# PREPARATION OF LOW MOLECULAR WEIGHT NATURAL RUBBER *VIA* PHOTOOXIDATION IN LATEX STATE

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# PREPARATION OF LOW MOLECULAR WEIGHT NATURAL RUBBER *VIA* PHOTOOXIDATION IN LATEX STATE

**by**

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**requirement for the Doctor of Philosophy**

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## DECLARATION

I declare that the content presented in this dissertation entitled "**PREPARATION OF LOW MOLECULAR WEIGHT NATURAL RUBBER *VIA* PHOTOOXIDATION IN LATEX STATE**" is my own work which was done at Universiti Sains Malaysia unless informed otherwise. This dissertation has not been previously submitted for any other degree.

Saya isytiharkan bahawa kandungan yang dibentangkan didalam disertasi ini bertajuk "**PENYEDIAAN GETAH ASLI RENDAH BERAT MOLEKUL MELALUI FOTOOKSIDASI DALAM KEADAAN LATEKS**" adalah hasil kerja saya dan dijalankan di Universiti Sains Malaysia kecuali dimaklumkan sebaliknya. Disertasi ini juga tidak pernah disertakan untuk ijazah lain sebelumnya.

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| | |
|---|---|
| AOP | Advanced oxidation process |
| $^{13}C$ | Carbon thirteen NMR |
| $CDCl_3$ | Deuterated chloroform |
| $C_q$ | Quaternary carbon |
| DEPT | Distortionless enhancement by polarization transfer |
| DPNR | Deproteinized natural rubber |
| DRC | Dry rubber content |
| ENR | Epoxidized natural rubber |
| ENR50 | Epoxidized natural rubber with 50% mole epoxidation |
| EVA | Ethylene vinyl acetate |
| FE-SEM | Field emission scanning electron microscopy |
| FTIR | Fourier transform infrared |
| GPC | Gel permeation chromatography |
| $^{1}H$ | Proton NMR |
| $H_2O_2$ | Hydrogen peroxide |
| HA | High ammonia natural rubber latex |
| HMQC | Heteronuclear multiple quantum coherence |
| HTNR | Hydroxyl telechelic liquid natural rubber |
| ICP-MS | Inductively coupled plasma mass spectrometry |
| IRCA | *Institute de Recherches sur la Caoutchouc* |
| $K_2S_2O_8$ | Potassium persulfate |
| LATZ | Low ammonia-tetramethyl thiuram disulphide/zinc oxide preserved NR latex |

| | |
|---|---|
| LENR | Liquid epoxidized natural rubber |
| LNR | Liquid natural rubber |
| MB | Methylene blue |
| Mn | Number average of molecular weight |
| NMR | Nuclear magnetic resonance |
| NR | Natural rubber |
| OH | Hydroxyl |
| PE | Polyethylene |
| RAFT | Reversible addition-fragmentation chain transfer |
| SDS | Sodium dodecyl sulfate |
| TEM | Transmision electron microscopy |
| Teric | Teric 16A30 |
| TGA | Thermogravimetric Analysis |
| $TiO_2$ | Titanium dioxide |
| TMS | Tetramethylsilane |
| TMTD | Tetramethylthiuram disulfide |
| TPNR | Thermoplastic natural rubber |
| TTIP | Titanium tetraisoperoxide |
| UV | Ultraviolet |
| XRD | X-ray diffraction spectroscopy |

## LIST OF SYMBOLS

| | |
|---|---|
| $^{o}$ | Degree |
| $^{o}C$ | Degree celcius |
| α | Alpha |
| β | Betha |
| µm | Micronmeter |
| ɵ | Theta |
| ω | Gamma |
| Phr | Part per hundred rubber |
| % | Percentage |
| Mn | Number average molecular weight |
| δ | Delta |
| nm | Nanometer |
| g/mol | Gram per mole |

**PENYEDIAAN GETAH ASLI RENDAH BERAT MOLEKUL MELALUI FOTOOKSIDASI DALAM KEADAAN LATEKS**

## ABSTRAK

Cahaya ultraungu (UV) telah digunakan untuk mengurai bahan organik, termasuklah getah asli (GA) terutama dalam pelarut organik. Kajian ini bertujuan untuk menyediakan getah asli cecair (GAC) menggunakan kaedah fotodegradasi di dalam lateks, dan mencirikan sifat fizikal dan kimia GAC yang diperolehi. Kecekapan tindakbalas telah ditentukan melalui pengurangan berat molekul dan kandungan gel. Struktur molekul GAC ditentukan melalui inframerah transformasi fourier (FTIR) dan resonans magnet nuklear (NMR). Sementara itu, mikroskop elektron imbasan (SEM) dan mikroskop elektron penghantaran (TEM) telah digunakan untuk mengenalpasti morfologi partikel lateks. Parameter tindakbalas seperti cahaya UV, suhu, hidrogen peroksida, masa tindak balas, kandungan getah kering (DRC) dan penstabil telah menunjukkan kesan bersinergi dan mempengaruhi keberkesanan tindakbalas. Surfaktan jenis anionik (SDS) didapati memberikan kestabilan yang lebih baik kepada lateks GA berbanding dengan surfaktan bukan ionik (Teric). Keupayaan zeta bagi lateks GA telah meningkat semasa tindakbalas photodegradasi, disumbangkan oleh caj negatif asid lemak. Kandungan fosfat yang mewakili asid lemak didapati meningkat dalam serum lateks, terhasil daripada penguraian fosfolipid apabila terdedah kepada UV dan agen pengoksidaan. Titanium dioksida ($TiO_2$) anatase telah disediakan melalui kaedah gel sol. Penyebaran $TiO_2$ kedalam lateks telah menunjukkan kesan pemangkinan terhadap fotodegradasi. Kehadiran metilen biru sebagai fotosensitif telah menurunkan sedikit berat molekul GAC. Pemutusan rantai GA semasa fotodegradasi berlaku pada ikatan C=C dan C-C. Struktur molekul GAC

adalah hampir sama dengan GA, tetapi terdapat peningkatan kumpulan hidroksil dan karbonil. Kumpulan-kumpulan fungsi ini terbentuk hasil dari pemutusan rantai GA. Tindakbalas fotodegradasi terhadap lateks getah asli terepoksida (ENR50) telah menunjukkan reaksi tindakbalas yang sama dengan lateks GA tanpa menjejaskan peratusan mol epoksi. Walau bagaimanapun, kehadiran $TiO_2$ tidak mempengaruhi tindakbalas, tetapi telah menyebabkan pembukaan gelang kumpulan epoksi kepada hidroksil.