Mechanical properties of polymer / clay nanocomposites

Mechanical Properies of Polymer / Clay Nanocomposites

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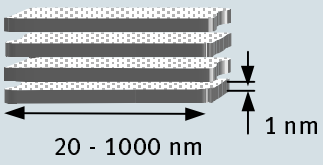
Introduction

Hybrid inorganic/organic nanocmposites based on polymers reinforced with silicate minerals (clay) can exhibit marked improvement in properties like stiffness, barrier, thermal stability, flame retardance at low filler content of approximately 5wt%. The goal of this project is to investigate the micro mechanical behaviour of these materials and link it with their macroscopic properties.

Materials and Methods

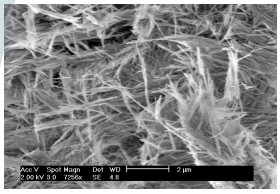
Clays are naturally occurring highly crystalline hydrophilic minerals. Two types of clays were used as a reinforcing elements for the PE and PP matrix.

- Layered silicates



- High aspect ratio platelets
- Surface area ~ 800m^2/gr.
- Negatively charged layers balanced by alkali cations

- Fibrilous clay minerals



- High aspect ratio L=400-600 nm, D=20-30 nm
- Hollow structure

Nanocomposite preparation

Clays are rendered organophilic trough ion exchange reactions with organic cations and subsequently dispersed into polymer matrix via extrusion melt mixing. In the case clay platelets three types of structures are obtainable depending on the thermodynamic interactions between the matrix and clay layers:

Phase separation Intercalation Exfoliation

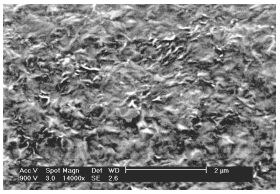
⇨ Using surface modifying agents for the clay to promote more favourable clay-polymer interactions.

For the PP matrix clay was modified using PEO-EBE block copolymer, for the PE based nanocomposite PE-MAS was used as a modifier.

Results

Layered clay minerals

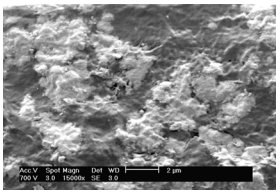
PE / Somasif 5%



Clay platelets are homogeneously dispersed

Material	E-modulus, MPa
Pure PE	420
PE/clay 5%	710

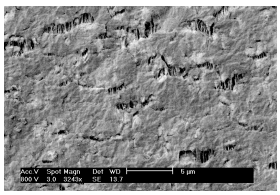
PP / Montmorillonie 5%



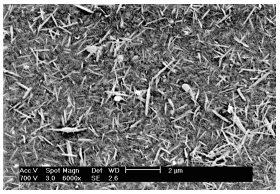
Distribution of clay platelets and tactoids

Material	Impact Energy, kJ/m^2
Pure PP	4.9
PP/clay 5%	7.0

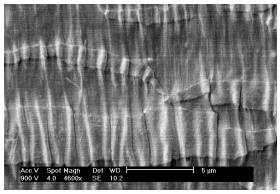
In-situ tensile testing under ESEM shows formation of crazes around clay tactoids



Fibrilous clay minerals



Homogeneous dispersion of fibrilous clay paricles



Fibrils formation during tensile deformation

Future work

- Further investigation of the morphology, crystallisation and structure development of polymer / clay nanocomposites
- Investigation of the deformation behaviour of polymer/clay nanocomposites by means of in-situ SAXS, WAXS, ESEM, AFM

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