Effects of NCO/OH Ratios on Bio-Based Polyurethane Film Properties Made from Acacia mangium Liquefied Wood

ABSTRACT

The compatibility between isocyanate and polyol plays an important role in determining a polyurethane product's performance. This study aims to evaluate the effect of varying the ratios between polymeric methylene diphenyl diisocyanate (pMDI) and Acacia mangium liquefied wood polyol on the polyurethane film properties. A. mangium wood sawdust was liquefied in polyethylene glycol/glycerol co-solvent with H_2SO_4 as a catalyst at 150 ◦C for 150 min. The A. mangium liquefied wood was mixed with pMDI with difference NCO/OH ratios to produce film through the casting method. The effects of the NCO/OH ratios on the molecular structure of the PU film were examined. The formation of urethane, which was located at 1730 cm^{-1}, was confirmed via FTIR spectroscopy. The TGA and DMA results indicated that high NCO/OH ratios increased the degradation temperature and glass transition from 275 ◦C to 286 ◦C and 50 ◦C to 84 ◦C, respectively. The prolonged heat appeared to boost the crosslinking density of the A. mangium polyurethane films, which finally resulted in a low sol fraction. From the 2D-COS analysis, the hydrogen-bonded carbonyl (1710 cm^{-1}) had the most significant intensity changes with the increasing NCO/OH ratios. The occurrence of the peak after 1730 cm^{-1} revealed that there was substantial formation of urethane hydrogen bonding between the hard (PMDI) and soft (polyol) segments as the NCO/OH ratios increased, which gave higher rigidity to the film.