Microscopic deformation behavior of Polyethylene-Clay Nanocomposites

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Introduction
Nanocomposites based on polymers and organophilic clay minerals can exhibit improvement in various mechanical, thermal and optical properties. The objective of this study is to relate the microscopic deformation processes to the macroscopic mechanical behavior of these materials.

Material and methods
The nanocomposites based on HDPE matrix have been produced via melt extrusion using PE grafted with maleic anhydride (PE-g-MA) as compatibilizer. Two different types of clay have been used - layered silicates and fibrous clay. To investigate the deformation process in-situ X-ray and ESEM experiments during tensile deformation have been performed.

Results

- **Dispersion results - ESEM**

  - HDPE + 5% platelet clay
  - HDPE + 5% fibrous clay

- **Some microscopic mechanical properties of fibrous clay filled material**

  - HDPE + PE-g-MA
  - HDPE + PE-g-MA + 5% fibrous clay

- **Stress-strain behavior of fibrous clay filled HDPE**

With the increase of the fibrous clay content the yield stress decreases and the strain hardening sets in at lower strains.

- **Microscopic deformation - ESEM observations during drawing**

  - HDPE
  - HDPE + platelets
  - HDPE + fibers

  During tensile deformation of the material filled with platelet shaped clay there is a formation of voids around the clay stacks. In the case of fibrous clay filled system the deformation takes place through formation and extension of microfibrils. The deformation proceeds in a more homogeneous manner which allows to achieve higher strains.

- **SAXS patterns obtained in-situ during drawing**

  - HDPE
  - HDPE + platelets
  - HDPE + fibers

  The increase of intensity around the center in the SAXS patterns is due to the presence of micro-voids. In the case of platelet clay filled material the formation of such voids occurs at yield. For the fibrous clay filled material no void formation is observed.

Conclusions

- **Intercalated stacks in platelet clay reinforced polymers leads to localization during deformation**

- **Less interparticle surface interaction in the case of fibrous clay compared to platelets allows better dispersion on nanometer length scale**

References:

