AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
DESIGN AND PRODUCTION ENGINEERING DEPARTMENT

Effect of Natural Fibers on Properties of Polymeric Composites

A thesis Submitted in partial fulfillment of the requirements of the degree of M.Sc. in mechanical Engineering

Submitted By

Mohammed Sameh Ahmed Ahmed

Bachelor of Science in Mechanical Engineering

Faculty of Engineering, Ain Shams University, 2010

Under Supervision of

Prof. Dr. M. H. Abd EL-Latif

Dr. Ramadan B. M. El-Gamsy

Dr. Ayman A. Abd El-Wehab

Faculty of Engineering - Ain shams University

Cairo 2019

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Thesis summary

Due to environmental pollution aspects and increase of harmful emissions around us which caused from using non-natural compounds in the field of industry, many different health and environmental problems have been resulted. Natural fibers became good candidates to invade the field of industry as an alternative to synthetic fibers due to low cost, low density and good properties compared with other fibers.

In this research, the effect of natural fiber on polymeric composites was studied; banana Pseudo stem BPS fiber was selected due high availability (3.5 million banana trees /year) and non-exploitation of it, and select acrynitrile butadiene styrene (ABS) due to its applications in automotive industry and 3D printing and increase in market share forecasting till 2020.

Firstly, Banana Pseudo Stem (BPS) fibers were extracted by fiber extractor machine then crushed by crushing machine and sieved to (short size fibers with average size 0.21mm) by three manual hand sieves followed by alkaline treatment (5% NaOH – 1% HCL). Moisture content test was done for fiber before and after treatment, the treated fibers were dried in oven at 80^{o}C for 48 hrs.

Secondly, ABS granules were dried in oven at 80^{o}C for 48 hrs. **Thirdly**, BPS fiber with different mass fraction (0-10-20-30 %) were mixed with ABS granules at 180^{o}C by thermal mixer machine, then the BPS/ ABS mixture was crushed by crushing machine followed by injection molding of BPS/ABS crushed granules at temperatures of (150^{o}C and 220^{o}C), pressure equal to 60 bar and the injection and cooling times are 10 and 25 seconds respectively.

The BPS fibers under investigation were characterized using physical and thermal analysis.

The composite specimens with different fiber weight percentage were characterized through tensile, impact, MFI, and dimensional stability tests, beside SEM, TGA and DSC analysis.

Acknowledgement

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Nomenclature

Symbols

T_g	Glass transition temperature	[^{o} C]
T_m	Melting temperature	[^{o} C]
σ	Tensile load	[MPa]
l_c	Fiber critical length	[mm]
d	Fiber diameter	[µm]
τ_c	Fiber- matrix bonding strength	[MPa]
σ_f^*	Fiber tensile strength	[MPa]
ϵ_f^*	Fiber rupture strain	
ϵ_m^*	Matrix yield strain	
σ_f^*	Fiber fracture tensile strength	[MPa]
σ_m^*	Matrix fracture tensile strength	[MPa]
E	Modulus of elasticity	[GPa]
V_{min}	Minimum volume fraction of fiber	
σ_c^u	Failure tensile strength for composite	[MPa]
σ_c^m	Failure tensile strength for matrix	[MPa]
K	Fiber efficiency parameter	

Abbreviations

PMCs	Polymer matrix composite materials
CMCs	Ceramics matrix composite materials
MMCs	Metallic matrix composite materials
TPCs	Thermoplastic composite materials
TSCs	Thermosets composite materials
TP	Thermoplastic polymer
TS	Thermoset polymer
SBR	Styrene-butadiene rubber
NBR	Nitrile rubber
ABS	Acrynitrile butadiene styrene
LDPE	Low density polyethylene
HDPE	high density polyethylene
PP	Poly propylene
PVC	Poly vinyl chloride
PS	Poly styrene
PET	Polyethylene terephthalate
NF	Natural fiber
SF	Synthetic fiber
BPS	Banana Pseudo Stem fiber
AGW	Agricultural waste
BF	Banana fiber
NFCs	Natural fiber composites
NFRCs	Natural fiber reinforced composites
MA	Maleic Anhydride
RIM	Rim Injection Molding
MC	Moisture Content
SEM	Scanning Electron Microscope
WA%	Water absorption percentage