Fracture Behavior–Morphology Relationships in an Unsaturated Polyester Resin Modified with a Liquid Oligomer

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ABSTRACT: An unsaturated polyester (UP) resin modified with a liquid polymer, polyoxypropylenetriamine (POPTA), at a concentration of 10 wt% has been precured at several temperatures. Phase separation takes place before gelation at all precure temperatures used. The glass-transition region has been analyzed by dynamic mechanical analysis. Mechanical properties have been related to microstructural features. With a precure temperature fixed, the unsaturated polyester (UP) resin has also been modified with different contents of POPTA. Fracture toughness of the mixtures has also been analyzed and results are compared to those for the unmodified mixture. © 1999 John Wiley & Sons, Inc. J Polym Sci B: Polym Phys 37: 1677–1685, 1999

Keywords: unsaturated polyester resins; liquid modifiers; cure schedule; ultimate properties

INTRODUCTION

Thermosetting resins are brittle. Small amounts of a second component, mainly rubber or thermoplastic, are often incorporated in order to improve mechanical properties of these resins.[1–3] While thermoplastic modification has the advantage of reducing contraction during cure, rubber modification improves mechanical properties.[4–6]

To produce a successful toughening additive for polyester, it is necessary to use a rubber that is compatible with uncured resin, so that the rubber will readily dissolve in the liquid resin, and remain in homogeneous solution until the beginning of the curing reaction. As the cure proceeds, the rubber precipitates out as a fine dispersion of particles. Polyoxypropylenetriamine (POPTA) has been found to be compatible with polyester and such a mixture may produce a fine dispersion of elastomeric particles under suitable curing conditions.

The influence of cure conditions and modifier content on the mechanical properties is examined in this study. Dynamic mechanical measurements have been carried out in order to determine the matrix glass transition. Mechanical behavior of modified mixtures has been analyzed as a function of the resultant morphologies, which have been characterized by scanning electron microscopy (SEM).

EXPERIMENTAL

Nuclear magnetic resonance (NMR) spectroscopy, Varian VXR 300 MHz, was used to characterize the resin. The Estratil 1.112 resin, provided by

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