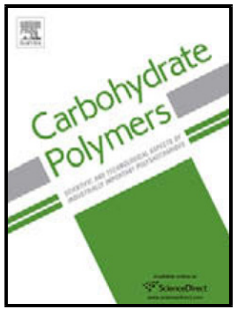

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PII: S0144-8617(15)00706-7
DOI: http://dx.doi.org/doi:10.1016/j.carbpol.2015.07.077
Reference: CARP 10179

To appear in:

Received date: 5-5-2015
Revised date: 6-7-2015
Accepted date: 22-7-2015

Please cite this article as: Cordero, Andrés Ignacio., Amalvy, Javier Ignacio., Fortunati, Elena., Kenny, José María., & Chiacchiarelli, Leonel Matías., The role of nanocrystalline cellulose on the microstructure of foamed castor-oil polyurethane nanocomposites.*Carbohydrate Polymers* http://dx.doi.org/10.1016/j.carbpol.2015.07.077

The role of nanocrystalline cellulose on the microstructure of foamed castor-oil polyurethane nanocomposites

Andrés Ignacio Cordero[1], Javier Ignacio Amalvy[1], Elena Fortunati[2], José María Kenny[2], Leonel Matías Chiacchiarelli[3]

1: Instituto de Investigaciones Fisicoquímicas Teóricas y Aplicadas (INIFTA), CCT La Plata CONICET-UNLP, Diag. 113 y 64, La Plata, Argentina

2: Materials Engineering Center, UdR INSTM, University of Perugia, Strada di Pentima 4 05100, Terni, Italy

3: Instituto de Tecnología de Polímeros y Nanotecnología (ITPN), CONICET-UBA, Buenos Aires, Argentina

* lmchiacchiarelli@yahoo.com.ar

Highlights ►

Nanostructured Polyurethane Foams based on castor oil, nanocrystalline cellulose (NCC) and MDI isocyanate were synthesized. ► The migration of the NCC was studied with DSC, DMA, TGA and SEM, finding that only for a low isocyanate index and NCO number, the NCC migrated to the Hard Segment. ► The migration of the NCC to the HS was the key aspect so as to obtain substantial improvements of the mechanical properties of the bio-based nanocomposite foams. ► ►

Abstract

Nanocrystalline cellulose (CNC), obtained by sulphuric acid hydrolysis, was used to synthesize polyurethane foams (PUFs) based on a functionalized castor oil polyol and a Methylene diphenyl diisocyanate (MDI). Formulations with varying isocyanate index (FI) and NCO number were prepared. At 0.5 wt. %, SEM's of the fractured surface underlined that the CNC acted both as a nucleation agent and as a particulate surfactant with cell geometries and apparent density changing selectively. The chemical structure of the PUF (FTIR) changed after the incorporation of CNC by a relative change of the amount of urea, urethane and isocyanurate groups. A low NCO number and isocyanate index contributed to the migration of the CNC to the Hard Segment (HS), acting as reinforcement and improving substantially the compressive mechanical properties (E_c and σ_c improvements of 63 and 50%, respectively). For a high NCO number or isocyanate index, the CNC migrated to the Soft Segment (SS), without causing a reinforcement effect. The migration of the CNC was also detected with DSC, TGA and DMA, furtherly supporting the hypothesis that a low NCO number and index contributed both to the formation of a microstructure with a higher content of urethane groups.

Keywords: polyurethane foams, castor oil polyol, nanocrystalline cellulose, mechanical properties, thermal properties.