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Publication date:
2008

Citation (APA):
Johansen, N. R., & Plackett, D. (2008). *Biopolymer nanocomposite films for use in food packaging applications*. Poster session presented at Nordic Polymer Days 2008, Stockholm, Sweden.

Biopolymer nanocomposite films for use in food packaging applications

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Abstract

A wider use of polylactide (PLA) in applications like food packaging requires further material development in order to achieve the necessary properties such as heat stability as well as improved mechanical and barrier characteristics. In the NANOPACK project (www.nanopack.dk), funded by the Danish Council for Strategic Research, we are investigating nano-scale reinforcement of PLA based on organomodified-clays or layered double hydroxides (LDH) in order to achieve improvements in these properties.

Project partners

Risø DTU
National Laboratory for Sustainable Energy

FÆRCH PLAST
Packaging that cares

DTU Food
National Food Institute

NANOPACK project work packages

- WP1: Raw materials and pilot scale production
- WP2: Characterization of performance in relation to food packaging
- WP3: Risk characterization

Preparation of PLA bionanocomposite films

- Granulates by twin-screw extrusion (Fig. 1)
- Film preparation by single-screw extrusion (Fig. 2)

Fig. 1: Twin-screw extruder used for compounding.

Fig. 2: Film extrusion.

Conclusions

1. XRD and TEM results show good dispersion of 2% Hycite 713 LDH in PLA film; however, PLA film transparency is reduced.
2. XRD and TEM results point to an intercalated/exfoliated morphology for 2% Cloisite 30B organoclay in PLA film; however, a reduction in oxygen transmission rate through the film has not yet been demonstrated.

Poster presented at Nordic Polymer Days 2008, Stockholm

Results

1. Extrusion of an LDH (Hycite 713, Ciba Speciality Chemicals Inc.) – PLA (Biomer L9000) film.

Fig. 3: PLA film with 2 % Hycite 713, thickness: 250 µm.

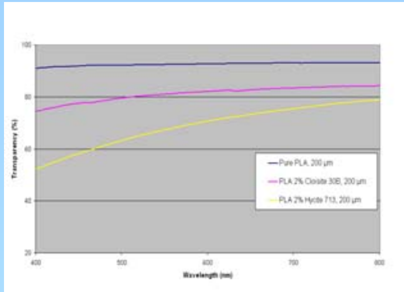

Fig. 4: Film transparency measurements.

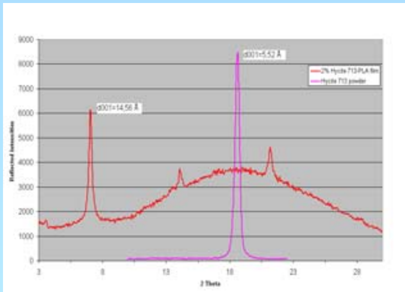

Fig. 5 : XRD results, courtesy of Christian Bender Koch, Faculty of Life Sciences, Copenhagen University, indicating insertion of PLA between LDH platelets.

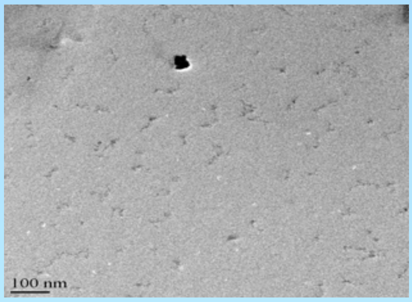

Fig. 6: High-resolution TEM photomicrograph of a PLA film containing 2% Hycite 713 LDH, courtesy of Dr Peter Weidler, Forschungszentrum Karlsruhe GmbH, Germany, showing good dispersion of LDH.

2. Extrusion of an organomodified-clay (Cloisite 30B, Southern Clay Products Inc.) – PLA (Biomer L9000) film.

Fig. 7: PLA film with 2 % Cloisite 30B, thickness: 175 µm.

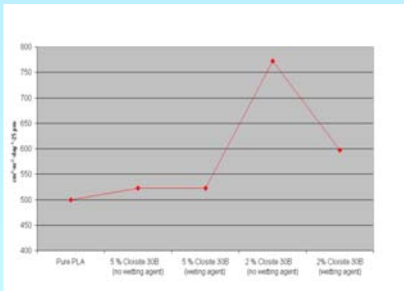

Fig. 8: O_2 transmission rate for Cloisite 30B films.

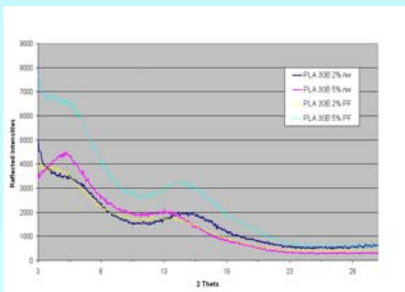

Fig. 9 : XRD shows the effect of a wetting agent.

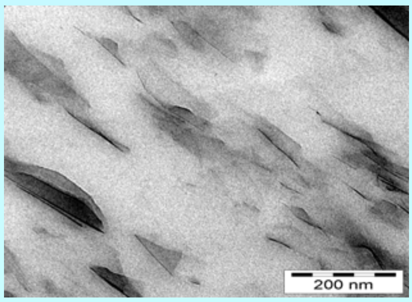

Fig. 10: TEM photomicrograph of a PLA film containing 2% Cloisite 30B. Image courtesy of Dr Ralf Thomann, University of Freiburg, Germany.

Future plans

- Completion of PLA processing with a range of commercial organoclays and identification of optimum films for packaging.
- Investigation of further commercial and laboratory-prepared LDHs as reinforcement in PLA films.