Development of *Jatropha curcas* oil based alkyd resins for effective surface coating and composite materials

ABSTRACT

The present thesis deals with synthesis, characterization, and properties evaluation of jatropha oil based alkyd resins and their nanocomposites with expanded graphite (EG) and graphene oxide (GO) nano-fillers. Blends of alkyd resins were prepared with commercially available epoxy resins. A considerable effort has been devoted to develop *green technology* in order to improve the performance characteristics such as curing time, thermal stability, mechanical properties, and hardness of the prepared alkyd resins. The influence of the nano-fillers on the curing, mechanical, thermal, and flame retardant properties of the resins was investigated. The contents of the thesis have been compiled into seven chapters.

Chapter 1 deals with the motivation and research background of the present investigation. A small portion of the chapter is devoted to introduce various vegetable oil derived polymers and composite materials and their importance in the recent time. The chapter briefly describes about the *Jatropha curcas* plant with its many attributes. A brief review on vegetable oil modified alkyd resins and their synthesis, characterization, properties, importance, and uses in various applications have been discussed. In addition, modifications of alkyd resins, including nanocomposite decoration have been conferred in this chapter. The chapter also outlines the scopes and objectives of the present investigation along with the plan of work.

Chapter 2 describes the synthesis and characterization of *Jatropha curcas* oil modified alkyd resins and their blends with epoxy resins. The structure, morphology, and performance characteristics of the resins are studied by Fourier transform infrared (FT-IR) spectroscopy, nuclear magnetic resonance spectroscopy (NMR), scanning electron microscopy (SEM), universal testing machine (UTM), and thermogravimetric analysis (TGA). The kinetics of polyesterification reaction during alkyd preparation has been

studied by monitoring the acid value at a regular time interval. The coating performances of the resins such as curing time, adhesion, flexibility, hardness, and gloss are evaluated. Chemical resistance test is done in four different chemical environments.

Chapter 3 reports the preparation, characterization, properties evaluation of blends of epoxidized alkyd resins based on jatropha oil and the epoxidized oil cured with an aqueous citric acid solution. The structure of the blends is studied by FT-IR and NMR, and the morphology is visualized by SEM analysis. The thermal and mechanical properties are evaluated by TGA and UTM, respectively. Epoxidation of the alkyd resin and the jatropha oil is done to facilitate the cross-linking reaction with citric acid. The performance characteristics such as curing time, scratch hardness, gloss, adhesion, tensile strength, and thermal stability of the blends are studied. The chemical resistance of the blends has been tested by measuring the weight loss after a definite time period.

Chapter 4 deals with the preparation of jatropha oil modified alkyd and epoxy blends and their composites with expanded graphite (EG). The structure and morphology of the composites are investigated by FT-IR, SEM, transmission electron microscopy (TEM), and X-ray diffraction (XRD) analysis. The tensile properties such as tensile strength and elongation at break of the composite films are determined by UTM. The thermal, mechanical, flame retardant, and water absorption properties of the bio-composites are studied as a function of different concentration of EG. The effect of EG on the flame retardant property of the composite is also evaluated. Degradation study of the composite films is carried out in phosphate buffer solution.

Chapter 5 describes the synthesis and characterization of jatropha oil modified alkyd and epoxy blends and their nanocomposites with graphene oxide (GO). The influence of GO on the curing characteristics of the nanocomposites is examined. Structures and properties of the nanocomposites are characterized with FT-IR, TGA, DSC, and tensile testing. TEM and XRD analysis is performed to visualize the microstructure of the nanocomposites. In addition, the dispersion of GO within the polymer matrix and nanocomposite morphology is also studied by TEM. The effects of different concentration of GO on the properties such as thermal stability, glass transition temperature, tensile strength, and elastic modulus are determined.

Chapter 6 reports the in situ synthesis of *green* bionanocomposites based on aqueous citric acid (CA) cross-linked epoxidized soybean oil (ESO) and carboxylic acid functionalized MWCNTs (c-MWCNTs). MWCNTs are acid functionalized to get better dispersion and interaction with the ESO-CA polymer networks. The formation of the ESO/CA/c-MWCNTs bionanocomposites is revealed by FT-IR analysis. The morphology of the bionanocomposites and dispersion of c-MWCNTs is studied by TEM. Thermal and mechanical properties are evaluated by TGA and UTM, respectively. In addition, the effect of c-MWCNTs on the chemical resistance property of the bionanocomposites is studied.

Chapter 7 summarizes the concluding remarks and highlights the findings and future scopes of the present investigation. The prepared blends and composites exhibited much improved performance characteristics than the neat jatropha oil modified alkyd resins. The composites are capable to compete with the conventional petroleum derived counterparts and can contribute to the enhanced sustainability. The observed results of the present investigation suggest high potential of the blends and composites in surface coating applications.