UNIVERSITI TEKNOLOGI MARA

SYNTHESIS AND CHARACTERIZATION OF ULTRA VIOLET (UV) CURING ADHESIVE FROM NATURAL OILS

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ABSTRACT

Bio-Adhesive from natural oil is expected to become important sources of renewable raw material in the resin industry. The synthesis and modification process of abundant natural oil such as sunflower, vegetable, palm oil, jatropha oil are the strategy to study the potential of green resin in various applications. In this study, natural oil from sunflower, rapseed and vegetable oils were chosen to be synthesized and modified to new natural modified resin which could be exploited as adhesive and coatings resin. Oils had been chosen according to their unsaturation in glyceride. The starting materials are in the form of fatty acids and triglyceride to produce bio-adhesive resin. Fatty acid or triglyceride had been synthesized to produced modified oil via various routes of synthesize method, consist of amide prepolymer, urethane oil prepolymer and fatty acid dimers. A stoichiometry and reaction temperature was studied to explore the kinetic of reactions in each of synthesize route. Gel permeation chromatography, wet chemistry and spectroscopy techniques; Fourier transform infrared (FTIR), Nuclear Magnetic Resonance (NMR) were used as characterization method to identify the functional group and chemical properties of prepolymers. Then, functional groups in these three prepolymers were activated using epoxidation and acrylation process. Epoxidation process was done via in-situ epoxidation by peroxoformic acid. This process had been optimized with the study of the effects of formic acid and hydrogen peroxide, temperature and solvents in different type of prepolymers. Grafting of Ultra violet reactive functional group were performed via acrylation. It was found that, amide polymer from isophorone diisocyanate backbone produce low viscosity pre-polymer and appropriate molecular weight for epoxidation process. Prepolymer from sunflower contain highest acrylated functional group and followed by rapseed and vegetable oil. After synthesize and modification process, ultra-violet curing (UV) resin was studied by formulating the resin with appropriate photoiniators and the intensity of UV in curing process. Co-initiator in UV curing polymerization was studied in this research due to the weakness of photoinitiator used in adhesive. The UV filtration by plastic substrate when used as UV adhesive shows the requirement of co-initiator. The performance of cured resin was evaluated by hardness, adhesion, tensile, shear strength, shrinkage, thermal resistance, chemical resistance, transition of glass, gel fraction and water adsorption. The result shows that, high crosslink network in the resin provide better physical and chemical properties. However, the density of crosslink network had reduced the adhesion properties due to the shrinkage phenomenon. To overcome this critical factor, resins from different routes of synthesis were formulated with monofunctional dan multifunctional monomers to reduce shrinkage and increase the adhesion properties. Monomers consist of mono acrylate, di acrylate, triacrylate, and teatraacrylate. The optimum formulation provides a better performance of ultraviolet curing bio-polymer.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND STUDY

In recent years, polymeric materials derived from natural and renewable resources had attract the attention of many researchers due to their potential to substitute petrochemical derivatives[1, 2]. Currently, the interest in cheap biodegradable polymeric materials has encourage the development of such materials from readily available, renewable, inexpensive natural sources such as starch, polysaccharide, and edible oils[3].

Oils and fats of vegetables and animal origin make up the greatest proportion of the current consumption of renewable material in chemical industry. They offer a large number of possibilities in modification in chemistry that can be rarely met by petrochemical [4]. For example, vegetable oils contain unsaturated side on fatty acids bond which have potential in polymerization of biopolymers [5, 6]. Numerous fatty acids are now available in purity and that makes it more attractive for synthesis and raw material for industrial use especially in oil-based polymer.

The biggest usage area of triglyceride oil-base polymers is in coatings industry, but starting in last decade they had been used in much different application such as composites, adhesives and printings [7]. Some type of polymer that can be prepared from triglyceride oil and its derivatives are oxypolymerized oils, polyesters (alkyd and unsaturated polyesters), polyurethanes (urethane oil and polyol as raw materials), polyamides, acrylic resins, epoxy resins, and polyester amides [8].

In this research, acrylated oil-base polymers were synthesized for ultraviolet (UV) adhesives application. UV curing systems are widely used in the area of coatings and assuming increasing importance in various industrial applications due to their particular characteristics and advantages with respect to the thermal and solvent base coatings. The advantages of this technology can be concised as follows: (i) solvent free process (100% solid, no volatile organic compound released); (ii) fast curing system; (iii) room temperature curing process and lower energy consumption compared to thermal curing; (iv) can be used in continuous production line and