UNIVERSITI TEKNOLOGI MARA

PREPARATION, CHARACTERIZATION AND PROPERTIES OF EPOXIDIZED PALM OIL-MODIFIED EPOXY RESIN/GLASS FIBER COMPOSITE

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledge as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Surface treatment was carried out on E-glass fiber surface using different concentrations of hydrochloric acid solutions [0.01M-2.0M]. The morphologies of untreated and treated E-glass fiber surfaces were analysed by using scanning electron microscopy (SEM) and the peak of silanol group was identified by using Fourier Transform Infrared (FTIR). The treated glass fiber composites at 0.01MHCI showed the improvement on the tensile properties as compared to untreated and treated glass fiber composites at concentrations ranging from 0.1M to 2.0MHCI. Apart from that, the modified epoxy resin had also been studied by adding epoxidized palm oil (EPO) in the synthetic epoxy resin and it has a potential to partially substitute and toughen synthetic epoxy resin. The EPO was blended with the DGEBA type epoxy resin to determine the stoichiometric ratio for each ingredient for modified epoxy resin. Epoxidized Palm Oil modified epoxy resin was successfully cured by using aliphatic amine curing agent in the presence of imidazole catalyst of varied percentage ranging from 5% to 35%. The curing characteristics of modified epoxy resins were studied by using differential scanning calorimetry (DSC) and thermal gravimetric analyser (TGA). DSC and TGA thermograms revealed that 5% of imidazole catalyst provides good thermal stability as compared to the other percentages of imidazole catalyst. The value of glass transition temperature of modified epoxy resin that contains 5% imidazole catalyst gave the low Tg value and it indicates the flexibility properties. The modified epoxy resin exhibited rubbery behaviour due to the flexibility of fatty acid chain of EPO thus, improved the toughness of synthetic epoxy resin properties. Furthermore, the composition of cured modified epoxy resin was analysed using FTIR to identify the functional groups that produced after crosslinking reaction between EPO, epoxy and amine curing agent. According to the FTIR spectrum of the hybrid polymer resin indicates that the intensity of epoxide band decreased with the increment of the hydroxyl group intensity. It was proven that the curing reaction occurs with the opening of functional group of epoxide ring. Laminated glass fiber epoxy composite was fabricated by hand lay-up technique and it consists of one to four layers of glass fiber. Whereas for the hybrid polymer resin composite, it was fabricated using hand lay-up and dipping techniques. The mechanical and physical properties of the laminated glass fiber epoxy composites were analysed and compared with the properties of hybrid polymer resin composites. The tensile results of hybrid polymer resin composites showed the decrement on the tensile properties but for the impact result, it shows the increment of impact strength due to toughening properties of hybrid polymer resin about 210.6 kJ/m^2. For the water absorption results, it shows that hybrid polymer resin composite absorbs more water compared to laminate glass fiber composite. It would be happen due to the effect of crosslinking density. Meanwhile, the diffusion coefficient value of laminated glass fiber composite is high due to the polarity effect.

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CHAPTER ONE

INTRODUCTION

1.1 RESEARCH BACKGROUND

Polymer matrix composite (PMC) is a material containing two or more distinct parts which are dispersed and continuous parts. Both of these parts have different in physical and chemical properties. Once these parts are work together, it produced the composite where the properties of composite exceed the part's properties. The disperse parts may consist of synthetic and natural materials. Polymer matrixes are derived from the synthetic and natural polymers and it can be categorized into two groups which are thermoset and thermoplastic resins. Synthetic polymers such as aramid, polyester, epoxy, etc., are extensively used in many applications such as electronic materials, adhesives, coatings, sports, automotive fields and in structural applications due to their superior mechanical properties (May, 1988). Most of the synthetic polymers are derived from petrochemical resources (Michele & Brahim, 1998), and nowadays these resources are facing some problem due to the increasing emphasis on the environmental issues and Earth limited petroleum reserves (Z. Liu, S.N. Shah, R.L. Evangelista, & T.A. Isbell, 2013b; S. J. Park, F. L. Jin, & J. R. Lee, 2004) . The depletion of petroleum based lead to increase the cost of starting material for epoxy polymers. Therefore, the interest in the use of renewable resource has attracted considerable attention due to the increasing emphasis on waste disposal, environmental issues and depletion of non-renewable resources.

In this research, the type of epoxy resin that used is diglycidyl ether of bisphenol A (DGEBA). Epoxy resins are the one of the important thermosetting polymer that are currently used in advanced composites and coatings because of their high strength and stiffness, good chemical resistance and excellent electrical insulation properties (Z. Liu, S. N. Shah, R. L. Evangelista, & T. A. Isbell, 2013a; Michele & Brahim, 1998). However, there are some non-beneficial properties of epoxy resin which are poor crack resistance and brittle behavior due to high crosslinking density (Guo Yang, Fu, & Yang, 2007). The inherent brittleness material leads to the limitations its application in industry.