DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously 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 acknowledgement is made in the text.

Also, I hereby grant to the University of Moratuwa the non-exclusive right to reproduce and distribute my thesis in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or in part in the future work (such as articles or books).

Signature: Date:

The above candidate has carried out research for the Master's thesis under my supervision.

Signature of the supervisor: Date:

Name of the Supervisor: Dr. (Mrs.) N.M.V.K. Liyanage

Abstract

Carboxylated acrylonitrile butadiene rubber (XNBR) is synthetic elastomer which inherent number of physical and chemical properties such as comparable barrier protection, good puncture and chemical resistance and high durability under storage.

Although that there is a problem associated with synthetic elastomers that they are typically not self-reinforcing elastomers. Therefore, reinforcing fillers are incorporated to improve the properties of the compounds.

Silica is extensively used for latex products. Nanofillers can impart more advanced properties to the final nanocomposite than micro fillers. Surface modification has been introduced to avoid the incompatibility between inorganic filler silica and organic XNBR matrix.

Role of surface modifiers in this study play dual role, as a capping agent: to control the size of nanoparticles & as a coupling agent: to develop compatibility between rubber and filler. Synthetic surface modifiers i.e. Polymethacrylic acid & Polymethacrylic acid ethyl hexyl acrylate and natural surface modifiers i.e. cellulose, collagen, chitosan & gelatin were used in this study.

The FTIR analysis confirm that the surface of nanosilica particles has been successfully modified with acrylic polymers, forming ester bonds between carboxylic groups of acrylic polymers and surface silanol groups of nanosilica. TGA confirms the successful surface modification resulting lower weight loss; indicating small number of free surface silanols groups are present on the silica surface. XRD analysis revealed the amorphous nature of unmodified and all modified nanosilica particles. SEM results help to monitor the particle shape, size and agglomerations of synthesized particles.

Evaluation of XNBR vulcanizate properties of micro silica, unmodified nanosilica, acrylic polymer modified nanosilica and natural polymer modified nanosilica filled vulcanizates was carried out. The results show that addition of small quantities of nanosilica causes an increase of mechanical properties of XNBR vulcanizates, while high filler loading of nanosilica appear to decrease the mechanical properties due to the aggregation of nanosilica particles. 2% PMAA and 2% cellulose modified nanosilica filled vulcanizates show balance strength with stretch & comfort properties for the glove manufacturing.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

XNBR	Carboxylated acrylonitrile butadiene rubber
PMAA	Polymethacrylic acid homopolymer
P(MAA-EHA)	Polymethacrylic acid ethylhexyl acrylate copolymer
PEG	Poly ethylene glycol
ZDEC	Zinc diethyldithiocarbamate
KOH	Potassium hydroxide
MAA	Methacrylic acid
FTIR	Fourier transform infrared
TGA	Thermogravimetric analysis
SEM	Scanning electron microscopy
ZnO	Zinc oxide
SP	Styrenated phenol
UMNS	Unmodified nanosilica
VN_3	Ball milled micro silica
MNS_{M1}	1% Polymethacrylic acid modified nanosilica
$MNS_{M1.5}$	1.5% Polymethacrylic acid modified nanosilica
MNS_{M2}	2% Polymethacrylic acid modified nanosilica
$MNS_{M2.5}$	2.5% Polymethacrylic acid modified nanosilica
$MNS_{M/E1}$	1% Polymethacrylic acid ethylhexyl acrylate modified nanosilica
$MNS_{M/E1.5}$	1.5%Polymethacrylic acid ethylhexyl acrylate modified nanosilica
$MNS_{M/E2}$	2% Polymethacrylic acid ethylhexyl acrylate modified nanosilica
*MNS_{M2}	2% Polymethacrylic acid modified commercial nanosilica
*$MNS_{M/E1.5}$	1.5%Polymethacrylic acid ethylhexyl acrylate modified commercial nanosilica
CE	Cellulose

CO	Collagen
CHO	Chitosan
GE	Gelatin
*MNS_{CE2}	2% cellulose modified nanosilica
*MNS_{CO2}	2% collagen modified nanosilica
*MNS_{CHO2}	2% chitosan modified nanosilica
*MNS_{GE2}	2% gelatin modified nanosilica
MMS_{CE2}	2% cellulose modified microsilica
MMS_{CO2}	2% collagen modified microsilica
MMS_{CHO2}	2% chitosan modified microsilica
MMS_{GE2}	2% gelatin modified microsilica
TS	Tensile strength
EB (%)	Elongation at break (%)
M300	Modulus at 300% elongation
TRS	Tear strength

ACKNOWLEDGEMENT

I wish to express my gratitude to my supervisor Dr. Kalyani Liyanage for the useful comments, remarks and guidance through the learning process of this master thesis. Furthermore, I would like to thank the research committee, Drs. Shantha Amarasinghe and Shantha M. Egodage for reviewing the research as well for the support on the way. Also, I greatly appreciate the assistance that I received from the staff of Department of Materials Science and Engineering. This includes Mr. M.A.P.C. Gunawardhana, Mr. R.R.P. Perera, and Mr. M.T.M.R. Jayaweera. Further, I would like to thank Departments of Civil Engineering and Chemical and Process Engineering at University of Moratuwa. Financial support by SRC/LT/2016/05 university research fund is greatly acknowledged.

I would like to thank my family and my loved ones, who have supported me throughout the entire process, both by keeping me harmonious and helping me putting pieces together. My warm hearted thanks to my friends Bhagya Gannoruwa and Nuwan Pannilawithana for their endless support and encouragement to achieve this goal.

Ramasinghe R.L.P.