SYNTHESIS OF NANO-SILICA FROM NATURAL RESOURCES AND APPLICATIONS

Wijenayaka Mudiyanselage Gayan Indika Priyadarshana

(108030F)

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Department of Chemical and Process Engineering

University of Moratuwa

Sri Lanka

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DECLARATION OF THE CANDIDATE AND SUPERVISOR

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Signature   Date:

Dr. W. A. P. Jeewantha Premaratne
Senior Lecturer,
Dept. Of Chemistry,
University of Kelaniya

Date:

Senior Lecturer,
Dept. Of Chemical and Process Engineering,
University of Moratuwa

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Abstract

A fast growing interest in applying nanomaterials in various fields has been observed in recent years. Nano-silica is one of the widely used nanomaterials in adhesives, fiber optic strands, sealants, surface coatings, defoamers, cosmetics, food additives, cement-based building materials and rubber composites. As an agricultural country, Sri Lanka produces tones of paddy husk annually. The benefit of using paddy husk has been identified in many applications. Paddy husk is burnt to generate energy resulting paddy husk ash (PHA). PHA is rich in silica (~60 %) and can be an economically viable raw material for the production of nano-silica through chemical method as a value added product. Also Sri Lanka has highly pure vein quartz (~98%) which can be converted in to nano-silica. In this research, nano-silica was prepared by precipitation method from both PHA and vein quartz and characterized by various analytical techniques. Scanning electron micrographs showed that nano-silica particles from both resources were in the agglomerated form (primary particle size 50-70 nm). The particle shape was found to be spherical. X-ray diffractograms showed a strong broad peak at 22 ° (2Θ) indicating that the obtained products from both starting materials were amorphous and also the Infrared spectra data supports the presence of hydrogen bonded silinol groups and siloxane groups in silica. Silica nanoparticles were surface modified by oleic acid and characterized using TGA and FT-IR techniques.

Reinforcing ability of the synthesized nano-silica from PHA (NS) in natural rubber composites (NRNS) was investigated. Cure characteristics and mechanical properties of the NRNS nanocomposites were compared with that of commercial grade silica (PS) reinforced natural rubber composites (NRPS) and it was found that NS has lower reinforcing ability compared to that of PS.

Key Words: PHA, Vein quartz, nano-silica, surface modification, nanocomposites

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LIST OF ABBREVIATIONS AND SYMBOLS

%	Percentage
°C	Degree Celsius
A	Angstron
ASTM	American Society for Testing and Materials
cm	Centimeter
CTAB	Cetyltrimethylammonium bromide
DI	Deionized
DTG	Derivative Thermogravimetric Analysis
EDX	Energy Dispersive X-ray analysis
FT-IR	Fourier Transform Infrared Spectroscopy
g	Gram
GSMB	Geological Survey and Mines Bureau
Hz	Hertz
ICDD	International Centre for Diffraction Data
IPPD	N-isopropyl-N′-phenyl-p-phenylenediamine
kV	Kilo Volts
M	Molarity
M_{100}	Modulus at 100% elongation
M_{300}	Modulus at 300% elongation
M_{500}	Modulus at 300% elongation
MBTS	Mercaptobenzthiazole disulfide
MDR	Moving Die Rheometer
mg	Milligram
M_H	Maximum Torque
M_H-M_L	Torque difference
ml	Milliliter
mm	Millimeter
Mt	Metric Tons
nm	Nanometer

NR	Natural Rubber
NRNS	Natural Rubber/ Nano-Silica (from PHA)
NRPS	Natural Rubber/ Commercial grade precipitated Silica
NS	Nano-Silica
PDF	Portable Document Format
PEG	Polyethyleneglycol
PHA	Paddy Husk Ash
phr	Parts per Hundred Rubber
PS	Precipitated Silica
PU	Polyurethane
PXRD	Powder X-ray Diffraction
rpm	Revolutions per minute
RSA	Rice Straw Ash
RSS	Ribbed smoked sheet
SDS	Sodium dodecyl sulfate
SEM	Scanning Electron Microscope
SiO_2	Silica
SLINTEC	Sri Lanka Institute of Nanotechnology
T_{C90}	Cure time
TEM	Transmission Electron Microscope
TEOS	Tetraethylorthosilicate
TGA	Thermo Gravimetric Analysis/ Analyzer
T_{s2}	Scorch time
USA	United State of America
wt%	Weight percentage
λ	Wavelength
μm	Micrometer