TECHNICAL BULLETIN: ADVANCES IN NANOTECHNOLOGY

1. Introduction

The use of nanocomposites in theory offers great advantages, since these nanostructures possess excellent mechanical properties with a stiffness of up to 0.45 TPA. However there are still difficulties to be overcome to maximize the benefits provided by these compounds, such as: getting a good inercalación of the fibrils at the nanometer or exfoliation, which is key to obtaining the benefits they can offer these nanocomposites, also the proper use of a compatibilizing or functionalization of the matrix polymer to achieve good adhesion between the phases.

Polyethylene is a material that has a very wide range of applications, however, has certain limitations such as low resistance to cracking and, depending on its density, high permeability to gases and water vapor. The use of nanocomposites provides a great opportunity to overcome the limitations that the EP can have.

Among the most commonly used types of nanocomposites are laminated silicates (clay), carbon nanotubes and nano-whiskers of cellulose, titanate ultra thin laminate.

2. Silicates laminates

The silicate used in nanocomposite laminates usually belong to the family called 2:1 Phyllosilicate (mica, talc, the montmorilonita, etc..), The most used are: montmorilonita the hectorita the saponite and laponita. (1). The nanocomposites developed using montmorilonita (MMT) have been extensively studied in recent years (1-6), and has demonstrated its beneficial effect on the mechanical and chemical properties of the polymer by adding small proportions of the inorganic material (˜3% in weight).

The polar nature prevailing in the MMT produces difficulties in its accession to the non-polar polymers such as PE, for this reason has also investigated the changes of these clays organically. (2) What is done is to convert the clay into a hydrophilic surface organophilic. This modification, called the reaction of ion exchange (ion-exchange reaction ") is made through the uo of surfactanntes as alquilomonio. Despite this change, the dispersion of the clay has not been good in the polymeric matrix of polyethylene, especially in the case of low density polyethylene due to its many-branched chains that prevent the proper insertion of the clays in the matrix polymer.

Preparation and synthesis of these nanocomposites can be done primarily through three techniques:

a. Dispersion in solution.
b. In-situ polymerization.
c. Intercalation into molten.

a. Dispersion in solution.

Nanocomposites of high-density polyethylene surfaces modified clay have been prepared through the method of dispersion in solution (2), in the case of low density polyethylene, but because of its many ramifications, this method does not provide good results.

b. In-situ polymerization.

In-situ polymerization has been achieved in PE and silicate nanocomposites with a rolled exfoliated morphology. Studies in this direction have been made by Peoples et al, (4) and Qi et al, (22), among others.

The work of Monasterios et al. (7) uses different clays treated with silanes of different features to evaluate the mechanical properties of the various outcomes. Nanomaterials were prepared by employees of In-situ polymerization. The mechanical properties of the mixtures showed a reduction in elastic modulus and strain at fracture

c. Intercalation into molten.

Using the method of melt intercalation in had not provided good results in the preparation of nanocomposites of PE until the discovery of modified oligomers. Several investigations have been performed in this field because of the ease it provides the technique in the preparation of nanocomposites. Because the polyethylene does not include any polar group in terms of their chains, it is not possible to disperse the silicate laminates, which are hydrophilic in polyethylene without the use of a compatibilizing.

Reddy, M.M. et al (8) studied the relationship between the structure of nanocomposites of polyethylene grafted with maleic anhydride (PEgMA) with organo-modified MMT and the resulting rheological properties. In this work, we found a clear trend in increasing the viscosity of the melt at a higher degree of intercalation and / or exfoliation of nanoarcilla, so the tensile strength increases and the permeability decreases.

Sanchez, Saul et al. (5) studied the preparation and the degree of exfoliation achieved in PE nanocomposites with clay used as compatibilizing PEgDA and PEgAOH, which were prepared by reaction of maleic anhydride grafted PE (PEgAM) and a diamine (DA) or amino alcohol (AOH).

Other copatibilizantes like EVA and polyethylene oxide (PEO) have been tested to quantify the degree of intercalation in the polymer matrix (9-10). It is of particular interest, according to Durmus et al. (10), the properties of barrier to oxygen, achieved through the compatibilizing polyethylene oxidized low molecular weight are better than those achieved with compatibilizing as polyethylene grafted with maleic anhydride

3. Carbon nanotubes (CNT)

Discovered by researcher Sumio Iijima in 1991, carbon nanotubes are the most promising nanomaterials due to their excellent mechanical properties, thermal and electrical. (1) Carbon nanotubes are rolled sheets in a cylindrical, hexagonal arrangement of atoms carbon, whose diameters range from a few Angstroms to a few tenths of nanometers. Can be configured for single-walled (SWNT) or multi-wall (MWNT), in which case there are multiple concentric cylinders of nanotubes.

The interaction of the nanotubes and the poly is still in a nascent stage, some jobs can be found briefly explained and summarized in (1,2,11). Among the techniques investigated to improve the dispersion of nanotubes in the polymer matrix for different materials are:

- Functionalization of nanotubes in solution chemistry.
- Coating the surface of the nanotubes through polymer
- In-situ polymerization of nanocomposites.
- Ultrasonic dispersion in solution.
- Processing molten.
- Through surfactants.

Of particular interest is the study of Tang, W. Z. et al. (12) who prepared mixtures of CNT and HDPE by melt processing, finding a good degree of interlation.

4. Nanowhiskers cellulose

The cellulose nanowhiskers are the crystalline portion in cylindrical form, the cellulose fibers that are extracted from the microcrystalline cellulose through a process of hydrolysis with sulfuric acid. Typical dimensions of length are in the range of 200 - 400 nm and less than 10 nm wide. This bionanocompuesto can improve the properties of polymers such as mechanical (toughness, elasticity, and elongation at break), thermal stability, decreases permeability, improves the bio-degradability.

To prepare this type of nanocomposites have been tested, mainly two methods: mixing and dispersion in solution during the melt processing. (13, 14).

This research field is still very young and there are techniques that should be studied, improved and / or optimized. Among the challenges to be overcome are: techniques for isolation of nano fibers / whiskers, large-scale development of methods for drying, processing of the compounds. It is also necessary to develop surface treatments for proper dispersion of fibers in organic media.

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