PREFACE

In the name of God, the Most Beneficent and the Most Merciful

The research and development of a copolymer from of palm oil based macromer with MMA for dental application is a cooperative effort and depends on the contributions of several individuals and organizations. Sincerest gratitude is extended to my supervisor and co-supervisor, Professor Dr. Gan Seng Neon and Associate Professor Dr. Noor Hayaty Abu Kasim for their invaluable advice, support, constructive criticism and constant encouragement, striking a perfect balance between providing direction and encouraging independence.

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ABSTRACT

This dissertation describes the study using a specific palm kernel oil macromer, namely FA35 to modify the poly(methylmethacrylate) (PMMA) in attempt to enhance its properties of as a denture base polymer. This study is divided into two sections: (I) Characterization and copolymerization of FA35 macromer and methyl methacrylate (MMA), and (II) Evaluation of the copolymers as a denture base material. Copolymerization of macromer and MMA was carried out by solution and bulk processes. Both methods used benzoyl peroxide as initiator. This macromer-MMA copolymerization process was stable at 80°C for solution technique. Lower temperature was sufficient for bulk method which was from 60-70°C during the process of producing the pre-polymer syrup and 60°C for overnight curing. At the end of the reaction, the mixture was heated to 100°C for one hour to evaporate off residual monomer. Fourier Transform Infra Red (FTIR) analysis and thermal characterization of the copolymers confirmed that they contained repeating units from both macromer and MMA. Addition of cross-linking agent, ethylene(glycoldimethacrylate) or EGDMA did not significantly affect the T_g of the copolymers. Differential Scanning Calorimetry (DSC) analysis showed single value of T_g was obtained for each copolymer. Copolymers containing up to 20% w/w of macromer unit showed significantly lower water sorption. In addition, solubility of crosslinked copolymer (Group B) was relatively low and comparable with the solubility of the commercial resin. Mechanical test revealed that incorporation 5-10% w/w of macromer has significantly improved the impact and flexural strength of the PMMA, but further increase of macromer beyond 15% w/w progressively lowered the mechanical strength of copolymers. Visual inspection was performed to

determine type of fracture in the copolymers, from the two fragments resulting from the flexural test. Both broken fragments could be repositioned at the fractured line, presenting a smooth surface; hence the fractures were classified as brittle. Overall, the experimental copolymers which contained a noteworthy amount of non-petroleum based materials derived from palm oil increased the mechanical strength of acrylic resin.

ABSTRAK

Disertasi ini membincangkan penyelidikan penggunaan makromer daripada minyak kernel kelapa sawit, iaitu makromer FA35 untuk pengubahsuaian poli(metilmetakrilat) (PMMA) sebagai usaha untuk menambahbaik nilai PMMA sebagai bahan polimer berasaskan pergigian atau "denture base polymer". Kajian dibahagikan kepada dua bahagian, iaitu (I) Pencirian dan pengkopolimeran makromer FA35 dan metil metakrilat (MMA), dan (II) Penilaian kopolimer sebagai bahan polimer berasaskan pergigian. Pengkopolimeran makromer dan MMA telah dijalankan melalui teknik pengkopolimeran pukal dan larutan. Kedua-dua teknik ini menggunakan benzoil peroksida sebagai pemula tindak balas. Pengkopolimeran makromer-MMA adalah stabil pada suhu kira-kira 80°C untuk pengkopolimeran jenis larutan. Sebaliknya, suhu yang lebih rendah diperlukan bagi pengkopolimeran pukal iaitu pada 60-70°C dalam penghasilan sirap pra-polimer dan 60°C untuk proses 'curing' semalaman. Pada akhir tindak balas pengkopolimeran, kopolimer dipanaskan pada 100°C selama sejam bagi menghilangkan sisa monomer. Analisis Fourier Transform Infra Red (FTIR) dan analisis termal kopolimer membuktikan bahawa ia mengandungi unit ulangan daripada kedua-dua makromer dan MMA. Penambahan agen rangkai silang, etilene(glikoldimetakrilat) atau EGDMA tidak mengubah nilai T_g kopolimer dengan jelas. Walaubagaimanapun, analisis Differential Scanning Calorimetry (DSC) menunjukkan satu nilai T_g diperolehi bagi setiap kopolimer. Semua kopolimer yang mengandungi sehingga 20% w/w makromer menunjukkan nilai serapan air yang rendah secara relatifnya. Kadar keterlarutan kopolimer terangkai silang (Kumpulan B) adalah rendah secara relatif dan setanding dengan nilai keterlarutan polimer komersial. Analisis mekanikal

menunjukkan penggabungan makromer dengan rantai tak tepu ini telah meningkatkan kekuatan impak dan kelenturan (flexural) PMMA. Walaubagaimanapun, penambahan makromer melebihi 15% w/w merendahkan kadar kekuatan impak dan kelenturan kopolimer ini. Analisis mikroskopi dijalankan bagi menganalisis jenis retakan (fracture) daripada fragmen pecahan yang diperoleh dari ujian “flexural”. Kedua-dua fragmen tersebut didapati boleh disusun semula pada garis retakan dan menghasilkan permukaan yang licin; oleh yang demikian, retakan dikira sebagai “brittle fracture”. Keseluruhannya, kopolimer yang terhasil, yang mengandungi sejumlah bahan bukan-petroleum daripada kelapa sawit dapat mempertingkat kekuatan mekanikal resin akrilik.