

UNIVERSITI PUTRA MALAYSIA

SYNTHESIS AND CHARACTERIZATION OF PALM OIL-BASED RESIN FOR UV COATING

CHEONG MEI YEE.

FS 2006 37



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By

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CHEONG MEI YEE

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Master of Science

May 2006



To my family and friends,

For their unremitting support and encouragement





Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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May 2006

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Faculty: Science

The production of UV curable acrylated polyol esters from palm oil and its downstream products offers potential and promising materials for a number of applications such as polymeric film preparation and wood coatings. In this study, palm olein-based polyol of ethylene glycol was reacted with acrylic acid in the presence of a catalyst and inhibitors via condensation esterification process at various temperatures (70.0, 80.0, 90.0 or 100.0°C), stirring speed of 100 or 400 rpm and under vacuum for 15 hours. The reaction temperature of 80.0°C and the stirring rate of 400 rpm produce a homogeneous product. Optimizations for the synthesis were also carried out using a catalyst concentrations ranging from 0.0 to 5.0% of polyol weight.



Fifteen different formulations have been investigated using the synthesized prepolymers with monomers and a small amount of photoinitiator. Monomers used were 1, 6-hexanediol diarylate (HDDA) and trimethylolpropane triacrylate (TMPTA) while photoinitiator used was 1-hydroxy cyclohexyl phenylketone (Irgacure 184). The mixtures were cured to make thin polymeric films under UV radiation with doses between 2 to 14 passes (energy per pass is 0.600 J/cm²). Coating and curing was carried out on glass for pendulum hardness characterization, haziness and scratch measurement as well as FT-IR analysis. Coating and curing were done on rubber wood for cross hatch adhesion test.

Pendulum hardness of the film prepared from the UV curable formulation with monomer HDDA and the prepolymer prepared using 3% catalyst was 24.5%. The radiation dose was 14 passes. The highest pendulum hardness of 49.4% was achieved when using UV curable formulation with monomer TMPTA and the prepolymer prepared using 2% catalyst. The radiation dose needed was 10 passes. Formulation of UV curable coating using the optimized acrylated polyol ester prepolymer and monomer TMPTA exhibited higher scratch measurement and lower haziness compared to those of the formulation with monomer HDDA. UV curable formulation of prepolymer with monomer HDDA gave better adhesion on rubber wood than that of with monomer TMPTA. Films cured by UV radiation made from prepolymers on both glass panel and rubber wood surfaces showed good hardness, scratch resistance and adhesion with almost clear transparency. In general, it can be concluded that newly synthesized UV radiation curable palm-based acrylated polyol ester prepolymers are promising candidates for wood coating applications.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

SINTESIS AND PENCIRIAN RESIN BERASASKAN MINYAK SAWIT UNTUK PENGLITUPAN MATANG UV

Oleh

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Prapolimer poliester akrilat boleh matang UV yang disediakan daripada sumber minyak sawit dan terbitan hasilnya mempunyai potensi dan harapan untuk kegunaan bahan bukan makanan seperti pembuatan filem polimerik untuk litupan kayu. Dalam kajian ini, produk berasaskan minyak sawit iaitu poliol ditindakbalas dengan asid akrilik melalui proses esterifikasi dengan kehadiran mangkin dan perencat gel pada suhu berlainan (70.0, 80.0, 90.0 atau 100.0°C), kadar adukan; 100 rpm atau 400 rpm dan dalam keadaan vakum selama 15 jam. Suhu tindak balas 80.0°C dan kadar adukan 400 rpm menghasilkan produk homogen. Optimasi penyediaan dilakukan dengan menggunakan mangkin dalam linkungan 0.0 hingga 5.0% daripada berat poliol.



v

Kajian dilakukan untuk lima belas formulasi prapolimer yang disintesis bersama monomer dan sedikit bahan fotopemula. Monomer digunakan ialah 1, 6-heksanadiol diakrilat (HDDA) dan trimetilolpropana triakrilat (TMPTA) manakala bahan fotopemula ialah 1-hidroksi sikloheksil fenilketon (Irgacure 184). Campuran dimatangkan di bawah sinaran ultralembayung (UV) pada pelbagai dos di antara 2 hingga 14 laluan di mana tenaga per laluan ialah 0.600 J/cm² untuk menghasilkan filem polimer yang nipis. Litupan dan pematangan oleh UV dilakukan pada permukaan kaca untuk pencirian kekerasan, ukuran kelutsinaran, ujian tahan calar dan analisis FT-IR. Litupan dan pematangan UV juga dilakukan pada kayu untuk ujian daya kelekatan.

Kekerasan filem yang disediakan daripada formulasi matang UV dengan monomer HDDA dan prapolimer yang disediakan dengan menggunakan 3% mangkin ialah 24.5%. Dos radiasi yang diperlukan ialah 14 laluan. Kekerasan yang paling tinggi ialah 49.4% terhasil dengan menggunakan formulasi matang UV dengan monomer TMPTA dan prapolimer yang disediakan menggunakan 2% mangkin. Sinaran dos yang diperlukan ialah 10 laluan. Formulasi matang UV yang terdiri daripada prapolimer teroptima dan monomer TMPTA memberi ukuran tahan calar dan kelutsinaran yang tinggi manakala formulasi prapolimer dan monomer HDDA memberi daya kelekatan yang lebih tinggi pada kayu getah. Pada keseluruhannya, filem yang diperbuat oleh prapolimer yang telah dimatangkan oleh UV menunjukkan kekerasan, tahan calar, daya kelekatan dan kelutsinaran yang baik. Kesimpulannya, prapolimer poliester akrilat boleh matang UV yang disediakan daripada sumber minyak sawit berpotensi digunakan untuk litupan kayu.



ACKNOWLEDGEMENTS

I would like to express my sincere and deepest appreciation to Professor Dr. Wan Md. Zin B. Wan Yunus, the Chairman of my Supervisory Committee, for his intellectual advice, suggestions and guidance throughout the course of this project and for reviewing this thesis with constructive criticism. I am equally indebted to Professor Dr. Dzulkefly Kuang Abdullah who as a member of my Supervisory Committee gave invaluable supports, guidance and comments. My sincere thanks and deepest gratitude must be extended to Dr. Ooi Tian Lye whom is a member of my Supervisory Committee as well as Head of Oleochemical Product Development Unit (OPD) in Advanced Oleochemical Technology Division (AOTD), Malaysian Palm Oil Board (MPOB), for his kind, intellectual and direct supervision of my entire research work in his laboratory at AOTD, without which I would not be able to accomplish my Masters degree.

I am also heartily thanking Dr. Salmiah Ahmad, Director of AOTD (MPOB) for permission to conduct my entire project at AOTD. I acknowledge with thanks for the financial support from MPOB Graduate Research Programme. I would express my heartfelt thanks to staff of AOTD for their technical assistance throughout the entire course of my research, especially Puan Asma Don, Puan Sapiah Hashim, Puan Sefiah Ariffin, Puan Selasiah Abdullah, Puan Zamiah Hasham, Puan Rosmah Umam, Encik Halim Ariffin, Encik Roslan Ramli, Encik Mohammed Ahir Musa and many others. I would also like to thank Dr. Chong Chew Let and his subordinate, Encik Khairul in MPOB Bangi (headquarters) for their technical assistance.

I would like to express my sincere appreciation to Dr. Khairul Zaman Hj. Mohd Dahlan, Director of Division of Radiation Processing Technology, Malaysian Institute for Nuclear Technology research (MINT) for permission to conduct my project in MINT. I would to extend heartfelt appreciation and thank you to Dr. Nik Ghazali, Cik Mek Zah, Encik Rosley and staff of MINT for their technical assistance and guidance.

My appreciation also goes to staff of Intermed Sdn Bhd, Ms. Tan Mei Yun and Mr. Dennis Chong, for providing many samples of polyol of ethylene glycol. I would like to thank Mr. Too Wing Meng from Haint (M) Sdn. Bhd. for providing Ciba® range of photoinitiator samples.

Last but not least, I am also greatly indebted to my parents, Cheong Lee Tai and Wong Teo Yang; brothers, Cheong Yow Kouen and Cheong Yow Lam; and friends, Chong Chun Wai, Lee Chia Yen, Sharmini, Lee Ching Shya, Lee Choy Sin, Chan Wai Theng, Aminah Azizan, Shah and Lim Sheo Kun; whose relentless encouragement and support have contributed towards the accomplishment of this project.





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TABLE OF CONTENTS

| DEDICAT | ION | ii |
|-----------------|--|-------|
| ABSTRAC | T | iii |
| ABSTRAK | | v |
| ACKNOW | 'LEDGMENTS | vii |
| APPROV A | NL | ix |
| DECLARA | ATION | xi |
| LIST OF 1 | TABLES | xv |
| LIST OF H | IGURES | xviii |
| LIST OF A | ABBREVIATIONS | xxvi |
| CHAPTER | | |
| 1 INT | RODUCTION | |
| 1.1 | Malaysian Oil Palm Industry | 1 |
| 1.2 | Polyol Based on Sustainable Raw Material | 2 |
| | 1.2.1 Palm Oil-Based Polyol | 3 |
| 1.3 | Palm Oil-Based Resin from Polyol | 6 |
| 1.4 | Scope of the Study | 9 |

| 1.4 | Scope | of the | Study |
|-----|-------|--------|-------|
|-----|-------|--------|-------|

| 2 | LITE | RATURE REVIEW | |
|---|------|---|----|
| | 2.1 | Malaysian Palm Oil Products | 10 |
| | 2.2 | Composition and Characteristics of Palm Oil | 16 |
| | | 2.2.1 Minor Components | 21 |
| | | 2.2.2 Other Properties of Palm Oil | 25 |
| | 2.3 | Polyols | 26 |
| | 2.4 | Palm Oil-Based Resin for UV Coating | 30 |
| | 2.5 | Resin | 34 |
| | 2.6 | Alkyd Resin | 37 |
| | | 2.6.1 Reaction in Alkyd Resin Synthesis | 38 |
| | 2.7 | Other Resins | 41 |
| | | 2.7.1 Acrylic Resin | 44 |
| | 2.8 | Radiation Curable Systems | 49 |
| | 2.9 | Application of UV Curing | 58 |
| | 2.10 | Monomer | 61 |
| | 2.11 | Photoinitiator | 63 |
| | | 2.11.1 The Critical Role of Photoinitiator | 63 |
| | | 2.11.2 Types of Photoinitator | 65 |
| | 2.12 | Inhibitor | 70 |
| | | 2.12.1 Factors Resulting in Gelation | 71 |
| | 2.13 | Ultraviolet Radiation | 73 |
| | | 2.13.1 Photo-Polymerization Reaction under UV Light | 75 |
| | | 2.13.2 Mechanism of Photoinitated Polymerization | 76 |
| 3 | METI | HODOLOGY | |
| | 3.1 | Material and Reagent | 81 |
| | | 3.1.1 Standard Solution | 86 |
| | 3.2 | Method | 86 |

xii

Page

| | 3.2.1 | Synthesis of Palm-Based Acrylated Polyol Ester | |
|------|-----------------|--|---------|
| | | Prepolymer | 86 |
| | 3.2.2 | Preparation of Palm-Based Acrylated Polyol Ester | |
| | | Prepolymer | 88 |
| | 3.2.3 | Purification | 89 |
| | 3.2.4 | Optimization of Reaction | 90 |
| | | 3.2.4.1 Reaction Conditions | 91 |
| | | 3 2 4 2 Catalyst and Inhibitor | 91 |
| 33 | Charac | terization Technique for PoEG and Acrylated Polyol Ester | <i></i> |
| 5.5 | Prenoly | vmer | 94 |
| | 331 | Acid Value | 94 |
| | 332 | Hydroxyl Value | 95 |
| | 333 | Iodine Value | 97 |
| | 334 | Saponification Value | 99 |
| | 225 | Ovirane Ovugen Content | 100 |
| | 3.3.5 | Viscosity | 100 |
| | 3.3.0 | Fourier Transform Infrared (FT ID) Spectroscopy | 102 |
| | 3.3.1 | ¹ LI NLAP & ¹³ C NLAP (Nuclear Magnetic Pasananae) | 105 |
| | 3.3.0 | n-invik & C-inivik (inuclear inaghetic Resonance) | 104 |
| | 220 | Class Transition Terms centure (T.) and Crustelling Making | 104 |
| | 3.3.9 | Chass Transition Temperature (T_g) and Crystatime Mening | 104 |
| | 2 2 10 | $1 \text{ emperature } (1_m)$ | 104 |
| | 3.3.10 | Molecular Weight Determination | 105 |
| | 3.3.11 | Water Content | 105 |
| | 3.3.12 | pH Measurement | 107 |
| ~ 4 | 3.3.13 | Colour Measurement | 107 |
| 3.4 | Prepar | ation of UV Curable Coating Formulation, Application and | 100 |
| | UVCu | iring of Coating | 108 |
| | 3.4.1 | Materials | 108 |
| | 3.4.2 | Method | 112 |
| | 3.4.3 | Coating and UV Curing of the Formulation on Glass Plate | 114 |
| | 3.4.4 | Coating and UV Curing of the Formulation on Wood | 116 |
| | ~ | 3.4.4.1 Preparation of Wood Surface | 117 |
| 3.5 | Charac | cterization of UV Cured Film | 122 |
| | 3.5.1 | Fourier Transform Infrared (FT-IR) Spectroscopy | 122 |
| | 3.5.2 | Pendulum Hardness | 122 |
| | 3.5.3 | Scratch Measurement | 123 |
| | 3.5.4 | Cross-Hatch Adhesion | 124 |
| | 3.5.5 | Haze Measurement | 124 |
| RESU | TS AN | ID DISCUSSION | |
| A | PREPA | RATION AND ANALYSIS | |
| 41 | Prenara | ation and Analysis of Acrylated Polyol Ester Prepolymer | 126 |
| 42 | Reactio | n Mechanism | 127 |
| 43 | Effect | of Various Reaction Parameters on the Acid Value | 131 |
| ч.5 | 431 | Effect of Mechanical Stirring Rate | 131 |
| | 432 | Effect of Reaction Temperature | 132 |
| | т.J.2 Д 2 2 | Effect of Reaction Period | 132 |
| | т.J.J Л 2 Л | Effect of Catalyst and Its Concentrations | 127 |
| A A | 7.J.4 Effaat | of Various Reaction Parameters on the Hudrovid Value | 1/1 |
| 4.4 | | Effect of Mechanical Chirring Rate | 1/1 |
| | 4.4.1 | LINN OF MUMARICAL SUITING NAU | 141 |

4

| | 4.4.2 Effect of Reaction Temperature | 142 |
|--------|---|-----|
| | 4.4.3 Effect of Reaction Period | 142 |
| | 4.4.4 Effect of Catalyst and Its Concentrations | 146 |
| 4.5 | Effect of Various Reaction Parameters on the Iodine Value | 148 |
| | 4.5.1 Effect of Mechanical Stirring Rate | 148 |
| | 4.5.2 Effect of Reaction Temperature | 149 |
| | 4.5.3 Effect of Catalyst and Its Concentrations | 151 |
| 4.6 | Effect of Various Reaction Parameters on the Yield of Synthesis | 153 |
| | 4.6.1 Effect of Mechanical Stirring Rate | 153 |
| | 4.6.2 Effect of Reaction Temperature | 154 |
| | 4.6.3 Effect of Catalyst and Its Concentrations | 155 |
| 4.7 | Effect of Various Reaction Parameters on the Viscosity | 156 |
| | 4.7.1 Effect of Mechanical Stirring Rate | 156 |
| | 4.7.2 Effect of Reaction Temperature | 157 |
| | 4.7.3 Effect of Catalyst and Its Concentrations | 158 |
| 4.8 | Fourier Transform Infrared (FT-IR) Spectroscopy | 161 |
| 4.9 | H-NMR & ¹³ C-NMR Spectra Analysis | 169 |
| | 4.9.1 ¹ H-NMR for Acrylated Polyol Ester Prepolymer | 169 |
| | 4.9.2 H-NMR PoEG | 174 |
| | 4.9.3 ¹³ C-NMR for Acrylated Polyol Ester Prepolymer | 176 |
| • | 4.9.4 ¹³ C-NMR PoEG | 178 |
| 4.10 | Molecular Weight Determination | 179 |
| 4.11 | Glass Transition Temperature (Tg) and Crystalline Melting | 184 |
| | Temperature (T_m) | |
| 4.12 | Moisture Analysis | 194 |
| В | EVALUATION | |
| 4.13 | Characterization of UV Cured Formulation | 195 |
| 4.14 | Fourier Transform Infrared (FT-IR) Spectroscopy | 195 |
| 4.15 | Pendulum Hardness | 199 |
| 4.16 | Scratch Measurement | 208 |
| 4.17 | Cross-Hatch Adhesion | 211 |
| 4.18 | Haziness of Film | 214 |
| 5 CONG | CLUSIONS | 218 |
| BIBLIO | RAPHY | 221 |
| APPEND | DICES | 237 |
| BIODAT | A OF THE AUTHOR | 244 |
| | | |

xiv

LIST OF TABLES

| Table | | Page |
|-------|---|------|
| 2.1 | World production of 17 oils & fats: 1994-2003 ('000 tonnes) | 13 |
| 2.2 | World major producers of palm oil: 1994-2003 ('000 tonnes) | 14 |
| 2.3 | World major exporters of palm oil: 1994-2003 ('000 tonnes) | 15 |
| 2.4 | Fatty acids and their compositions in triglycerides of palm oil | 18 |
| 2.5 | Composition of normal RBD palm olein | 19 |
| 2.6 | Carotenoid composition of Malaysian crude palm oil | 22 |
| 2.7 | Tocopherols and tocotrienols in crude palm oil | 23 |
| .2.8 | Cholesterol levels in crude oils and fats | 24 |
| 2.9 | Sterol composition of crude and refined palm oil and their products (ppm) | 25 |
| 2.10 | Physical and chemical properties of palm oil and its products | 25 |
| 2.11 | Applications of palm oil and its products as food and non-food purposes | 26 |
| 2.12 | Examples of non-polyester / non-polyether polyol | 27 |
| 2.13 | Example of polyester polyol | 28 |
| 2.14 | Examples of polyether polyol | 29 |
| 2.15 | Composition and properties of vegetable oil | 36 |
| 2.16 | Examples of polybasic acid | 39 |
| 2.17 | Examples of polyhydric alcohol | 40 |
| 2.18 | Examples of other resins | 41 |
| 2.19 | Examples of vinyl and acrylic resins | 43 |
| 2.20 | Physical properties of acrylic acid | 44 |
| 2.21 | Physical properties of methacrylic acid | 45 |
| 2.22 | Energy consumption and mechanism involved | 50 |

.



| 2.23 | Various product of radiation curable resin under UV curing process | 58 |
|------|---|-----|
| 2.24 | Various applications of radiation curable resins under UV curing process | 59 |
| 2.25 | Commercially available monofunctional monomers | 62 |
| 2.26 | Commercially available multifunctional monomers | 62 |
| 2.27 | Some of the common photoinitiators (Type I) and their structure | 68 |
| 2.28 | Some of the common photoinitiators (Type II) and their structure | 69 |
| 2.29 | Some of the common inhibitors | 70 |
| 3.1 | Characteristics of PoEG | 81 |
| 3.2 | Reagent used in the study | 82 |
| 3.3 | Chemical used in the study | 83 |
| 3.4 | Solvent used in the study | 84 |
| 3.5 | UV curing reagent used in the study | 84 |
| 3.6 | Instrumentation used in the study | 85 |
| 3.7 | Catalyst, inhibitor and solvent used | 89 |
| 3.8 | Sample codes with their heating temperatures and stirring rates | 90 |
| 3.9 | The chemicals and their molecular structure that are used in UV curing formulation | 109 |
| 3.10 | Physical characteristics and molecular structure of 1,6-hexane diol diacrylate (HDDA) | 110 |
| 3.11 | Physical characteristics and molecular structure of trimethylol propane triacrylate (TMPTA) | 111 |
| 3.12 | Physical characteristics and molecular structure of Ciba® Irgacure® 184 photoinitiator | 112 |
| 3.13 | Formulation codes and their ratio of acrylated polyol ester prepolymer (oligomer), monomer and photoinitiator | 113 |
| 3.14 | The conveyor speed (m/min) and its corresponding energy (J/cm^2) given out by the UV lamp type: 200 watt/cm | 115 |

xvi



| 3.15 | Base coat formulation codes and their ratios of acrylated polyol ester prepolymer (oligomer), monomer and photoinitiator | 119 |
|------|--|-----|
| 3.16 | Top coat formulation codes and their ratios of acrylated polyol ester prepolymer (oligomer), monomer and photoinitiator | 120 |
| 4.1 | Characteristics FT-IR peaks of acrylic acid | 161 |
| 4.2 | Characteristics FT-IR peaks of PoEG | 163 |
| 4.3 | Characteristics FT-IR peaks of acrylated polyol ester prepolymer | 165 |
| 4.4 | Substituent constants (Z) for chemical shifts of substituted ethylene | 170 |
| 4.5 | Calculation of chemical shift in of alkene protons in substituted ethylene | 170 |
| 4.6 | ¹ H-NMR of purified acrylated polyol ester prepolymer | 173 |
| 4.7 | ¹ H-NMR of PoEG | 175 |
| 4.8 | ¹³ C-NMR of purified acrylated polyol ester prepolymer | 177 |
| 4.9 | ¹³ C-NMR of PoEG | 179 |
| 4.10 | Weight average molecular weight, M_w , number average molecular weight, M_n and polydispersity (M_w/M_n) of PoEG and acrylated polyol ester prepolymer samples | 183 |
| 4.11 | UV curable formulation and constituent of the film samples | 196 |
| | | |

•



LIST OF FIGURES

| Figure | | Page |
|--------|---|------|
| 1.1 | Conversion sequence of palm oil to palm-based polyol | 4 |
| 1.2 | General reaction scheme of synthesis of acrylated polyol ester prepolymer | 7 |
| 1.3 | Reaction scheme of synthesis of acrylated polyol ester prepolymer | 8 |
| 2.1 | Processing of palm oil and palm kernel oil (Salmiah, 1995) | 16 |
| 2.2 | Hydrolysis of a fat or oil produces a mixture of fatty acids | 18 |
| 2.3 | Example of polyester polyol | 28 |
| 2.4 | Examples of polyether polyol | 29 |
| 2.5 | Reaction between fatty acid and trimethylol propane to produce polyol | 30 |
| 2.6 | Reaction scheme for the production of epoxidised palm olein acrylate (EPOLA) | 31 |
| 2.7 | Reaction scheme for the production of epoxidised palm olein methacrylate (EPOMA) | 31 |
| 2.8 | Reaction scheme for the production of palm oil-based urethane acrylate (POBUA) | 32 |
| 2.9 | Esterification in alkyd resin preparation | 38 |
| ·2.10 | Representation of alkyd resin molecule | 38 |
| 2.11 | Reaction scheme of acrylic acid production from ethylene oxide and hydrogen cyanide | 44 |
| 2.12 | Reaction scheme of methacrylic acid production from isobutene | 45 |
| 2.13 | Examples of esters of methacrylic and acrylic acid | 45 |
| 2.14 | Examples of acrylic amides and nitriles | 46 |
| 2.15 | Acrylic ester and methacrylic ester | 47 |
| 2.16 | 2-Hydroxy ethyl acrylate and 2-hydroxy ethyl methacrylate | 48 |
| 2:17 | Acrylic acid and methacrylic acid | 48 |



| 2.18 | Glycidyl acrylate and glycidyl methacrylate | 48 |
|------|---|-----|
| 2.19 | Acrylamine and methacrylamide | 49 |
| 2.20 | Photoinitiator / stabilizer cycle | 72 |
| 2.21 | Electromagnetic spectrum of ultraviolet (UV) light | 74 |
| 2.22 | Excited and free radical form of photoinitiator in photopolymerization reaction | 75 |
| 2.23 | Main steps in mechanism of photoinitiated polymerization | 76 |
| 2.24 | Mechanism of photoinitiated polymerization | 78 |
| 2.25 | Free radicals formation from photoinitiator | 80 |
| 3.1 | Synthesis of acrylated polyol ester prepolymer | 87 |
| 3.2 | Mechanism of inhibition of polymerization by 4-methoxyphenol | 92 |
| 3.3 | Mechanism of inhibition of polymerization by hydroquinone | 93 |
| 3.4 | Oxirane oxygen | 101 |
| 3.5 | Schematic diagram of coating process and UV curing technique | 116 |
| 3.6 | Finishing line for UV curing of high gloss wood coating | 121 |
| 4.1 | Mechanism of acrylated polyol ester prepolymer synthesis with primary alcohol group | 129 |
| 4.2 | Mechanism of acrylated polyol ester prepolymer synthesis with primary and secondary alcohol groups | 130 |
| 4.3 | Effect of reaction period on the acid value. Other reaction conditions: temperature (70.0°C), catalyst concentration (5.0%) and stirring rate (100 or 400 rpm) | 134 |
| 4.4 | Effect of reaction period on the acid value. Other reaction conditions: temperature (80.0° C), catalyst concentration (5.0°) and stirring rate ($100 \text{ or } 400 \text{ rpm}$) | 134 |
| 4.5 | Effect of reaction period on the acid value. Other reaction conditions: temperature (90.0°C), catalyst concentration (5.0%) and stirring rate (100 or 400 rpm) | 135 |
| 4.6 | Effect of reaction period on the acid value. Other reaction conditions: temperature (100.0°C), catalyst concentration (5.0%) and stirring rate (100 or 400 rpm) | 135 |
| | | |

xix



| 4.7 | Effect of reaction period on the acid value. Other reaction conditions: temperature (70.0, 80.0, 90.0 or 100.0°C), catalyst concentration (5.0%) and stirring rate (100 rpm) | 136 |
|------|--|-----|
| 4.8 | Effect of reaction period on the acid value. Other reaction conditions: temperature (70.0, 80.0, 90.0 or 100.0°C), catalyst concentration (5.0%) and stirring rate (400 rpm) | 136 |
| 4.9 | Effect of reaction period on the acid value. Other reaction conditions: temperature (80.0°C), catalyst concentration (0.0%) and stirring rate (400 rpm) | 138 |
| 4.10 | Effect of reaction period on the acid value. Other reaction conditions: temperature (80.0°C), catalyst concentration (1.0%) and stirring rate (400 rpm) | 138 |
| 4.11 | Effect of reaction period on the acid value. Other reaction conditions: temperature (80.0°C), catalyst concentration (2.0%) and stirring rate (400 rpm) | 139 |
| 4.12 | Effect of reaction period on the acid value. Other reaction conditions: temperature (80.0°C), catalyst concentration (3.0%) and stirring rate (400 rpm) | 139 |
| 4.13 | Effect of reaction period on the acid value. Other reaction conditions: temperature (80.0°C), catalyst concentration (4.0%) and stirring rate (400 rpm) | 140 |
| 4.14 | Effect of reaction period on the acid value. Other reaction conditions: temperature (80.0°C), catalyst concentration (5.0%) and stirring rate (400 rpm) | 140 |
| 4.15 | Effect of reaction period on the hydroxyl value. Other reaction conditions: temperature (70.0°C), catalyst concentration (5.0%) and stirring rate (100 or 400 rpm) | 143 |
| 4.16 | Effect of reaction period on the hydroxyl value. Other reaction conditions: temperature (80.0°C), catalyst concentration (5.0%) and stirring rate (100 or 400 rpm) | 143 |
| 4.17 | Effect of reaction period on the hydroxyl value. Other reaction conditions: temperature (90.0°C), catalyst concentration (5.0%) and stirring rate (100 or 400 rpm) | 144 |
| 4.18 | Effect of reaction period on the hydroxyl value. Other reaction conditions: temperature (100.0°C), catalyst concentration (5.0%) and stirring rate (100 or 400 rpm) | 144 |



xx

| 4.20 Effect of reaction period on the hydroxyl value. Other reaction conditions: temperature (70.0, 80.0, 90.0 or 100.0°C), catalyst concentration (5.0%) and stirring rate (400 rpm) 4.21 Effect of reaction period on the hydroxyl value. Other reaction conditions: temperature (80.0°C), catalyst concentration (0.0%) and stirring rate (400 rpm) 4.22 Effect of reaction period on the hydroxyl value. Other reaction conditions: temperature (80.0°C), catalyst concentration (1.0, 2.0, 3.0, 4.0 or 5.0%) and stirring rate (400 rpm) 4.23 Iodine value for unpurified and purified prepolymers prepared at different heating temperatures. Other reaction conditions: catalyst | 145 147 147 |
|--|-------------------|
| 4.21 Effect of reaction period on the hydroxyl value. Other reaction conditions: temperature (80.0°C), catalyst concentration (0.0%) and stirring rate (400 rpm) 4.22 Effect of reaction period on the hydroxyl value. Other reaction conditions: temperature (80.0°C), catalyst concentration (1.0, 2.0, 3.0, 4.0 or 5.0%) and stirring rate (400 rpm) 4.23 Iodine value for unpurified and purified prepolymers prepared at different heating temperatures. Other reaction conditions: catalyst | 147 147 |
| 4.22 Effect of reaction period on the hydroxyl value. Other reaction conditions: temperature (80.0°C), catalyst concentration (1.0, 2.0, 3.0, 4.0 or 5.0%) and stirring rate (400 rpm) 4.23 Iodine value for unpurified and purified prepolymers prepared at different heating temperatures. Other reaction conditions: catalyst | 147 |
| 4.23 Iodine value for unpurified and purified prepolymers prepared at different heating temperatures. Other reaction conditions: catalyst | |
| concentration (5.0%), stirring rate (100 rpm) and reaction period (15 hours) | 150 |
| 4.24 Iodine value for unpurified and purified prepolymers prepared at different heating temperatures. Other reaction conditions: catalyst concentration (5.0%), stirring rate (400 rpm) and reaction period (15 hours) | 150 |
| 4.25 Iodine value for unpurified and purified prepolymers prepared with no catalyst. Other reaction conditions: temperature (80.0°C), stirring rate (400 rpm) and reaction period (25 hours) | 152 |
| 4.26 Iodine value for unpurified and purified prepolymers prepared with different amount of catalyst. Other reaction conditions: temperature (80.0°C), stirring rate (400 rpm) and reaction period (15 hours) | 152 |
| 4.27 Effect of different heating temperatures used in prepolymer preparation on the total yield. Other reaction conditions: catalyst concentration (5.0%), stirring rate (100 rpm) and reaction period (15 hours) | 154 |
| 4.28 Effect of different heating temperatures used in prepolymer preparation on the total yield. Other reaction conditions: catalyst concentration (5.0%), stirring rate (400 rpm) and reaction period (15 hours) | 155 |
| 4.29 Effect of different amount of catalyst used in prepolymer preparation on the total yield. Other reaction conditions: temperature (80.0°C), stirring rate (400 rpm) and reaction period (15 hours) | 156 |

xxi

| 4.30 | Effect of different heating temperatures used in prepolymer preparation on the viscosity of sample. Other reaction conditions: catalyst concentration (5.0%), stirring rate (100 or 400 rpm) and reaction period (15 hours) | 157 |
|------|---|-----|
| 4.31 | Effect of different amount of catalyst used in prepolymer preparation on the viscosity. Other reaction conditions: temperature (80°C), stirring rate (400 rpm) and reaction period (15 hours) | 159 |
| 4.32 | Effect of different shear rate on the viscosity of PoEG and prepolymer samples. Other reaction conditions: temperature (80°C), stirring rate (400 rpm) and reaction period (15 hours) | 160 |
| 4.33 | FT-IR spectrum of acrylic acid | 162 |
| 4.34 | FT-IR spectrum of PoEG | 164 |
| 4.35 | FT-IR spectrum of purified acrylated polyol ester prepolymer (sample: C3/80/400 rpm-purified) | 166 |
| 4.36 | FT-IR spectra of (a) 0 hour of synthesis, (b) 15 th hour (unpurified) and (c) 15 th hour (purified) acrylated polyol ester prepolymer (sample: C5/70/400 rpm) | 168 |
| 4.37 | Unsaturated systems of ethylene | 169 |
| 4.38 | Unsaturated systems with different alkene protons | 170 |
| 4.39 | ¹ H-NMR of purified acrylated polyol ester prepolymer (sample: C5/80/400 rpm-purified) | 172 |
| 4.40 | ¹ H-NMR of PoEG | 174 |
| 4.41 | ¹³ C-NMR of purified acrylated polyol ester prepolymer (sample: C5/80/400 rpm-purified) | 176 |
| 4.42 | ¹³ C-NMR of PoEG | 178 |
| 4.43 | GPC spectrum of PoEG | 180 |
| 4.44 | GPC spectrum of unpurified acrylated polyol ester prepolymer (sample: C5/80/400 rpm-unpurified) | 181 |
| 4.45 | GPC spectrum of purified acrylated polyol ester prepolymer (sample: C5/80/400 rpm-purified) | 182 |
| 4.46 | DSC thermogram of PoEG | 186 |



| 4.47 | DSC thermogram of purified acrylated polyol ester prepolymer (sample: C1/80/400 rpm-purified) | 187 |
|------|---|-----|
| 4.48 | DSC thermogram of purified acrylated polyol ester prepolymer (sample: C2/80/400 rpm-purified) | 188 |
| 4.49 | DSC thermogram of purified acrylated polyol ester prepolymer (sample: C3/80/400 rpm-purified) | 189 |
| 4.50 | DSC thermogram of purified acrylated polyol ester prepolymer (sample: C4/80/400 rpm-purified) | 190 |
| 4.51 | DSC thermogram of purified acrylated polyol ester prepolymer (sample: C5/80/400 rpm-purified) | 191 |
| 4.52 | DSC thermogram of purified prepolymers synthesized at 80.0°C with different amount catalyst (1.0, 2.0, 3.0, 4.0 or 5.0% catalyst) | 192 |
| 4.53 | Effect of different amount of catalyst used in prepolymer preparation on the glass transition temperature (T_g) and crystalline melting temperature (T_m) . Other reaction conditions: temperature (80.0°C), stirring rate (400 rpm) and reaction period (15 hours) | 193 |
| 4.54 | Effect of different amount of catalyst used in prepolymer preparation on the moisture. Other reaction conditions: temperature (80.0°C), stirring rate (400 rpm) and reaction period (15 hours) | 194 |
| 4.55 | FT-IR spectrum of UV cured film after 14 passes of UV radiation (prepolymer: C3/80/400 rpm-purified, monomer: HDDA, 1 pass = 0.600 J/cm ²) | 197 |
| 4.56 | FT-IR spectrum of UV cured film after 10 passes of UV radiation (prepolymer: C2/80/400 rpm-purified, monomer: TMPTA, 1 pass = 0.600 J/cm^2) | 198 |
| 4.57 | Effect of number of passes under UV radiation on pendulum hardness of UV cured film. Formulation: HDDA monomer with purified or unpurified prepolymers synthesized using 1.0% catalyst | 200 |
| 4.58 | Effect of number of passes under UV radiation on pendulum hardness of UV cured film. Formulation: HDDA monomer with purified or unpurified prepolymers synthesized using 2.0% catalyst | 200 |
| 4.59 | Effect of number of passes under UV radiation on pendulum hardness of UV cured film. Formulation: HDDA monomer with purified or unpurified prepolymers synthesized using 3.0% catalyst | 201 |

xxiii

| 4.60 | Effect of number of passes under UV radiation on pendulum hardness of UV cured film. Formulation: HDDA monomer with purified or unpurified prepolymers synthesized using 4.0% catalyst | 201 |
|------|--|-----|
| 4.61 | Effect of number of passes under UV radiation on pendulum hardness of UV cured film. Formulation: HDDA monomer with purified or unpurified prepolymers synthesized using 5.0% catalyst | 202 |
| 4.62 | Effect of number of passes under UV radiation on pendulum hardness of UV cured film. Formulation: HDDA monomer with unpurified prepolymers synthesized using 1.0, 2.0, 3.0, 4.0 or 5.0% catalyst | 203 |
| 4.63 | Effect of number of passes under UV radiation on pendulum hardness of UV cured film. Formulation: HDDA monomer with purified prepolymers synthesized using 1.0, 2.0, 3.0, 4.0 or 5.0% catalyst | 203 |
| 4.64 | Effect of number of passes under UV radiation on pendulum hardness of UV cured film. Formulation: TMPTA monomer with purified prepolymers synthesized using 1.0, 2.0, 3.0, 4.0 or 5.0% catalyst | 205 |
| 4.65 | Effect of different ratio of purified prepolymer and HDDA on pendulum hardness of UV cured film. Formulation: prepolymer synthesized using 2.0% catalyst and number of passes under UV: 10 passes (1 pass = 0.600 J/cm^2) | 207 |
| 4.66 | Effect of different ratio of purified prepolymer and TMPTA on pendulum hardness of UV cured film. Formulation: prepolymer synthesized using 2.0% catalyst and number of passes under UV: 10 passes (1 pass = 0.600 J/cm^2) | 208 |
| 4.67 | Scratch measurement of UV cured film for purified prepolymer with HDDA or TMPTA. Formulation: prepolymer synthesized using 1.0, 2.0, 3.0, 4.0 or 5.0% catalyst and number of passes under UV: 10 passes (1 pass = 0.600 J/cm^2) | 209 |
| 4.68 | Effect of different ratio of purified prepolymer and HDDA on scratch measurement of UV cured film. Formulation: prepolymer synthesized using 2.0% catalyst and number of passes under UV: 10 passes (1 pass = 0.600 J/cm^2) | 210 |
| 4.69 | Effect of different ratio of purified prepolymer and TMPTA on scratch measurement of UV cured film. Formulation: prepolymer synthesized using 2.0% catalyst and number of passes under UV: 10 passes (1 pass = 0.600 J/cm^2) | 210 |

xxiv

