HIGH TEMPERATURE VARTM USING LARC-PETI-9 POLYIMIDE RESIN

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Introduction

The use of composites materials as primary structures for aerospace applications has increased dramatically over the past decade. NASA Langley Research Center has developed a series of phenylethynyl terminated imide (PETI) resin systems to meet the processing requirements associated with high temperature vacuum assisted resin transfer molding (HT-VARTM) of aerospace components [1-3]. LaRC-PETI-9 is a low molecular weight imide oligomer that was synthesized specifically for HT-VARTM. The first objective of this investigation was to investigate the curing reactions of LaRC-PETI-9 resin and to develop a mathematical model to describe the cure rate as a function of the degree of cure and temperature. The second objective was to measure the viscosity of LaRC-PETI-9 resin at elevated temperatures and develop a model to predict the resin viscosity as a function of the degree of cure and temperature.

Results

Dynamic and isothermal differential scanning calorimetry (DSC) measurements were used to investigate curing of LaRC-PETI-9 resin and develop a cure kinetics model for the resin system. Dynamic scans were performed at heating rates of 2, 5, and 10°C/min from room temperature to 450°C while the isothermal scans were completed at temperatures ranging from 310 °C to 360°C. The cure reaction of the resin is very complex and could not be fit with a single mathematical model. A two-equation model was developed by fitting the initial stage of cure to a mathematical expression describing an autocatalytic reaction and the later stage of cure to a mathematical expression representing an *nth* order reaction. The overall models were able to describe the cure reaction kinetics of LARC-PETI-9 resin accurately over the range of temperatures selected for this study.

Isothermal rheological measurements of LARC-PETI-9 resin were performed to measure the viscosity as a function of time during cure. The viscosity data were obtained at temperatures ranging from 290°C to 320°C. At each measurement temperature, the viscosity versus time data were converted to viscosity as a function of degree of cure using the cure kinetics model. The viscosity versus degree of cure data sets were used to develop the viscosity model for the LaRC-PETI-9 resin. The viscosity model is a simple mathematical expression and considers the effects of both temperature and cure on viscosity. Comparisons between the calculated and measured viscosities show that the model accurately predicts the viscosity of LaRC-PETI-9 resin with temperature and degree of cure, and will be useful in defining and optimizing the HT-VARTM processing parameters of LaRC-PETI-9 resin.

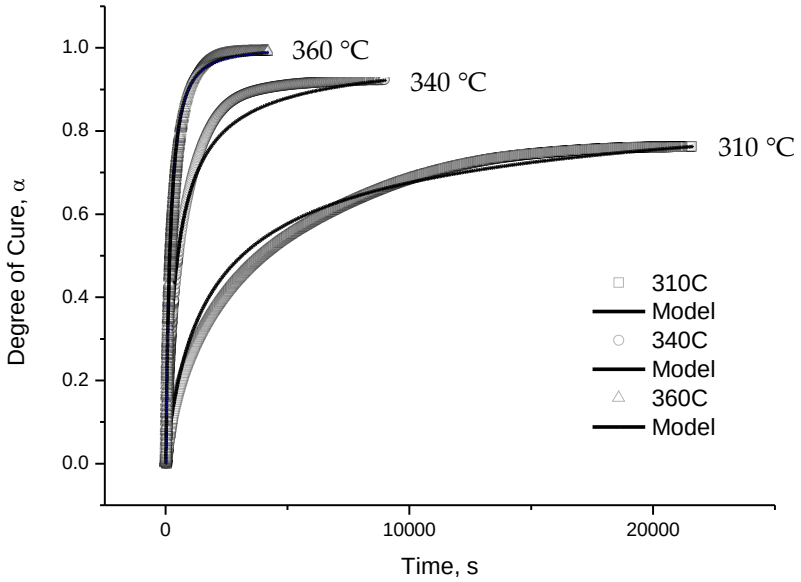

Figure 1: *Comparisons between the calculated and measured degree of cure versus time.*

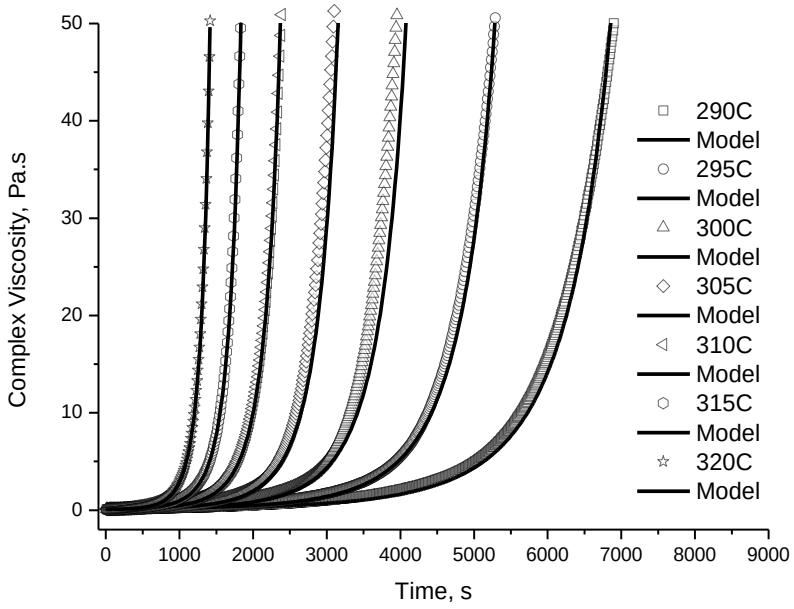

Figure 2: *Predicted and measured viscosities versus time*

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References

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