SAND2016-12128C

Cure mechanisms of diglycidyl ether of bisphenol A (DGEBA) epoxy with diethanolamine

John D. McCoy[2], *Windy B. Ancipink*[2], *Caitlyn M. Clarkson*[2], *Jamie M. Kropka*[1], *Mathias C. Celina*[1], *Nicholas H. Giron*[1], *Lebelo Hailesilassie*[2] *and Narjes Fredj*[2]
[1]*Sandia National Laboratories*
Albuquerque, NM, USA
[2]*New Mexico Institute of Mining and Technology*
Socorro, NM, USA
jmkropk@sandia.gov

Summary

When diethanolamine (DEA) is used as a curative for a DGEBA epoxy, a rapid "adduct-forming" reaction of epoxide with the secondary amine of DEA is followed by a slow "gelation" reaction of epoxide with hydroxyl and with other epoxide. Through an extensive review of previous investigations of simpler, but chemically similar, reactions, it is deduced that at low temperature the DGEBA/DEA gelation reaction is "activated" (shows a pronounced induction time, similar to autocatalytic behavior) by the tertiary amine in the adduct. At high temperature, the activated nature of the reaction disappears. The impact of this mechanism change on the kinetics of the gelation reaction, as resolved with differential scanning calorimetry, infrared spectroscopy, and isothermal microcalorimetry, is presented. It is shown that the kinetic characteristics of the gelation reaction of the DGEBA/DEA system are similar to other tertiary-amine activated epoxy reactions and consistent with the anionic polymerization model previously proposed for this class of materials. It is established that the reaction rate of epoxide consumption cannot be generically represented as a function only of temperature (T) and degree of epoxy conversion (α). The complex chemistry active in the material requires specific consideration of the dilute intermediates in the reaction sequence in order to define a model of the reaction kinetics applicable to all time-temperature cure histories.

Acknowledgements

Sandia National Laboratories is a multi-mission laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Reference

1. McCoy, J. D.; Ancipink, W. B.; Clarkson, C. M.; Kropka, J.M.; Celina, M.C.; Giron, N.H.; Hailesilassie, L. Fredj, N. *Polymer* **2016,** 105, 243-254.