Title: Flexible Polyurethane Foam Formation from Castor Oil

Abstract

Flexible polyurethane foams are widely used in automobile, upholstery, packaging and biomedical applications. Their conventional synthesis is largely dependent on petroleum resources. In this thesis we conducted various studies on flexible polyurethane foams when the conventional hydroxyl oligomer is replaced by castor oil. Foam stability and segmented polymeric phase morphology of polyurethane foams synthesized partially and completely from castor oil are investigated. The stability and morphology show unique trends depending on the concentration of castor oil used in foam synthesis. Low concentrations of castor oil do not significantly affect the foaming process, but at high concentrations, the volumetrically expanding liquid matrix remains in a non-equilibrium state during the entire foaming period. The fraction of monodentate urea undergoes agglomeration in foams synthesized completely from castor oil, thus prominently modifying the segmented morphology. The glass transition temperature of soft segments of partially substituted foams shows moderate increase, with indications of phase mixing between the polyether and castor oil generated urethane domains. Foaming dynamics were estimated using surface shear rheological studies. *In situ* development of viscoelasticity of urethane films at polymer-air interface was monitored using surface rheology under non-foaming conditions. These data along with normal stress measurements under foaming conditions were used to estimate the film thinning, cell opening and plateau border drainage dynamics. Same technique was also used to find a suitable surfactant for castor oil based polyurethane foam from a set of commonly used bio-polyol compatible surfactants. Partial modification of castor oil was done, which enabled us to synthesize superior quality of polyurethanes from it without the addition of external urethane-linkage modifying compound for chain extension and cross-linking agents. The modification involved the reaction of pure castor oil in the presence of an organo-lithium compound and water. Highly curable and stable polyurethane foams are synthesized from this modified hydroxyl oligomer. We also conducted detailed analysis of soft domain glass transition temperature, thermal degradation profile and mechanical properties of polyurethane foams. The effect of wetting of polyurethane hard block was monitored by small angle neutron

scattering using contrast variation method. An increase in core radius and volume fraction is observed for both urea and urethane domains due to swelling of Polyurethane foam and beads.

Key words: Biopolymers and renewable polymers; polyurethanes; polyurethane foam; castor oil; surface rheology; film rupturing time; surfactant; polymer from renewable resource; segmented morphology; small angle neutron scattering; deuterium oxide wetting.