



**Effect of Surface Treatment of Kenaf Fiber with Zinc
Oxide Nanoparticles on the Properties of Unsaturated
Polyester/Kenaf Fiber Biocomposites**

by

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TABLE OF CONTENTS

	PAGE
DECLARATION OF THESIS	i
ACKNOWLEDGMENT	ii
TABLE OF CONTENTS	iii
LIST OF TABLES	viii
LIST OF FIGURES	xi
LIST OF ABBREVIATIONS	xx
ABSTRAK	xxi
ABSTRACT	xxiii
CHAPTER 1 : INTRODUCTION	1
1.1 Background	1
1.2 Problem Statement	7
1.3 Research Objective	11
1.4 Research Scope	12
CHAPTER 2 : LITERATURE REVIEW	14
2.1 Overview of Polymer Composite Materials	14
2.1.1 Kenaf Fibers	15
2.1.2 Properties of Kenaf Fiber Reinforced Composites	17
2.1.3 Mechanical Properties of Kenaf Fiber Based Polymer Composite	18
2.1.4 Thermal Properties of Kenaf Fiber Based Polymer Composite	20
2.2 Compositions and Natural Fibers Properties	20
2.2.1 Characteristics and Properties of Natural Fibers	23

2.2.2	Properties of Natural Fibers as a Filler in Polymer Composites	25
2.3	Applications of Natural Fiber Composites	27
2.4	Challenges of Natural Fiber as Reinforcement in Polymer Composite	28
2.4.1	Interphase of Biocomposite	29
2.4.2	Moisture Durability	30
2.5	Effect of Fiber Content on Moisture Absorption	33
2.6	Effects of Weathering Exposure on Degradation	33
2.7	Effect of Surface Treatment on Moisture Absorption	35
2.8	Physical Modification	36
2.9	Chemical Modification	37
2.9.1	Alkaline Treatment	37
2.9.2	Silane Treatment	38
2.9.3	Benzoylation Treatment	39
2.9.4	Acrylation Treatment	40
2.9.5	Polyolefin-g-MA Coupling Agents	40
2.9.6	Fatty Acids Treatment	41
2.10	Biological Modification	42
2.11	Nanotechnology Modification	43
2.11.1	Summary of Past Studies	44
2.11.2	Effect of Nanoparticles on Mechanical Behavior of Nanocomposites	45
2.11.3	Adhesion and Interaction of Nanoparticles	48
2.11.4	Effects of Particle Size, Particle/Matrix Interface Adhesion and Particle Loading on Mechanical Properties	50
2.12	Zinc Oxide Nanoparticles	53
2.12.1	Crystal Structure of ZnO	54
2.12.2	Impact of ZnO Morphology	55

2.13	Mechanism of Repellency Water Activity of ZnO-NPs	55
2.13.1	UV Illumination Effect	58
2.13.2	Surface Defects	61
2.14	Proposed Mechanisms of ZnO as Antibacterial Activity in Natural Fiber	62
2.15	Applications of Zinc Oxide	65
2.15.1	The Textile Industry	66
2.15.2	The Electronics and Electro Technology Industries	67
2.15.3	ZnO-NP as an Antibacterial Agent in Food	68
2.16	Polymer Matrix Composite (PMC)	69
2.16.1	Thermosetting Resin	69
2.16.2	Polyester	70
2.16.3	Curing Agent	73
2.16.3.1	Methyl Ethyl Ketone Peroxide (MEKP)	73
CHAPTER 3 : METHODOLOGY		75
3.1	Materials	75
3.2	Experimental	77
3.2.1	Kenaf Preparation	77
3.2.2	Treatment with Nano-ZnO	77
3.2.3	Composite Preparation	78
3.2.4	Weathering Exposure Study	79
3.2.5	Condition of Weathering	80
3.3	Testing and Characterization	82
3.3.1	Tensile Test	82
3.3.2	Flexural Tests	82
3.3.3	Scanning Electron Microscope (SEM)	82
3.3.4	X-Ray Diffraction (XRD) Analysis	83

3.3.5	Fourier Transform Infrared Spectroscopy (FT-IR)	83
3.3.6	Thermogravimetric Analysis (TGA)	84
3.3.7	Contact Angle Measurements	84
3.3.8	Transmission Electron Microscope (TEM)	84
3.3.9	Water Uptake Tests	85
CHAPTER 4 : RESULTS & DISCUSSION		86
4.1	Introduction	86
4.2	Pre- study of Unsaturated Polyester, Kenaf Fiber and Zinc Oxide Nanoparticale	86
4.2.1	Mechanical Properties	86
4.2.2	Thermo-Gravimetric Analysis (TGA)	89
4.2.3	Fourier Transform Infrared Spectroscopy (FTIR)	91
4.2.4	Scanning Electron Microscope (SEM) Observation	94
4.2.5	X-Ray Diffraction (XRD) Analysis	97
4.2.6	Transmission Electron Microscopy (TEM) Observation	99
4.3	Effect of Kenaf Fibre Layers on Properties of Kenaf/Unsaturated Polyester Composites	100
4.3.1	Mechanical Properties	100
4.3.2	Surface Morphology	107
4.3.3	Fourier Transform Infrared Spectroscopy (FTIR)	111
4.3.4	Thermal Properties	112
4.3.5	Water Uptake Test	116
4.4	Effect of Weathering Exposure on Properties of Kenaf/Unsaturated Polyester Composites	118
4.4.1	Mechanical Properties	119
4.4.2	Surface Morphology	128
4.4.3	Thermal Properties	134

4.4.4	Fourier Transform Infrared Spectroscopy (FTIR)	140
4.5	Effect of Treatment of Kenaf Fibre with Zinc Oxide Nanoparticles on Properties of Kenaf/Unsaturated Polyester Composites	143
4.5.1	Mechanism of Incorporation of Zinc Oxide Nanoparticle into Kenaf Fiber	144
4.5.2	Mechanical Properties	149
4.5.3	Surface Morphology	167
4.5.4	Fourier Transform Infrared Spectroscopy (FTIR)	171
4.5.5	Thermal Properties	174
4.5.6	Contact Angle (CA) Measurement	178
4.5.7	Water Uptake Test	182
4.6	Effect of Weathering Exposure on Properties of Unsaturated Polyester/Kenaf-Zinc Oxide Nanoparticles Composites	185
4.6.1	Mechanical Properties	185
4.6.2	Fourier Transform Infrared Spectroscopy (FTIR)	200
4.6.3	Surface Morphology	203
4.6.4	Thermal Properties	208
4.6.5	Application of Up/KF-ZnONPs Composite	212
	CHAPTER 5: CONCLUSION	213
5.1	Conclusion	213
5.2	Recommendations for Future Study	216
	PUBLICATIONS	220
	REFERENCES	218

LIST OF TABLES

		PAGE
Table 2.1	Mechanical Properties of Kenaf	18
Table 2.2	Comparison of different ZnO nanostructures used in photocatalytic applications	61
Table 2.3	Typical values for various properties of cured polyester, unfilled reinforced (Kresonm, 2012)	72
Table 3.1	Typical properties of unsaturated polyester resin	76
Table 3.2	Typical properties of ZnONPs	76
Table 3.3	Typical Properties of Methyl Ethyl Keton Peroxide	76
Table 3.4	Percentage of KF, UP, and MEKP	77
Table 3.5	Percentage of ZnONPs	78
Table 3.6	Conditions of Weathering in Kupang Gajah	80
Table 4.1	Mechanical properties of UP	88
Table 4.2	Mechanical properties of KF	89
Table 4.3	Weight loss summary of UP/KF composites	115
Table 4.4	Weight loss stages of UP/KF composites	116
Table 4.5	The decrement percentage difference in tensile strength before and after exposure to weathering	120
Table 4.6	The decrement percentage difference in tensile modulus before and after exposure to weathering	122

Table 4.7	The decrement percentage difference in elongation at break before and after exposure to weathering	124
Table 4.8	The decrement percentage difference in flexural strength before and after exposure to weathering	126
Table 4.9	The decrement percentage difference in flexural modulus before and after exposure to weathering	128
Table 4.10	Weight loss summary of UP/KF composites after exposure to weathering for 6 months in an interval of 1 month	140
Table 4.11	The percentage difference in tensile strength before and after treatment with ZnONPs	153
Table 4.12	The percentage difference in tensile modulus before and after treatment with ZnONPs	156
Table 4.13	The percentage difference in elongation at break before and after treatment with ZnONPs	159
Table 4.14	The percentage difference in flexural strength before and after treatment with ZnONPs	163
Table 4.15	The percentage difference in flexural modulus before and after treatment with ZnONPs	166
Table 4.16	Weight loss summary of UP/KF-ZnONPs for all layer arrangement	178
Table 4.17	The percentage difference in tensile strength of the weathered samples before and after treatment with ZnONPs	189
Table 4.18	The percentage difference in tensile modulus of the weathered samples before and after treatment with ZnONPs	191
Table 4.19	The percentage difference in elongation at break of the weathered samples before and after treatment with ZnONPs	194

Table 4.20	The percentage difference in flexural strength of the weathered samples before and after treatment with ZnONPs	197
Table 4.21	The percentage difference in flexural modulus of the weathered samples before and after treatment with ZnONPs	200
Table 4.22	Weight loss summary of UP/KF-ZnONPs for all layer arrangement after exposure to weathering for 6 months in an interval of 1 month	212

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LIST OF FIGURES

	PAGE
Figure 2.1 Subdivision of Natural Fibers Based on Origin, Adapted from (Liua et al., 2012)	21
Figure 2.2 Structure of Bio-fiber (Liua et al., 2012)	22
Figure 2.3 Cell Wall Polymers Responsible for the Properties of Lignocellulosics (Azwa et al., 2013)	23
Figure 2.4 Free Water and Bound Water in Polymer Matrix (Azwa et al., 2013)	32
Figure 2.5 Effect of Water on Fiber-Matrix Interface (Azwa et al., 2013)	32
Figure 2.6 UV Degradation of Natural Fiber/Polymer Composite and Its Components (Azwa et al., 2013)	35
Figure 2.7 Mechanism of photocatalysis of ZnO atom (Ahmed et al., 2010)	59
Figure 2.8 Worldwide consumption of zinc oxide (Kołodziejczak-Radzimska & Jesionowski., 2014)	65
Figure 2.9 Schematic representation all the application of ZnO (Kołodziejczak-Radzimska & Jesionowski., 2014)	66
Figure 2.10 Chemical Structure of UP	73
Figure 2.11 Chemical Structure of MEKP	74
Figure 3.1 Fabrication of composites	79
Figure 3.2 Flow chart Process of fabrication of composites	81
Figure 4.1 TGA profiles of UP and KF	90

Figure 4.2	The derivative weight loss curves of UP and KF	90
Figure 4.3	FT-IR spectrum of KF	92
Figure 4.4	FT-IR spectrum of UP	93
Figure 4.5	FT-IR spectrum of ZnONPs	94
Figure 4.6	SEM image of KF prior to composite process	95
Figure 4.7	SEM image of UP prior to composite process	95
Figure 4.8	FESEM images of ZnONPs: (a) with no measurement and (b) with measurement	97
Figure 4.9	XRD pattern of KF	98
Figure 4.10	XRD pattern of the ZnONPs	99
Figure 4.11	TEM images of ZnONPs	100
Figure 4.12	SEM micrograph of UP/KF composite with 4 layers of KF	101
Figure 4.13	Tensile strength of UP/KF composites of 0 layers, 1 layer, 2 layers, 3 layers and 4 layers of KF	102
Figure 4.14	Tensile modulus of UP/KF composites of 0 layers, 1 layer, 2 layers, 3 layers and 4 layers of KF	103
Figure 4.15	The elongation at break of UP/KF composites for 0 layer, 1 layer, 2 layers, 3 layers and 4 layers of KF	104
Figure 4.16	Flexural strength of composites for 0 layer, 1 layer, 2 layers, 3 layers and 4 layers of KF	105
Figure 4.17	Flexural modulus of UP/KF composites for 0 layer, 1 layer, 2 layers, 3 layers and 4 layers of KF	106
Figure 4.18	SEM micrographs of UP/KF composite with 1 layer of KF	107
Figure 4.19	SEM micrographs of UP/KF composite with 2 layers of KF	108

Figure 4.20	SEM micrographs of UP/KF composite with 3 layers of KF	109
Figure 4.21	SEM micrographs of UP/KF composite with 4 layers of KF	110
Figure 4.22	FTIR spectra of UP/KF specimens composite of 1, 2, 3, 4 layers arrangement	112
Figure 4.23	TGA curves of UP/KF composites with different layers of KF	114
Figure 4.24	DTG curves of UP/KF composites with different layers of KF	116
Figure 4.25	Water uptake test of UP/KF composites with different layer	118
Figure 4.26	The tensile strength of UP/KF composites with different layers after exposure to weathering	120
Figure 4.27	The tensile modulus of UP/KF composites with different layers after exposure to weathering	121
Figure 4.28	The break elongation of UP/KF composites with different layers after exposure to weathering	124
Figure 4.29	The flexural strength of UP/KF composites with different layers after exposure to weathering	125
Figure 4.30	The flexural modulus of UP/KF composites with different layers after exposure to weathering	127
Figure 4.31	SEM micrographs of UP/KF composite with 1 layer of KF after exposure to weathering for: (a) 1 month, (b) 2 months, (c) 3 months, (d) 4 months, (e) 5 months, (f) 6 months	130
Figure 4.32	SEM micrographs of UP/KF composite with 2 layers of KF after exposure to weathering for: (a) 1 month, (b) 2 months, (c) 3 months, (d) 4 months, (e) 5 months, (f) 6 months	131

Figure 4.33	SEM micrographs of UP/KF composite with 3 layers of KF after exposure to weathering for: (a) 1 month, (b) 2 months, (c) 3 months, (d) 4 months, (e) 5 months, (f) 6 months	132
Figure 4.34	SEM micrographs of UP/KF composite with 4 layers of KF after exposure to weathering for: (a) 1 month, (b) 2 months, (c) 3 months, (d) 4 months, (e) 5 months, (f) 6 months	133
Figure 4.35	TGA curves of UP/KF composites with 1 layer of KF after exposure to weathering for 1- 6 months	136
Figure 4.36	DTG curves of UP/KF composites with 1 layer of KF after exposure to weathering for 1- 6 months	136
Figure 4.37	TGA curves of UP/KF composites with 2 layers of KF after exposure to weathering for 1- 6 months	137
Figure 4.38	DTG curves of UP/KF composites with 2 layers of KF after exposure to weathering for 1- 6 months	137
Figure 4.39	TGA curves of UP/KF composites with 3 layers of KF after exposure to weathering for 1- 6 months	138
Figure 4.40	DTG curves of UP/KF composites with 3 layers of KF after exposure to weathering for 1- 6 months	138
Figure 4.41	TGA curves of UP/KF composites with 4 layers of KF after exposure to weathering for 1- 6 months	139
Figure 4.42	DTG curves of UP/KF composites with 4 layers of KF after exposure to weathering for 1-6 months	139
Figure 4.43	FTIR spectra of UP/KF composites with different layers of KF after exposure to weathering for 2 months	142
Figure 4.44	FTIR spectra of UP/KF composites with different layers of KF after exposure to weathering for 4 months	142

Figure 4.45	FTIR spectra of UP/KF composites with different layers of KF after exposure to weathering for 6 months	143
Figure 4.46	Illustration on proposed reaction of KF,ZnONPs with UP	146
Figure 4.47	Photoactivity of ZnONPs on components of UP/KF composite	147
Figure 4.48	Principle of photocatalysis (Ahmed et al., 2010)	149
Figure 4.49	Tensile strength of the fabricated ZnONPs-treated and untreated UP/KF composites	152
Figure 4.50	SEM micrographs off KF-ZnONPs with 4 layers of KF after treatment with 2% of ZnONPs	152
Figure 4.51	The tensile modules of the fabricated ZnONPs-treated UP/KF composites	155
Figure 4.52	The elongation at break of the fabricated ZnONPs-treated and untreated UP/KF composites	158
Figure 4.53	Flexural strength of the fabricated ZnONPs-treated and untreated UP/KF composites	161
Figure 4.54	Flexural modulus of the fabricated ZnONPs-treated and untreated UP/KF composites	165
Figure 4.55	SEM micrographs of KF-ZnONPs with 4 layers of KF after treatment with different percentage of ZnONPs: (a) 1%, (b) 2%, (c) 3%, (d) 4%, (e) 5%	169
Figure 4.56	SEM micrographs of UP/KF-ZnONPs composites after treatment with 1% percentage of ZnONPs: (a) 1 layer, (b) 2 layers, (c) 3 layers, (d) 4 layers of KF	170
Figure 4.57	SEM micrographs of UP/KF-ZnONPs composites after treatment with 2% percentage of ZnONPs: (a) KF, (b) 1 layer, (c) 2 layers, (d) 3 layers, (e) 4 layers	171

Figure 4.58	FTIR spectra of UP/KF-ZnONPs composites after treatment with 1% percentage of ZnONPs with 1, 2, 3, 4 layers arrangement	173
Figure 4.59	FTIR spectra of UP/KF-ZnONPs composites after treatment with 2% percentage of ZnONPs with 1, 2, 3, 4 layers arrangement	173
Figure 4.60	TGA curves of UP/KF-ZnONPs composites for all layer arrangement with 1% treatment with ZnONPs	176
Figure 4.61	DTG curves of UP/KF-ZnONPs composites for all layer arrangement with 1% treatment with ZnONPs	176
Figure 4.62	TGA curves of UP/KF-ZnONPs composites for all layer arrangement with 2% treatment with ZnONPs	177
Figure 4.63	DTG curves of UP/KF-ZnONPs composites for all layer arrangement with 2% treatment with ZnONPs	177
Figure 4.64	Micrograph images of water dropping of KF with different percentage of ZnONPs: (a) 0%, (b) 1%, (c) 2%, (d) 3%, (e) 4%, (f) 5%	181
Figure 4.65	Water uptake test of UP/KF-ZnONPs composites for 1 layer of KF with different ZnONPs treatment percentage	183
Figure 4.66	Water uptake test of UP/KF-ZnONPs composites for 2 layers of KF with different ZnONPs treatment percentage	183
Figure 4.67	Water uptake test of UP/KF-ZnONPs composites for 3 layers of KF with different ZnONPs treatment percentage	184
Figure 4.68	Water uptake test of UP/KF-ZnONPs composites for 4 layers of KF with different ZnONPs treatment percentage	184

Figure 4.69	The tensile strength of UP/KF-ZnONPs composites with different layers and 1% treatment with ZnONPs after exposure to weathering	187
Figure 4.70	The tensile strength of UP/KF-ZnONPs composites with different layers and 2% treatment with ZnONPs after exposure to weathering	188
Figure 4.71	The tensile modulus of UP/KF-ZnONPs composites with different layers and 1% treatment with ZnONPs after exposure to weathering	190
Figure 4.72	The tensile modulus of UP/KF-ZnONPs composites with different layers and 2% treatment with ZnONPs after exposure to weathering	190
Figure 4.73	The elongation at break of UP/KF-ZnONPs composites with different layers and 1% treatment with ZnONPs after exposure to weathering	192
Figure 4.74	The elongation at break of UP/KF-ZnONPs composites with different layers and 2% treatment with ZnONPs after exposure to weathering	193
Figure 4.75	The flexural strength of UP/KF-ZnONPs composites with different layers and 1% treatment with ZnONPs after exposure to weathering	196
Figure 4.76	The flexural strength of UP/KF-ZnONPs composites with different layers and 2% treatment with ZnONPs after exposure to weathering	196
Figure 4.77	The flexural modulus of UP/KF-ZnONPs composites with different layers and 1% treatment with ZnONPs after exposure to weathering	198

Figure 4.78	The flexural modulus of UP/KF-ZnONPs composites with different layers and 2% treatment with ZnONPs after exposure to weathering	199
Figure 4.97	FTIR spectra of UP/KF-ZnONPs composites with different layers of KF treated with 1% of ZnONPs after exposure to weathering for 6 months	202
Figure 4.80	FTIR spectra of UP/KF-ZnONPs composites with different layers of KF treated with 2% of ZnONPs after exposure to weathering for 6 months	202
Figure 4.81	SEM micrographs of UP/KF-ZnONPs composite treated with 1% ZnONPs for 1 layer of KF after exposure to weathering for: (a) 2 months, (b) 4 months, (c) 6 months and UP/KF-ZnONPs composite treated with 2% ZnONPs for 1 layer of KF after exposure to weathering for: (d) 2 months, (e) 4 months, (f) 6 months	204
Figure 4.82	SEM micrographs of UP/KF-ZnONPs composite treated with 1% ZnONPs for 2 layers of KF after exposure to weathering for: (a) 2 months, (b) 4 months, (c) 6 months and UP/KF-ZnONPs composite treated with 2% ZnONPs for 2 layers of KF after exposure to weathering for: (d) 2 months, (e) 4 months, (f) 6 months	205
Figure 4.83	SEM micrographs of UP/KF-ZnONPs composite treated with 1% ZnONPs for 3 layers of KF after exposure to weathering for: (a) 2 months, (b) 4 months, (c) 6 months and UP/KF-ZnONPs composite treated with 2% ZnONPs for 3 layers of KF after exposure to weathering for: (d) 2 months, (e) 4 months, (f) 6 months	206

Figure 4.84	SEM micrographs of UP/KF-ZnONPs composite treated with 1% ZnONPs for 4 layers of KF after exposure to weathering for: (a) 2 months, (b) 4 months, (c) 6 months and UP/KF-ZnONPs composite treated with 2% ZnONPs for 4 layers of KF after exposure to weathering for: (d) 2 months, (e) 4 months, (f) 6 months	207
Figure 4.85	TGA curves of UP/KF-ZnONPs composites with different layers of KF treated with 1% of ZnONPs after exposure to weathering for 6 months	210
Figure 4.86	DTG curves of UP/KF-ZnONPs composites with different layers of KF treated with 1% of ZnONPs after exposure to weathering for 6 months	210
Figure 4.87	TGA curves of UP/KF-ZnONPs composites with different layers of KF treated with 2% of ZnONPs after exposure to weathering for 6 months	211
Figure 4.88	DTG curves of UP/KF-ZnONPs composites with different layers of KF treated with 2% of ZnONPs after exposure to weathering for 6 months	211

LIST OF ABBREVIATIONS

CA	Contact Angle
FTIR	Fourier Transform Infrared Spectroscopy
KF	Kenaf fiber
SEM	Scanning Electron Microscops
TEM	Transmission Electron Microscopy
TGA	Thermo-Gravimetric Analysis
UP	Unsaturated Polyester
UP/KF	Unsaturated Polyester composite with Kenaf Fiber
XRD	X-Ray Diffraction
ZnONPs	Zinc Oxide Nano-Particles

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Kesan Rawatan Permukaan Gentian Kenaf dan Zarah Nano Zink Oksida Terhadap Sifat Biokomposit Poliester Tak Tepu/Gentian Kenaf Biokomposit

ABSTRAK

Keperluan peningkatan bahan-bahan dengan ciri khas telah membawa kepada pelbagai jenis penemuan yang baru, antara bahan baru yang mempunyai ciri khas dan fungsi adalah bahan komposit. Oleh itu, kajian ini menyatakan rawatan permukaan zarah nano zink kedalam komposit poliester tak tepu/kenaf (UP/KF-ZnONPs). Komposit UP/KF-ZnONPs telah direka menggunakan kaedah proses lapisan menggunakan tangan. Pada awalnya, komposit poliester tak tepu/kenaf (UP/KF) mengandungi 1 hingga 4 lapisan gentian kenaf (bersamaan 10 hingga 40 peratus w/w% KF) telah disediakan untuk mengkaji kesan lapisan KF terhadap komposit UP. Komposit ini dibandingkan dengan sistem kawalan yang mengandungi poliester tak tepu (UP) sahaja. Sifat komposit ini telah dinilai dengan menggunakan sifat mekanikal (kekuatan tegangan, modulus tegangan, kekuatan lenturan, modulus lenturan dan pemanjangan pada takat putus), morfologi (SEM), struktur kimia (FTIR), sifat termal (TGA) dan ujian pengambilan air. Hal ini menunjukkan komposit dengan 4 lapisan KF mengandungi kekuatan tegangan yang tinggi berbanding lapisan yang lain. Hasil daripada ujian mekanikal, gentian kenaf dapat meningkatkan sifat mekanikal terhadap komposit. Selain itu, komposit UP/KF dapat meningkatkan kestabilan termal dengan penambahan lapisan KF dari 1 hingga 4 lapisan. Analisis SEM menunjukkan terdapat banyak gentian ditarik keluar melalui komposit daripada 1 lapisan ke 4 lapisan komposit gentian. Ujian pengambilan air mendedahkan bahawa pengambilan air bertambah dengan beban lapisan KF dan tempoh rendaman sehingga pengambilan air berkurangan hampir selepas 3 minggu dari tempoh ujian. Di samping itu, komposit ini didedahkan di luar selama 6 bulan berturut-turut dalam tempoh sebulan untuk mengkaji kesan cuaca dan keupayaan komposit untuk bertahan dengan keadaan cuaca. Sifat mekanikal (kekuatan tegangan, modulus tegangan, kekuatan lenturan, modulus lenturan dan pemanjangan pada takat putus) telah dikenalpasti. Tambahan pula, FTIR analisis spektrum dan TGA juga SEM telah dijalankan. Walaubagaimanapun, sifat mekanikal terhadap komposit semakin berkurang selepas bulan pertama didedahkan kepada cuaca. Hasil daripada sifat mekanikal jelas menunjukkan gentian semulajadi dan kompositnya tidak berupaya untuk bertahan dalam keadaan alam sekitar kerana ianya mempunyai tahap kelembapan yang kurang, ketidaksesuaian dengan matrik polimer dan pengambilan air yang tinggi. Berdasarkan ciri-ciri pengambilan air yang tinggi (dimana telah disahkan oleh analisis FTIR), terdapat ruang kosong dan tidak melekat diantara gentian dan matrik dimana ia mengurangkan sifat mekanikal bagi komposit seperti kekuatan lenturan dan modulus lenturan, ia disokong oleh keputusan SEM. Bagi menyelesaikan masalah ini, penggabungan KF dengan ZnONPs telah dilakukan. KF telah dirawat dan dilaksanakan dengan menggunakan 5 jenis larutan ZnONPs, contohnya 1%, 2%, 3%, 4%, dan 5 wt%. Sifat-sifat komposit UP/KF-ZnONPs telah dinilai dengan menggunakan sifat mekanikal (kekuatan tegangan, modulus tegangan, kekuatan lenturan, modulus lenturan dan pemanjangan pada takat putus), morfologi (SEM), struktur kimia (FTIR), sifat termal (TGA), pengukuran sudut hubungan dan ujian pengambilan air. Komposit UP/KF-ZnONPs dengan kandungan 2% ZnONPs mempunyai sifat mekanikal

yang amat stabil dengan sifat kekenyalan yang sederhana dibandingkan sistem ZnONPs. Dengan kehadiran ZnONPs didalam komposit ianya dapat disahkan oleh FTIR dan bagi keupayaan termal pula ia dapat ditingkatkan dengan penggabungan ZnONPs. Pengukuran sudut hubungan dengan menggunakan keupayaan penolakkan air menunjukkan KF menjadi lebih hidrofobik selepas rawatan permukaan dengan ZnONPs, ianya amat baik dalam mencapai prestasi yang tinggi bagi komposit untuk mengelakkan daripada degradasi komposit.

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Effect of Surface treatment of Kenaf Fiber with Zinc Oxide Nanoparticles on the Properties of Unsaturated Polyester/Kenaf Fiber Biocomposites

ABSTRACT

Increasing need for materials with special features have brought various new inventions, one of the most promising hope for new material with special features and functionalities is composites materials. Thus, this study reports the surface treatment of zinc nanoparticles into kenaf/polyester polymer composite (UP/KF-ZnONPs). UP/KF-ZnONPs composites were fabricated by using hand lay-up process. Initially, composites of unsaturated polyester/ kenaf (UP/KF) containing 1 layer up to 4 layers of kenaf fiber (equal to 10% up to 40% w/w% of KF) were prepared to study the effect of KF layers on UP composite. These composites were compared with a control system containing unsaturated polyester (UP) only. The properties of these composites were evaluated in term of mechanical properties (tensile strength, tensile modulus, flexural strength, flexural modulus and elongation at break), morphology (SEM), chemical structure (FTIR), thermal properties (TGA) and water uptake test. It was shown that the composite with 4 layers of KF showed the highest tensile strength as compared to that of other layers into the composites. The results of the mechanical tests suggest that kenaf fibers improved the mechanical properties of the composites. Moreover, the thermal stability of UP/KF composites was improved with increasing the layers of KF from 1 to 4 layers. SEM analysis showed that more fiber pull-outs are observed in higher loading of KF in composites from the 1 layer to 4 layers fiber composite. The water uptake test revealed the water uptake increased with increasing loading of KF layer and the period of immersion until it has been saturated almost after 3 weeks of the test period. In addition, these composites were exposed outdoor for consecutive six months with interval of 1 month. To study the effect of weathering conditions and the capability of the composites to withstand weather conditions. The mechanical properties (tensile strength, tensile modulus, flexural strength, flexural modulus and elongation at break) were observed. In addition, FTIR spectra analysis and TGA as well as SEM were conducted. Unfortunately, the mechanical properties of the composites started to decrease constantly after the first month of exposure to weathering conditions. From the mechanical properties result obtained it clearly seen that natural fiber and their composites are not able to withstand the environmental condition because they have poor wettability, incompatibility with polymeric matrices and high water uptake. Due to the high water uptake properties (which was confirmed by FTIR analysis), there are formation of voids in interfacial adhesion between fiber and matrix which can reduce the mechanical properties of composite such as flexural strength or flexural modulus this clearly supported by SEM results. To overcome this problem, the surface treatment of KF with ZnONPs was carried out. KF was treated with 5 different percentage of ZnONPs, i.e. 1%, 2%, 3%, 4%, and 5 wt%. The properties of UP/KF-ZnONPs composites were evaluated in term of mechanical properties (tensile strength, tensile modulus, flexural strength, flexural modulus and elongation at break), morphology (SEM), chemical structure (FTIR), thermal properties (TGA), contact angle measurement and water uptake test. UP/KF-ZnONPs composites with 2% of ZnONPs had the most stable mechanical properties with

moderate elastic properties compared with that of the remaining ZnO NPs systems. The presence of ZnONPs in the composites was confirmed by FTIR analysis and the thermal stability was improved by ZnONPs surface treatment. The water repellent capability, which was confirmed by contact angle measurement that showed that KF became more hydrophobic after surface treatment with ZnONPs, is good enough to achieve the high performance of the composite to prevent the degradation of the composite.

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