USE OF MICA AS A REINFORCEMENT IN EPOXY SYSTEMS

by

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CERTIFICATE

This is to certify that the thesis entitled, **"USE OF MICA AS A REINFORCEMENT IN EPOXY SYSTEMS"** being submitted by Mr. R. Ananda kumar, to the Indian Institute of Technology, Delhi, for the award of the degree of DOCTOR OF PHILOSOPHY in the Department of Chemistry, is a record of bonafide research work carried out by him. Mr. R. Ananda kumar, has worked under our guidance and supervision and fulfilled the requirements for the submission of the thesis.

The results contained in this thesis have not been submitted, in part or in full, to any other Institute or University for the award of a degree or diploma.

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ABSTRACT

Micronised mica (muscovite type, 17μm size) has been used as a reinforcement in a bisphenol-A based epoxy resin cured with an aromatic diamine. Three coupling agents, 3-aminopropyl triethoxy silane, 3-glycidoxypropyl trimethoxy silane and neoalkoxy tri(dioctyl pyrophosphato)zirconate have been used to improve the rheological and mechanical properties for mica/epoxy composites.

The cure kinetics of the mica/epoxy systems with diamino diphenylmethane as a hardener has been reported. In this study a series of isothermal and dynamic differential scanning calorimetric experiments were performed. The overall kinetics of curing follows a simple Arrhenius type temperature dependence with an activation energy ranging from 50 - 80 kJ/mol and first order. A significant increase in the curing rate was observed in the presence of mica. Influence of coupling agents on the cure kinetics of the above system has also been studied.

The effect of both untreated and surface treated mica on the flow behaviour of the resin without the hardener in the temperature range 60 - 90°C. With increase in mica loading (10-40 percent), the viscosity increased. With increase in temperature the viscosity decreased. However the drop in viscosity was significant in the case of surface

treated mica filled resin mixtures. The zirconate coated mica filled resin mixture showed the minimum viscosity values. The coupling agent coated samples were found to be more temperature sensitive. Shear thickening effect was observed in zirconate and amino silane treated mica/epoxy samples.

The thermal and electrical properties of the mica filled epoxy samples were studied using thermo mechanical analyser, differential scanning calorimetry, thermo gravimtry, dielectric measurements etc. The addition of mica decreased the thermal expansion considerably. The glass transition temperature decreased slightly on the addition of mica. Mica did not seem to have significant effect on the thermal stability of epoxy resin. Dielectric constant and loss tangent were determined using an impedance bridge in the frequency range 100 Hz to 10 MHz at room temperature. Dielectric strength and arc resistance were also evaluated.

Mechanical properties of untreated and surface treated mica/epoxy samples were investigated. The relative performance of the four coupling agents has been assessed from the results obtained from these studies. The modulus increased with increase in mica content but the strength values decreased. The surface treated samples showed better results. Aging (boiling in water for two hours) deteriorated the mechanical properties of the mica filled samples but to lesser extent in the case of surface treated mica/epoxy composites. The fracture morphology has also been studied by using scanning electron microscopy.

An attempt has been made to use glass fabric with mica/epoxy system to make a hybrid composite. The flexural modulus and interlaminar shear strength were found to improve considerably.

From the results obtained in various studies mentioned above, it was apparent that mica can be successfully used as a filler in an epoxy resin along with coupling agents. The application of such a system in electric and electronic industries might be of importance.

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