



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

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Bachelor of Science in Mechanical Engineering

Faculty of Engineering, Ain Shams University, 2010

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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 acrylonitrile 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°C for 48 hrs.

Secondly, ABS granules were dried in oven at 80°C for 48 hrs. **Thirdly**, BPS fiber with different mass fraction (0-10-20-30 %) were mixed with ABS granules at 180°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°C and 220°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.

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Nomenclature

Symbols

| | | |
|----------------|--|-------------|
| T_g | Glass transition temperature | [° C] |
| T_m | Melting temperature | [° C] |
| σ | Tensile load | [MPa] |
| l_c | Fiber critical length | [mm] |
| d | Fiber diameter | [μ m] |
| 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 | Acrylonitrile 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 |