Functional Block Copolymers as Compatibilizers for Nanoclays in Polypropylene Nanocomposites

Jankova, Katja; Stribeck, Norbert; Zeinolebadi, Ahmad; Potarniche, Catalina-Gabriela; Jensen, Erik Appel; Christiansen, Jesper de Claville; Hvilsted, Søren

Published in:
Nordic Polymer Days 2011

Publication date:
2011

Document Version
Early version, also known as pre-print

Link to publication from Aalborg University

Citation for published version (APA):
**Functional Block Copolymers as Compatibilizers for Nanoclays in Polypropylene Nanocomposites**

Katja Jankova¹, Anders E. Daugaard¹, Norbert Striebeck², Ahmad Zeinolebadi², Morteza Ganjaae Sari², Catalina-Gabriela Potarmiche³, Erik Appel Jensen³, Jesper de Claville Christiansen³, Søren Hvilshed¹

 Danish Polymer Centre, Department of Chemical and Biochemical Engineering, Technical University of Denmark, DK-2800 Kgs. Lyngby¹

 Institute for Technical and Macromolecular Chemistry, University of Hamburg, Bundesstr. 45, DE-20146 Hamburg²

 Department of Mechanical and Manufacturing Engineering, Aalborg University, DK-9220 Aalborg³

**Introduction**

Nanoclays (NCI) possess a significant ion exchange capacity. Wetting of their naturally hydrophilic surface by the matrix polymer is undoubtedly a prerequisite for nanocomposites (NC) formation. Usually the NCI surface is rendered compatible with organic molecules by an ammonium exchange of the Na⁺ ions using hydrophobic surfactants like dimethyl dehydrogenated tallow ammonium ions.¹

Design, synthesis & characterization of a compatibilizer for MMT - PP nanocomposites

With the aim of creating tough nanocomposites (NC) [1] based on polypropylene (PP) and nanoclay (NCI) in the framework of the 7th EU program NANOTOUGH we have designed amphiphilic block copolymers utilizing Atom Transfer Radical Polymerization (ATRP) [2]. They consist of a hydrophobic block of Kraton L-1203 from Kuraray Co., Japan with molecular weight 7000 and PDL=1.05 (compatible with PP), and a hydrophilic block of quaternized dimethylaminoethyl methacrylate, DMAEMA (compatible to perform the Na⁺ exchange): [3]

The size of the hydrophilic block was varied, which increasingly caused better dispersibility of the block copolymer in water. This was essential for the exchange of the Na⁺ ions of the used NCI (3.8 wt.-7% dispersion of montmorillonite, MMT from Laviosa Chimica Mineraria, Italy) by the synthesized charged block copolymer, which was performed in water. The modified MMT was then washed with water/ethanol until no Na⁺ was detected (0.1 M AgNO₃) and freeze dried.

**Abstract**

Novel amphiphilic block copolymer has been designed, characterized and tested as a compatibilizer in PP-MMT nanocomposites in 2 different contents. SAXS has been used to monitor slow mechanical tests. The MMT acts like a nucleating agent to the PP that starts competitive nucleation of crystallites in the PP during manufacturing. Consequently, the PP crystallites in the composites are small and imperfect - the self-reinforcement of the PP is replaced by alien-reinforcement.

**Nanostructure evolution**

Stress relaxation

Simplified structural model for the semicrystalline structure of pure PP (left) and of the PP phase in the MMT nanocomposites (right). The thin vertical domains are drawn only to indicate that the composite contains MMT layers.

**Conclusions**

- Novel block copolymer has been designed and tested as compatibilizer for PP/MMT nanocomposites.
- Missing improvement of the tensile properties appears to result predominantly from the inhibition of a load-bearing smectic morphology inside the PP by the MMT.
- From the respective half-lives we have for the first time assessed the reinforcement of the composite and the weakening of the PP.

**Acknowledgments**

This work has been supported by the 7th framework program of the European Union (Project NANOTOUGH FP7-NMP-2007-LARGE), Kuraray Co., Ltd, Elastomer Division, Japan is acknowledged for providing Kraton L-1203, Z. Vuluga and Mr. Radovici from ICECHIM CP, Romania for the XRD analyses. The authors thank the Hamburg Synchrotron Radiation Laboratory (HA-4/VLAB) for beam time granted in the frame of projects IL-2009-4015 and L2111-007.

**References**


