DEVELOPMENT OF BIOPOLYMER FILLED NATURAL RUBBER LATEX-BASED COMPOSITE FILMS TO ENHANCE BIODEGRADATION

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Degree of Master of Philosophy

Department of Chemical and Process Engineering

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Thesis submitted in partial fulfillment of the requirements for the degree Master of Philosophy in Chemical and Process Engineering

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Declaration of candidate and supervisors

I, LPI Jayathilaka hereby declare that this is my own research study and this thesis does not incorporate without acknowledgment any material previously published submitted for a Degree or Diploma in any other university or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

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Abstract

Natural rubber latex (NRL) is the primary resource in developing thin film products including NRL gloves. These comprehensive applications of NRL are lead to the widespread formation of discarded solid material. Majority of these NRL-based product wastes are subjected to an incineration, landfill, or recycling. Recycling of NR waste is not usually effective owing to expensive and inadequate resources. Therefore the generation of heavy buildup of NR waste has become an immense social and environmental issue. Although NRL is biodegradable in nature, it has become more resistant to degradation, with the alteration of its properties to meet the processing requirements. To reduce the rising of NR waste problem, an attempt to enhance biodegradation process by coupling NR with degrading biomaterials has attracted more interest in research. Therefore this study is focused on evaluating applicability of corn-derivatives (cornstarch (CS), corn flour (CF), and corn grain (CG)) to develop a novel NRL-based biocomposite to enhance biodegradation as well as physico-mechanical, aging properties and compare with the conventional fillers.

Corn-derivatives were employed to enhance the biodegradability and physico-mechanical properties of NRL-based composite films by changing filler content from 0 to 50 phr. Significant alteration in physico-mechanical properties were noticed with the type of the filler and NR-CG demonstrate improved adherence with NR matrix. Moreover addition of CG in NRL-based composite films increased degradation; with exceeding 70% mineralization detected for 50 phr CG loading after 15 weeks of soil burial. The agreement among physico-mechanical properties and biodegradation restrict the CG loading in the NRL-based composite films to 20 phr by obtaining the specifications of NRL-based products. The results showed that NRL-based composite films with CG loading of 20 phr support to the ASTM D3578, the specification for producing NRL gloves; with 50% mineralization after 15 weeks of soil burial. A glove material was successfully produced with NRL-based compounds including CG 20 phr loading and further improvements of composite films can be done by using it with industrial glove manufacturing process.

Keywords: Biodegradation, corn, fillers, natural rubber latex, renewable biopolymers

Dedication

To my husband and to my parents

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LIST OF ABBREVIATIONS

Abbreviation	Description
BC	Bacterial Cellulose
ENR	Epoxidized Natural Rubber
$Ca(NO_3)_2$	Calcium Nitrate
$CaCO_3$	Calcium Carbonate
CPWP	Cassava Peel Waste Powder
CaS	Cassava Starch
CF	Corn Flour
CG	Corn Grain
CS	Corn Starch
DRC	Dry Rubber Content
MDF	Medium Density Fiberboards
FTIR	Fourier Transform Infra-Red
HA	High Ammonia
IPN	Interpenetrating Polymer Network
KP	Kanaf Powder
KOH No.	Potassium Hydroxide Number
LA	Low Ammonia
MCC	Microcrystalline Cellulose
MgO	Magnesium Oxide
MST	Mechanical Stability Time
NCC	Nanocrystalline Cellulose
NR	Natural Rubber

NR-g-CaS	Natural Rubber Compound Prepared by grafting with modified Cassava Starch
NR-CG	Corn Grain filled Natural Rubber latex-based composite films
NR-CG-20	Corn Grain filled Natural Rubber latex-based composite films with 20 phr Corn grain loading
NR-CF	Corn Flour filled Natural Rubber latex-based composite films
CR-CS	Corn Strach filled natural rubber latex-based composite films
NRL	Natural Rubber Latex
PbO	Lead (II) Oxide
phr	parts per hundred parts of rubber
PE	Polyethylene
PS	Polystyrene
PSN	Potato Starch Nanocrystals
PVC	Polyvinyl Chloride
RF	Resorcinol Formaldehyde
RHP	Rice Husk Powder
RS	Rice Starch
SS	Sago Starch
SEM	Scanning Electron Microscopy
SPL	Screw Pine Leaves
TGA	Thermogravimetric Analysis
TEM	Transmission Electron Microscope
TSC	Total Solids Content
UF	Urea-Formaldehyde

VFA No	Volatile Fatty Acid Number
XRD	X-Ray Diffraction
Zn	Zinc
ZnO	Zinc Oxide