REINFORCEMENT OF THERMOPLASTIC POLYURETHANE-NATURAL RUBBER BLEND WITH SURFACE MODIFIED COCONUT SHELL POWDER

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CERTIFICATE

Certified that the work embodied in the thesis entitled **"REINFORCEMENT OF THERMOPLASTIC POLYURETHANE-NATURAL RUBBER BLEND WITH SURFACE MODIFIED COCONUT SHELL POWDER"** has been carried out by **Aparna K Balan** under my supervision at the Department of Chemistry, University of Calicut, Kerala and further, the results embodied in this thesis, in full or in part have not been submitted previously elsewhere for the award of any other degree or diploma.

Calicut University **Dr. E. Purushothaman**

DECLARATION

I hereby declare that the matter embodied in the thesis entitled **"REINFORCEMENT OF THERMOPLASTIC POLYURETHANE-NATURAL RUBBER BLEND WITH SURFACE MODIFIED COCONUT SHELL POWDER"**, is based on the original research work carried out by me under the guidance of **Dr. E. Purushothaman**, Professor (Retd.), Department of Chemistry, University of Calicut, Kerala and the same has not been submitted elsewhere previously for the award of any other degree or diploma.

Calicut University **Aparna K Balan**

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Aparna K Balan

For

Unnikutty...

with love and tears...

GLOSSARY OF TERMS

ASTM	-	American society for testing and materials
CRI	-	Cure rate index
CSP	-	Coconut shell powder
D	-	Diffusion coefficient
DCP	-	Dicumyl peroxide
DSC	-	Differential scanning calorimetry
E_D	-	Activation energy of diffusion
E_P	-	Activation energy of permeation
FT-IR	-	Fourier transform infrared spectroscopy
GPTMS	-	Glycidyloxypropyltrimethoxy silane
ΔG	-	Gibbs free energy of sorption
ΔH_S	-	Enthalpy of sorption
IRM	-	Industrial reference materials
ISNR	-	Indian standard natural rubber
Ks	-	Equilibrium sorption constant
M_H	-	Maximum torque
M_L	-	Minimum torque
NR	-	Natural rubber
P	-	Permeability coefficient
PE	-	Polyethylene
Phr	-	Parts per hundred of rubber
PLA	-	Polylactic acid
PP	-	Polystyrene
PVA	-	Polyvinyl alcohol
PVC	-	Polyvinylchloride

Q_t	-	Moles of solvent sorbed by 100 g of polymer at time t
Q_∞	-	Moles of solvent sorbed by 100 g of polymer at equilibrium
R	-	Universal gas constant
R%	-	Swelling ratio
S	-	Sorption coefficient
SBR	-	Styrene butadiene rubber
ΔS	-	Entropy of sorption
SEM	-	Scanning electron microscopy
TEVS	-	Triethoxyvinylsilane
ts_2	-	Scorch time
t_{90}	-	Optimum cure time
T	-	Absolute temperature
T_g	-	Glass transition temperature
TG	-	Thermogravimetry
TPU	-	Thermoplastic polyurethane
V_r	-	Volume fraction
XRD	-	X-ray diffraction
ν	-	Crosslink density
χ	-	Interaction parameter

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PREFACE

The extreme desirable properties offered by polymers such as low cost, biological inertness, mechanical properties, persistence, *etc*., make them an inevitable material in day-today life of mankind. The imprudent use of non-biodegradable polymeric materials started altering the environment and atmosphere. Development of blends and composites provides new polymeric materials with excellent properties in an economical pathway. The search for sustainable, non-petroleum based, energy saving and environment friendly fillers led to natural fibres. Natural fibre filled polymer composites are fully or partially biodegradable in which the biodegradability of synthetic polymer component is enhanced by the incorporation of biodegradable filler material. The main aim of this investigation is to develop unmodified and modified coconut shell powder (CSP) reinforced TPU/NR (TN) blend-composites and to study their properties such as cure characteristics, mechanical properties, sorption properties, thermal analyses, aging studies and biodegradation studies. The thesis entitled ***"Reinforcement of thermoplastic polyurethane-natural rubber blend with surface modified coconut shell powder"*** is divided into seven chapters.

Chapter 1 gives a general introduction to polymer blends, composites, natural fibres, chemical treatments and related literature review. This chapter also highlights the scope and objectives of the present investigation. **Chapter 2** gives an account of the different materials and experimental methods used in the course of this study.

Chapter 3 contains the evaluation of silane treatments on CSP. The details of the development, cure characteristic studies and crosslink density evaluation of CSP filled TN blend-composites also are described here. **Chapter 4** presents the effect of silane treatment and filler loading on the mechanical and thermal properties of CSP filled TN blend-composites. Density, hardness, tensile strength, elongation at break and abrasion resistance were determined. **Chapter 5** deals with the transport studies of samples using aromatic solvents, petroleum fuels and industrial reference oils. The solvents used were benzene, toluene and xylene for aromatic solvents, petrol, kerosene and diesel for petroleum fuels and IRM 901, 902 and 903 for oils. Kinetic and thermodynamic parameters were determined for aromatic and petroleum fuels and % swelling for oils was determined with special references to the effect of filler loading, filler modifications, penetrant size and temperature. **Chapter 6** describes the aging and biodegradation of different CSP loaded TN blend-composites under various conditions. Aging studies include oil-aging, thermal aging and water-aging. Biodegradation analysis includes soil-burial test and morphological analysis. **Chapter 7** presents major conclusions arrived at touching upon future outlook of the research.

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