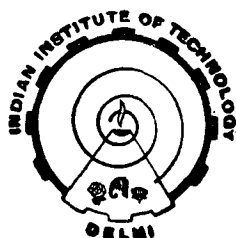


USE OF MICA AS A REINFORCEMENT IN EPOXY SYSTEMS

by
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A thesis submitted
in fulfilment of the requirements
of the degree of
DOCTOR OF PHILOSOPHY

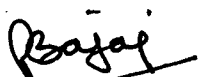


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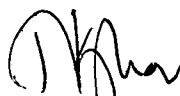
CERTIFICATE

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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(R. Ananda Kumar)

ABSTRACT

Micronised mica (muscovite type, 17 μ m 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, thermogravimetry, 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.

CONTENTS

CHAPTER 1 INTRODUCTION AND LITERATURE SURVEY

1	INTRODUCTION	1
1.1	EPOXY RESINS	1
1.1.1	Preparation of Epoxy Resins	4
1.1.2	Curing Agents.	4
1.1.3	Applications of Epoxy Resins	5
1.2	FILLERS	6
1.2.1	Calcium Carbonate.	8
1.2.2	Talc.	8
1.2.3	Silica	9
1.2.4	Kaolin	9
1.2.5	Alumina trihydrate	10
1.2.6	Mica	10
1.3	ROLE OF COUPLING AGENTS	11
1.3.1	Classification of Coupling Agents	16
1.3.1.1	Organo Silanes	17
1.3.1.2	Organo Titanates and Zirconates	18
1.4	MICA FILLED/REINFORCED COMPOSITES	20
1.5	AIMS OF THE PRESENT INVESTIGATION	23

CHAPTER 2 CURING BEHAVIOUR OF MICA FILLED EPOXY SYSTEM

2.1	INTRODUCTION	26
2.2	EXPERIMENTAL	28
2.2.1	Materials	28
2.2.2	Coating of Mica	29

2.2.3	Mica/Resin/Hardener mixture	29
2.2.4	Differential Scanning Calorimetry	30
2.3	RESULTS AND DISCUSSION	30
2.3.1	Calculation of Rate and Fractional extent of Cure	30
2.3.2	Dynamic DSC Studies	31
2.3.3	Isothermal Studies	32
2.3.4	Mechanism of Reaction	33
2.3.5	Effect of Coupling Agents	35

CHAPTER 3 THE EFFECT OF COUPLING AGENTS ON THE RHEOLOGICAL BEHAVIOUR OF MICA FILLED EPOXY RESIN

3.1	INTRODUCTION	38
3.2	EXPERIMENTAL	40
3.2.1	Contact Angle Studies	40
3.2.2	Mixing Mica with the Epoxy Resin	40
3.2.3	Evaluation of Flow Behaviour	40
3.3	RESULTS AND DISCUSSIONS	45
3.3.1	Effect of Mica loading	45
3.3.2	Effect of Coupling Agents	45
3.3.3	Effect of Shear Rate	46
3.3.4	Effect of Temperature	51
3.4	YIELD STRESS	53
3.5	THEORETICAL ANALYSIS	54

CHAPTER 4 THERMAL AND ELECTRICAL PROPERTIES OF MICA FILLED EPOXY COMPOSITES

4.1	INTRODUCTION	57
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4.1.1	Thermal Expansion	57
4.1.2	Glass Transition Temperature	58
4.1.3	Thermal Stability	59
4.1.4	Electrical Properties.	61
4.2	EXPERIMENTAL	62
4.2.1	Sample Preparation	62
4.2.2	Thermomechanical Analysis.	63
4.2.3	Differential Scanning Calorimetry	64
4.2.4	Thermogravimetric Analysis	64
4.2.5	Dielectric Measurements	65
4.2.6	Dielectric Strength and Arc Resistance	65
4.3	RESULTS AND DISCUSSION	66
4.3.1	Thermo Mechanical Analysis	66
4.3.2	Differential Scanning Calorimetry	67
4.3.3	Thermogravimetric Analysis	70
4.3.4	Electrical Properties	73
4.3.4.1.	Dielectric Measurements	73
4.3.4.2	Dielectric Strength and Arc Resistance	74

CHAPTER 5 MECHANICAL PROPERTIES OF MICA EPOXY COMPOSITES

5.1	INTRODUCTION	77
5.2	EXPERIMENTAL	79
5.2.1.	Materials	79
5.2.2.	Preparation of Test Specimens	80
5.2.3	Ageing of the Samples	80
5.2.4	Preparation of Glass/Mica/Epoxy Laminates	80

5.2.5	Evaluation of Mechanical Properties	81
5.3	RESULTS AND DISCUSSION	81
5.3.1.	Flexural and Tensile Moduli	81
5.3.2	Flexural and Tensile Strength of Epoxy/Mica composites	84
5.3.3	Elongation at Break	85
5.3.4	Theoretical Analysis	86
5.3.5	Ageing (Effect of Boiling Water)	87
5.3.6	Fracture Morphology	89
5.3.7	Glass Fabric/Mica/Epoxy Laminates	90
 CHAPTER 6 SUMMARY AND CONCLUSIONS		
6.1	SUMMARY AND CONCLUSIONS	93
6.2	FUTURE SCOPE	97
	 REFERENCES	 99