**Facile Synthesis of Bio-Polyurethane Resins from Well Characterized Fractionated Lignin**

**Sucia Okta Handika1), Muhammad Adly Rahandi Lubis2\*), Rita Kartika Sari1\*)**

1Department of Forest Products, Faculty of Forestry and Environment, IPB University, Bogor, Indonesia

2Research Center for Biomaterials, Indonesian Institute of Sciences, Cibinong, Indonesia

\*Corresponding Author E-mail: [marl@biomaterial.lipi.go.id](mailto:marl@biomaterial.lipi.go.id) ; [rita\_kbu@yahoo.com](mailto:rita_kbu@yahoo.com)

*Abstract:* In this work, fractionated lignin from black liquor was used as a pre-polymer for the preparation of bio-polyurethane (Bio-PU) resins. Briefly, the isolated lignin was fractionated via single-step fractionation using four different solvents, such as ethyl acetate (EtAc), acetone (Ac), ethanol (EtOH) and methanol (MeOH). The fractions of lignin, such as lignin-EtAc (L-EtAc), lignin-acetone (L-Ac), lignin-ethanol (L-EtOH) and lignin-methanol (L-MeOH) were obtained by evaporating the liquid fractions using rotary eporator at specific condition. Each lignin’s fractions was dissolved in NaOH and then was reacted with polymeric 4,4-methylene diphenyl diisocyanates (pMDI) at NCO/OH ratio of 0.3. The isolated lignin, fractionated lignin, and lignin-based Bio-PU resins were characterized using several techniques, such as FTIR, DSC, TGA, and Py-GCMS. The isolated lignin had quite similar characteristics to lignin standard, indicating that isolation process could be used to produce lignin from black liquor. Fractionation of lignin with different solvents altered its characteristics as shown by FTIR, DSC, TGA, Py-GCMS. L-EtAc had different functional groups compared to other lignin’s fractions, particularly at 3374 cm−1, 2917 cm−1, 2849 cm−1 and 1708 cm−1 which belonged to O–H, –CH3, –CH2 and C=O vibrations. As the results, L-EtAc had greater -OH groups compared to other lignin’s fractions, which led to lower thermal stability of L-EtAc. The results showed that L-MeOH and L-EtOH had greater thermal properties and stability than those of L-EtAc and L-Ac. After the reaction of lignin’s fractions and pMDI, the absorption band of isocyanate (−N=C=O) groups was shifted to 2285 cm−1 from 2240 cm−1 owing to the reaction with the −OH groups in lignin, forming urethane (R−NH−C=O−R) groups at 1605 cm−1 in Bio-PU resins. Thermal properties and stability of Bio-PU resins derived from lignin’s fractions were further investigated using DSC and TGA.

*Keywords: lignin, fractionation, bio-polyurethanes, thermosetting resins.*