan, MRS Bulletin (2007), 32, 354-358

[8] A.D. Pomogailo, Colloid Journal (2005), 67, 658

[9] I. Marcu, E.S. Daniels, V.L. Dimonie, C. Hagiopol, J.E. Roberts, M.S. El-Aasser, Macromolecules (2003), 36, 328-332

[10] I. Tissot, C. Novat, F. Lefebre, E.L. Bourgeat (2002), Chem. Mater., 14, 1325