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Driving Forces Behind Nano-composite Formation by Clay Exfoliation in Rubber Matrices.

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Polymer/clay nanocomposites are investigated using mainly thermoplastic polymers such as polyamide 6, polyethylene, polypropylene... much less attention has been paid to rubbers and rubber-like materials. Our objective is to define parameters controlling clay exfoliation in elastomer matrices by direct blending. This latest condition implies no solvent use in the blend together with preserving maximum exfoliation to a single layer level.

Barriers hindering rubber incursion inside clay structure are identified as gathered in the table:

Character	Clay	Polymer
Physico-chemical	Hydrophilicity/surface energy	Hydrophobicity/surface energy
Structural	Interlayer gap/ion exchange capacity	MW
Physical	Agglomeration	MW distribution
Additives	Impurity	Antioxidant and other additives

In this work we present an attempt to overcome such obstacles by three major means:

- A- Clay synthesis
- B- Chemical modification of the synthesized clay
- C- Chemical modification of the polymer and MW variation

Since natural clay, as all natural products, suffers a lack of reliability, and therefore exhibits an experimental irreproducibility we chose to synthesize our clay in the laboratory. Thus, the sodium form of a montmorillonite-type $[\text{Na}_{0.3}(\text{Al}_{1.7}\text{Mg}_{0.3})\text{Si}_4\text{O}_{10}(\text{OH})_2]$ clay (Mmt) was prepared by hydrothermal synthesis in hydrofluoric acid medium at 220 °C for 48 hours in a stainless steel PTFE lined autoclave [1]. Further selection and control of the particle size and its influence is investigated.

Clays are basically hydrophilic materials, as a consequence, they cannot be blended properly with hydrophobic matrices such as elastomers. Two ways of material modification can be anticipated to overcome this dilemma:

1. Grafting the rubber with species having natural affinity for the clay and/or
2. Converting the clay into an organophilic material by cation exchange treatment

Both ways were investigated, chemical structure were verified by elemental and TGA analysis, exfoliation was monitored by X-ray diffraction, TEM and rheological measurements and hybrid composites were tested by dynamic mechanical thermal analysis.

Results will be discussed in term of modification/exfoliation relationship as well as polymer/clay-monolayer adsorption and hybrid three-dimensional network formation.

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