

TABLE OF CONTENTS

	Page no.
Title Page.....	i
Dedication	iii
Certificate of Approval.....	v
Certificate by the Supervisor.....	vii
Acknowledgements	ix
Declaration	xi
List of Symbols and Abbreviations.....	xiii
Abstract	xvii
Contents.....	xix
Chapter 1 Introduction	1-24
1.1 General Introduction.....	1
1.2 Different Nanofillers.....	3
1.2.1 Clay Based Fillers.....	3
1.2.1.1 Structure and Properties of Montmorillonite - Physical Characteristics.....	5
1.2.1.2 Structure and Properties of Sepiolite - Physical Characteristics.....	6
1.2.1.3 Clay Characterization.....	7
1.2.2 Carbon Based Nanofillers.....	9
1.2.2.1 Graphite.....	9
1.2.2.2 Carbon Nanotubes (CNT).....	9
1.2.2.3 Carbon Nanofiber (CNF).....	10
1.2.3 Surface Area of Nanofillers.....	11
1.3 Preparation of Nanocomposites.....	12
1.3.1 Solution Blending.....	12
1.3.2 Latex Compounding.....	13
1.3.3 Melt Intercalation.....	14
1.3.4 In-Situ Polymerization.....	14
1.4 Important Characterization Techniques for Nanocomposites.....	15
1.5 Health and Safety Aspects of Nanoparticles/Nanocomposites.....	15
1.6 Applications.....	16
1.7 Literature Survey of Polymer Nanocomposites- A Comprehensive Approach.....	16
1.7.1 Sepiolite Based Nanocomposites.....	16
1.7.2 Carbon Nanofiber Based Nanocomposites.....	17

1.7.3	Elastomer Nanocomposites Containing Carbon Black (CB)	18
1.7.4	Natural Rubber Nanocomposites	19
1.7.5	Theories/Modeling on Polymer-Filler Interaction in RNCs	20
1.7.6	Wear Resistance of Elastomer Nanocomposites	21
1.8	Scope and Objectives	22
Chapter 2	Experimental	25-46
2.1	Introduction	25
2.2	Materials	25
2.2.1	Rubber	25
2.2.2	Filler	25
2.2.3	Other Chemicals	27
2.3	Recipe	31
2.4	Preparation of Nanocomposites	33
2.4	Preparation of Nanocomposites Containing Carbon Black	34
2.6	Characterization of Nanocomposites	36
2.6.1	Mechanical Properties	36
2.6.1.1	Tensile Properties	36
2.6.1.2	Tear Strength	36
2.6.1.3	Hysteresis	36
2.6.1.4	Heat Build-up (HBU)	37
2.6.2	X-Ray Diffraction Studies (XRD)	37
2.6.3	Atomic Force Microscopy (AFM)	37
2.6.4	Transmission Electron Microscopy (TEM)	38
2.6.5	Dynamic Mechanical Thermal Analysis (DMTA)	38
2.6.6	Swelling Studies	38
2.6.7	Surface Energy	39
2.6.8	Cure Characterization	41
2.6.9	Rheological Studies	42
2.6.10	Abrasion Studies	42
2.6.10.1	Preparation of Rubber Specimen	42
2.6.10.2	Experimental Set-Up for Wear Investigation	43
2.6.10.3	Experimental Procedure for Investigations of Wear	44
2.6.10.4	Studies on Abraded Surface and Wear Debris	45
2.6.10.5	Image Analysis	45

Chapter 3	Influence of Different Nanofillers and their Dispersion Methods on Structure and Properties of Nanocomposites.....	47-74
3.1	Introduction.....	47
3.2	Results and Discussion	48
3.2.1	Mechanical Properties and Swelling Studies	48
3.2.1.1	Effect of Different Types of Fillers	48
3.2.1.2	Effect of Filler Loading	52
3.2.1.3	Effect of Various Dispersion Methods	55
3.2.2	Dynamic Mechanical Thermal Analysis (DMTA).....	60
3.2.3	Morphology-Property Correlations	63
3.2.3.1	X-Ray Diffraction Studies (XRD).....	63
3.2.3.2	Transmission Electron Microscopy (TEM).....	66
3.2.4	Mechanism	68
Chapter 4	Polymer-Filler Interaction in Nanocomposites: New Interface Area Function	75-98
4.1	Introduction.....	75
4.1.1	Theory Proposed in this Work.....	77
4.1.2	Derivation of the New Corrective Function.....	84
4.2	Results.....	87
4.3	Discussion.....	94
Chapter 5	Cure and Viscoelastic Properties of Nanocomposites	99-118
5.1	Introduction.....	99
5.2	Results and Discussion.....	100
5.2.1	Cure Behavior.....	100
5.2.2	Rheological Behavior	105
5.2.2.1	Viscoelastic Behavior of Uncured Nanocomposites.....	105
5.2.2.2	Viscoelastic Behavior of Cured Nanocomposites.....	110
5.2.2.3	Effect of Modification of Fillers	115
Chapter 6	Analysis of Wear Characteristics	119-144
6.1	Introduction.....	119
6.1.1	Taguchi Method	122
6.1.2	Design Factors and Response Variables	122
6.2	Results and Discussion	124

6.2.1	Taguchi Analysis of Wear Characteristics	124
6.2.2	Analysis of Variance (ANOVA)	127
6.2.3	Effect of Friction, Load and Viscoelasticity	128
6.2.4	Studies of Debris and Abraded Surface	133
Chapter 7A	Synergy in Carbon Black-filled Nanocomposites: Mechanical, Dynamic Mechanical Properties and Morphology.....	145-164
7A.1	Introduction.....	145
7A.2	Results and Discussion	147
7A.2.1	Effect of Carbon Black on Nanocomposites	147
7A.2.2	Effect of Carbon Black Loading on Nanocomposites.....	149
7A.2.3	Effect of Type of Carbon Black and its Loading	152
7A.2.4	Dynamic Mechanical Thermal Analysis	154
7A.2.5	Morphology - Property Relationships.....	158
Chapter 7B	Synergy in Carbon Black-filled Nanocomposites: Wear Resistance	165-180
7B.1	Introduction.....	165
7B.2	Results and Discussion	166
7B.2.1	Wear Resistance	166
7B.2.2	Rolling Resistance and Wet Skid Resistance.....	178
Chapter 8	Conclusions and Future Scope of Study.....	181-188
8.1	Summary and Conclusions	181
8.2	Major Contribution of this Work	187
8.3	Future Scope	188
References	189-202