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SYNTHESIS OF NANO-SILICA FROM NATURAL RESOURCES AND APPLICATIONS

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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

TABLE OF CONTENT

DECLARATION.....	i
ACKNOWLEDGEMENT	ii
Abstract.....	iii
TABLE OF CONTENT	iv
LIST OF FIGURES	vii
LIST OF TABLES	x
LIST OF ABBREVIATIONS AND SYMBOLS	xi
CHAPTER 1	1
1. INTRODUCTION.....	1
1.1 Introduction to silica	1
1.1.1 Crystalline silica	2
1.1.2 None crystalline (amorphous) silica	4
(a) Continuous random network model	4
(b) Microcrystalline model	4
1.2 Nano-silica.....	5
1.3 Methods for synthesis of nano-silica.....	7
1.3.1 Paddy husk ash as a renewable resource.....	8
1.3.2 Vein quartz as an earth resource.....	11
1.4 Applications of nano-silica.....	13
1.4.1 Application of nano-silica as reinforcing filler in rubber composites.....	13
1.5 Research objectives.....	16
CHAPTER 2	17
2. LITERATURE REVIEW.....	17

2.1 Synthesis of nano-silica by various raw materials.....	17
2.2 Surface modification	21
2.3 Applications of nano-silica.....	22
CHAPTER 3	24
3. EXPERIMENTAL.....	24
3.1 Characterization Techniques	24
3.1.1 Fourier Transform Infrared Spectroscopy (FT-IR)	24
3.1.2 Powder X-ray Diffraction (PXRD).....	25
3.1.3 Thermo Gravimetric Analysis (TGA)	26
3.1.4 Particle Size Analysis	26
3.1.5 Scanning Electron Microscopy (SEM).....	28
3.1.6 Energy Dispersive X-ray Spectroscopy.....	29
3.1.7 Cure Characterization of rubber composites.....	29
3.1.8 Evaluation of mechanical properties of vulcanized rubber composites	30
(a) Tensile properties	30
(b) Hardness	31
3.2 Methodologies	31
3.2.1 Characterization of Paddy Husk.....	31
(a) Elemental and Thermal Analysis of Paddy Husk.....	31
(b) Ash Analysis of Paddy Husk	32
3.2.2 Characterization of Paddy Husk Ash.....	32
3.2.3 Characterization of vein quartz	32
3.2.4 Synthesis of nano-silica from PHA	32
3.2.5 Synthesis of nano-silica from vein quartz.....	33
3.2.6 Surface modification of nano-silica.....	33
3.2.7 Application of nano-silica in rubber composites as a filler	33

(a) Optimization of silane coupling agent for NRPS and NRNS composites.	34
(b) Cure characteristics and mechanical properties of NRPS and NRNS composites.....	37
4. RESULTS AND DISCUSSION	39
4.1 Characterization of Paddy Husk	39
(a) Elemental and Thermal Characterization of Paddy Husk	39
(b) Ash Analysis of Paddy Husk.....	42
4.2 Characterization of Paddy Husk Ash (PHA).....	42
4.3 Characterization of vein quartz.....	45
4.4 Synthesis of nano-silica from PHA.....	48
4.5 Synthesis of nano-silica from vein quartz	54
4.6 Surface modification of nano-silica	57
4.7 Application of nano-silica in rubber composites as a reinforcing filler.....	63
4.7.1 Characterization of commercial grade precipitated silica (PS).....	63
4.7.2 Optimization of the silane coupling agent for NRPS and NRNS composites	65
4.7.3 Effects of silica loading on cure characteristics and mechanical properties of NRPS and NRNS composites.....	72
(a) Cure characteristics.....	72
(b) Mechanical properties	77
CHAPTER 5	82
5. CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORKS.....	82
5.1 Conclusions	82
5.2 Recommendations for future works.....	83
REFERENCES:.....	84



LIST OF FIGURES

Figure 1. 1: Interrelationship between forms of silica.....	2
Figure 1. 2: Arrangement of Si and O atoms in crystalline silica.....	3
Figure 1. 3: Three-dimensional schematic diagram of crystalline silica structure	3
Figure 1. 4: Arrangement of Si and O atoms in non-crystalline (amorphous) silica	5
Figure 1. 5: Types of silanol groups exist on the silica surface.....	6
Figure 1. 6: Surface modification and functionalization of silica nanoparticles	6
Figure 1. 7: The paddy producing regions in Sri Lanka.....	10
Figure 1. 8: Vein quartz deposits of Sri Lanka	12
Figure 3. 1: Bruker Vertex 80, Fourier Transform Infrared Spectrophotometer	25
Figure 3. 2: D8 Focus X-ray powder diffractometer at.....	25
Figure 3. 3: TA Instruments SDTQ600.....	26
Figure 3. 4: Malvern Zetasizer analyzer nano ZS (size range, 0.6 nm – 6 μ m.....	27
Figure 3. 5: FRITSCH, ANALYSETTE 22 MicroTec plus laser particle size analyzer (size range, 0.08 μ m to 2,000 μ m).....	27
Figure 3. 6: HITACHI SU6600 Scanning Electron Microscope (SEM).....	28
Figure 3. 7: Moving Die Rheometer (MDR: Ektron, EKT- 2000S).....	29
Figure 3. 8: (a) Elastocon AB Specimen Cutting Press, EP 08 and (b) dumbbell shape specimen.....	30
Figure 3. 9: (a) Bareiss digitest hardness meter and (b) Test specimen for measure the hardness	31
Figure 3. 10: Haake Rheomix 600, laboratory scale Internal Mixer.....	35
Figure 3. 11: (a) Two-roll mill and (b) Hot press	35
Figure 4. 1: Paddy Husk sample used in this study.....	39
Figure 4. 2: Spectral image of paddy husk	40
Figure 4. 3: TGA/ DTG thermogram of paddy husk.....	41
Figure 4. 4: EDX Spectrometric data of PHA after burning at 700 $^{\circ}$ C.....	43
Figure 4. 5: SEM image of PHA after burning at 700 $^{\circ}$ C	44
Figure 4. 6: PXRD pattern of PHA after burning at 700 $^{\circ}$ C.....	44
Figure 4. 7: PXRD pattern for natural vein quartz (from GSMB, Sri Lanka).....	45



Figure 4. 8: FT-IR Spectrum of vein quartz (from GSMB, Sri Lanka)	47
Figure 4. 9: PXRD patterns of (a) silica prior to HCl acid treatment, (b) silica after acid treatment followed by a washing cycle, (c) nano-silica (PHA) and (d) nano-silica (standard)	49
Figure 4. 10: FT-IR Spectra of (a) nano-silica (PHA) and (b) nano-silica	50
Figure 4. 11: TGA and DTG thermograms of (a) silica prior to HCl acid treatment, (b) silica after acid treatment followed by a washing cycle, (c) nano-silica (PHA) and (d) nano-silica (standard)	52
Figure 4. 12: Scanning Electron Microscopic images of the nano-silica obtained from PHA	53
Figure 4. 13: Particle size distribution of nano-silica powder obtained from PHA	54
Figure 4. 14: FT-IR spectra of (a) vein quartz, (b) nano-silica (from vein quartz) and (c) nano-silica (standard)	55
Figure 4. 15: PXRD pattern of (a) vein quartz, (b) nano-silica prior to wash, (c) nano-silica (from vein quartz) and (d) nano-silica (standard)	56
Figure 4. 16: Scanning Electron Microscopic images of (a) ground vein quartz and (b and c) nano-silica (from vein quartz)	57
Figure 4. 17: FT-IR spectra of (a) oleic acid and (b) oleic acid modified nano-silica	58
Figure 4. 18: TGA and DTG thermograms of (a) nano-silica, (b) pure oleic acid and (c) nano-silica modified with oleic acid	60
Figure 4. 19: Particle size distribution of oleic acid modified nano-silica dispersion in different time intervals	61
Figure 4. 20: Transmission Electron Micrograph (TEM) of oleic acid modified silica nanoparticles	62
Figure 4. 21: Particle size distribution of commercial grade precipitated silica	63
Figure 4. 22: PXRD pattern of commercial grade precipitated silica	64
Figure 4. 23: FT-IR spectrum of commercial grade precipitated silica	64
Figure 4. 24: Variation of maximum torque and ($M_H - M_L$) in (a) NRPS and (b) NRNS composites against the addition of Si69	66

Figure 4. 25: Variation of scorch time and optimum cure time of (a) NRPS and (b) NRNS composites against the addition of Si69.....	67
Figure 4. 26: Variation of minimum torque of (a) NRPS and (b) NRNS composites against the addition of Si69.....	68
Figure 4. 27: Tensile modulus of (a) NRPS (b) NRNS composites as a function of Si69 content.....	70
Figure 4. 28: Tensile strength and hardness of (a) NRPS (b) NRNS composites as a function of Si69 content.....	71
Figure 4. 29: Vulcanization curves of NRPS and NRNS composites with different loadings of precipitated silica (PS) and nano-silica (NS).....	74
Figure 4. 30: Comparison of minimum torque of NRPS and NRNS composites.....	75
Figure 4. 31: Comparison of scorch time of NRPS and NRNS composites	76
Figure 4. 32: Comparison of optimum cure time of NRPS and NRNS composites.....	77
Figure 4. 33: Comparison of (a) 100 %, (b) 300 % and (c) 500 % modulus of NRPS and NRNS composites	78
Figure 4. 34: Comparison of tensile strength of NRPS and NRNS composites.....	79
Figure 4. 35: Comparison of hardness of NRPS and NRNS composites.....	80



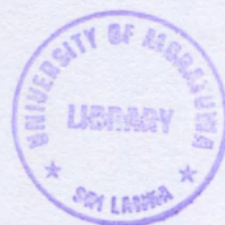
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LIST OF TABLES

Table 1. 1: Chemical composition of paddy husk ash.....	9
Table 3. 1: Compositions in parts per hundred rubbers (phr) of NRPS vulcanizate containing different concentrations of Si69.....	36
Table 3. 2: Compositions in parts per hundred rubbers (phr) of NRNS nanocomposite vulcanizate containing different concentrations of Si69	36
Table 3. 3: Compositions in phr of NRPS vulcanizate containing different loading of PS	37
Table 3. 4: Compositions in phr of NRNS nanocomposite vulcanizate containing different loading of NS	38
Table 4. 1: Elemental compositions of the paddy husk.....	40
Table 4. 2: Ash analysis data of Paddy Husk	42
Table 4. 3: Elemental composition of the PHA after burning at 700 °C.....	43
Table 4. 4: PXRD peaks obtained for vein quartz	46
Table 4. 5: EDX analysis data of vein quartz	46
Table 4. 6: Elemental analysis of the samples at different steps of the process	48
Table 4. 7: Elemental analysis of vein quartz and nano-silica (from Vein quartz)....	55
Table 4. 8: Cure characteristics of NRPS composites with different loadings of Si69.....	65
Table 4. 9: Cure characteristics of NRNS composites with different percentages of Si69	65
Table 4. 10: Cure characteristics of NRPS composites with different loadings of PS	72
Table 4. 11: Cure characteristics of NRNS composites with different loadings of NS.....	72



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LIST OF ABBREVIATIONS AND SYMBOLS

%	Percentage
°C	Degree Celsius
Å	Angstrom
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



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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



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