Swelling Behavior of Epoxy Amine Gels

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Polymers are versatile in that they can be specifically designed to encompass a wide range of characteristics such as hardness, hydrophobicity and conductivity. Their structure can be manipulated to suit a given set of behavioral characteristics for a wide array of applications. This work specifically focuses on the impact of tailoring the degree of porosity. The wide array of applications of such modified polymers includes functional composites, separation membranes and thermal insulators.

A technique for synthesizing nanoporous polymer networks developed by Raman was used in this work. The polymeric system used for this study was epoxy-mine (diglycidyl ether of bisphenol A - EPON and 4'4'-methylenebiscyclohexanmine) and tetrahydrofuran (THF). The goals of this study include (i) synthesis of nanoporous polymer networks using EPON 836 (EEW = 313) and EPON 1001-F (EEW = 538) with varying solvent concentrations (ii) equilibrium swelling studies of the polymers using both the Bray and Merrill swelling theory and modification suggested by Raman to determine the molecular weight between crosslinks and to evaluate the applicability of Rman's correction to other systems (iii) thermal analysis for determining the glass transition temperature of the dried gels and (iv) characterization of pore size and structure of supercritically dried systems using scanning electron microscopy (SEM) .

The results of swelling studies support the corrections proposed by Raman to the Bray and Merrill model. The measurements of molecular weight between crosslinks are consistent with DSC results when the corrected model is used to analyze data, but not so when the original model is applied. This was found to be the case for all epoxy-amine-THF systems evaluated in this study. It was further observed that as the epoxy equivalent weight increases the molecular weight between crosslinks as determined by swelling experiments also increases and networks with fewer crosslinks are formed. Additionally, the molecular weight between crosslinks was not affected by solvent content over the range of compositions tested. Secondly, after experimentally determining the glass transition temperatures for each gel system over a wide range of solvent content, the Tg within a given epoxy system was relatively constant. Moreover, DSC experiments have shown expectedly that as the epoxide equivalent weight increases, the glass transition temperature decreases.