

EFFECT OF LIGNINS ON STRUCTURE, TENSILE AND THERMAL PROPERTIES OF POLYURETHANES FILMS.

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The traditional source of plastic industry, such as fossil fuel reserves, is diminishing and the demand of renewable raw material for polymer production is increasing [1]. Lignin produced as by-product of lignocellulosic chemical processing are recognized as important renewable hydroxyl containing macromonomers for polyurethane (PU) production. The properties of lignins vary depending on methods of their isolation and plant source processed. Correspondingly, origin of lignin influence properties of PU formed.

In this study the effect of lignin on the properties of PU films obtained from three components systems included polyethelenglykol ($M_n=400$ g/mol), lignin and commercial diphenylmethane diisocyanate (MDI) Voratec SD 100 ($C_{NCO}=31\%$) were investigated.

The organosolv wheat straw lignin was produced on CIMV pilot plant (France) within 7th FP "BIOCORE" Project. Three fractions of lignin were obtained by it sequential extraction with dichloromethane, methanol and methanol/ dichloromethane mixture. The functionalities of fractions were completely characterized.

PU films were prepared by pre-polymerization of constituents in extra dry tetrahydrofuran followed by preparation of films by solution casting. The content of lignin fractions in PU varied in the range 5-40%. Tensile strength, modulus of elasticity and elongation at break were determined using ZWICK testing device at deformation rate 10%/min. The glass transition (T_g) temperature of PU films was identified on METLER TOLEDO DSC 823 device.

The cross-link density of the PU was determined experimentally by Flory-Rehner method [2].

The increase of cross-link density of PU from 0.24×10^{-3} mol/cm³ for PEG-MDI system up to $1.0-1.5 \times 10^{-3}$ mol/cm³ for lignin containing PU films was established. As the results the elastic modulus (E) and tensile strength (σ) of PU films are increased steadily with increasing of lignin content in PU composition. The most pronounced growth was determined for PU contained methanol and methanol/ dichloromethane soluble fractions. For these systems values of σ and E equal 60 MPa and 2.5 GPa, correspondingly, were achieved. The PU films contained dichloromethane soluble fraction of lignin demonstrated lower strength and modulus of elasticity. All PU films displayed a maximum in ultimate strain (170-200%) at 5-10% of lignin content.

The increasing of lignin fractions content in urethanes compositions up to 40 % was accompanied with linear growth of T_g values of PU films in the range 6°C-120°C.

The results obtained show that organosolv lignins of wheat straw acts as a cross linking macromonomer in PU compositions. The fractionation of lignin and variation of fractions contents in PU composition allow to control the properties of PU films and to obtain the elastomers in high elastic state at room temperature or rigid and glassy crosslinked PU.

REFERENCES

1. Lampinen J., "Bioplastics-Trends Markets and Applications." *Proceedings of 3th International conference of Biofoams.* ", September 21-23, Capri, pp. 41-46, 2011.
2. Colins E., Bares J and Billmeyer F., "*Experiments in Polymer science.*" Wiley-Interscience, New York, pp. 481-482, 1973.

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