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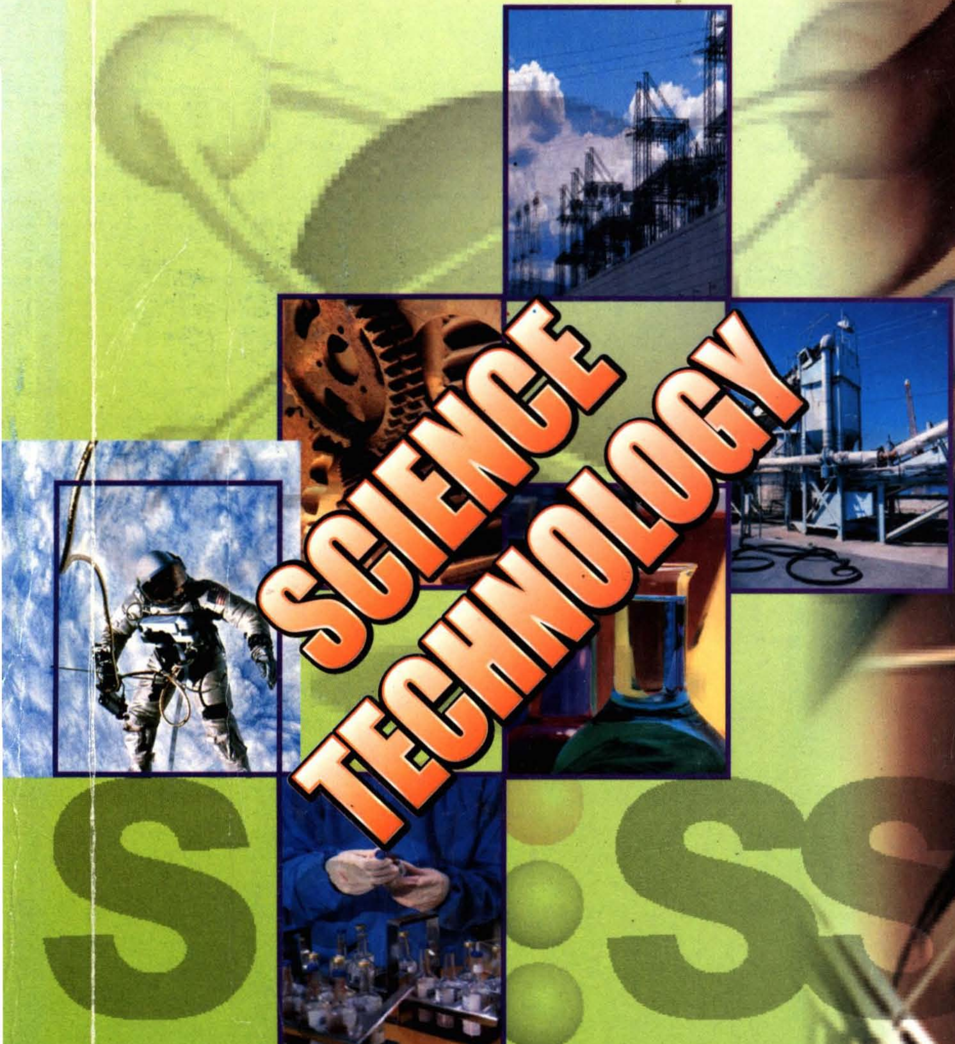

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Compatibilizer Influence on the Empty Fruit Bunch-Polypropylene Composites

Mohamad Jani Saad
Rozman Hj. Din
Zainal Arifin Mohd Ishak

ABSTRACT

The mixing between the empty fruit bunches fibres and the polypropylene along with aid of the competibilizer agents pertaining to solve the incompatibility within these different phases and nature has been successfully carried out. By doing these styles, the hydroxyl groups on the fibres surfaces should be bridged to the methyl groups of the polypropylene through the compatibilizer role as the middle part. The treatment on the respective composites by using maleic anhydride for enhancing the board performance can be utilized on the EFB prior to bind with a polypropylene as a binder. The effects of MAH treatment on the composites were analyzed by scanning electron microscopy (SEM) to look at the adhesion region or the interfacial parts. The SEM results became a site evidence of the good performance from board that treated compared to the untreated ones along with the mechanical or other relevance tests results.

Keywords: *empty fruit bunches, polypropylene, SEM, MAH*

Introduction

Many studies have been done to prove the good adhesion of lignocelluloses filled-thermoplastic composites (Rozman 1992), (Thomas et al.. 1997; Sjostrom 1993). The compatibility and interfacial bond strength between these two components are expected to be poor. This is due to the difference in nature between lignocelluloses filler and polymer matrix. Lignocelluloses are hydrophilic (contributed by hydroxyl groups in cellulose, lignin and hemicelluloses), whereas, thermoplastic such as polypropylene (PP) and polyethylene (PE) are hydrophobic. Various chemical have been employed to enhance the compatibility between the constituent materials, these include maleic anhydride modified-polypropylene (Rozman 1992), poly [methylene (polyphenyl isocyanate)] (Thomas et al. 1997), poly (propylene-acrylic acid) and silane (Sjostrom 1993). In these study, maleic anhydride (MAH) has been used to chemically modify the lignocelluloses fiber prior to incorporation with polypropylene (PP). The anhydride group is expected to be sufficiently reactive with the hydroxyl groups of lignocelluloses. Maleic anhydride, which is chemically attached to the lignocelluloses surface, may serve as a bridge between the former and the PP matrix. This study looks into the effect of MAH modification on the EFB-PP composites than without using MAH by using SEM analysis. The analysis stressed on the interfacial region to detect the contact of two different material that has been manipulated with chemical and non chemical. Also the compatibility of fiber – matrix and fiber look likes in the composites were analyzed.

Experiment

Materials

The fibers of EFB in long strands form were taken from Sabutek (M) Sdn. Bhd., Teluk Intan, Perak, Malaysia. Polypropylene (PP) in granular form was purchased from Polypropylene (M) Sdn. Bhd., Kuantan, Pahang, Malaysia. The PP characteristics including 12.0g/10 min for MFI and 0.903g/cm^3 for density. Maleic anhydride (MAH), which is in solid form, was purchased from Komita (M) Sdn. Bhd., Penang, Malaysia. The other chemicals involved are dimethyl formamide, dicumyl peroxide and acetone were purchased from the local company.

Preparation of the fibers

Fiber with the long strands form, was became the shorter form by grinding them in the grinder machine. To obtain the desire size of fiber, which is mesh 80, an Endicott's sieve was used.

Extraction of the fibers

Process of extraction on the fibers, which contains of oil or others unneeded things was performed by using the mixture of various of an organic solvents namely acetone, ethanol, and toluene (1:1:4, vol./vol.). Then, the so-called extracted fiber was dried in an oven for overnight (16 hours).

Filler treatment

The fibers were reacted in the round-bottom reaction flask with MAH solution (mixture of MAH and DMF at 3:7, v/v), heated at 90^{0}C with a constant stirrer for 1hrs. The treated fibers were then filtered to isolate the fibers and solution and subsequently washed with the fresh acetone. An extraction on the treated fibers has been taken with an acetone for 3 hours to dilute an unreacted MAH. Prior to calculate the weight percentage gain (formula as below) of treated fiber, the fibers were dried in an oven for overnight to remove an acetone.

$$\text{Weight percentage gain, WPG (\%)} = \frac{W_1 - W_2}{W_2}$$

W1 = weight of fiber after reaction
W2 = weight of fiber before reaction

Compounding and Processing

The compounding activity between MAH-treated and untreated fibers with PP was carried out in the Haake twin-screw extruder. The temperature in the extruder machine was set at 165^{0}C, 170^{0}C, 175^{0}C, and 180^{0}C for zone 1, 2, 3 and 4, respectively, and with screw speed maintain at 35 rpm. The mixture process was accomplished by adding of 2% of dicumyl peroxide as a catalyst (based on the WPG of treated fiber) for the treated fiber. Then, the mixture was extruded and palletized.

Scanning Electron Microscopy (SEM) Analysis

The SEM analysis has been conducted by using a Scanning Electron Microscope model Leica Cambridge S-360. Sample fracture from the tensile test which is 40% of filler loading (MAH treated at 10.66% WPG or without treated) was used. The samples were placed on an aluminum stub using double sided tape and subsequently coated with gold on the samples surfaces with a Polaron SEM coating unit. The purpose of samples being coated with gold is to avoid the electrical charging during the SEM analysis. There are various magnifications have been fixed on the adhesion picture's captured i.e. 80, 150, 500 and 700. The studies on the pictures obtained are stipulated on the fiber contact to the matrix, fiber breaking, fiber pull out as well as the compatibility within fiber and matrix.

Results and Discussions

Scanning electron microscopy (SEM) analysis has been used to study on the fracture sample surfaces (treated and untreated) taken from tensile tests. First micrograph (Figure 1) belonging to the untreated samples at 70 magnifications show the many fibers pull out from the matrix surfaces and leave the holes. It's probably because of lack or less fiber bonding between fiber and matrix. Such phenomenon came from the incompatibility within two different natures where the fiber is hydrophilic whereas the matrix or plastics are hydrophobic. The incompatibility situation has impart the inability of fiber to receive a stress been given from the matrix when the tensile test was carried out and directly influencing the performance of board.

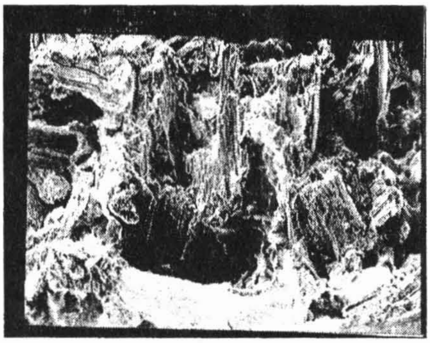

Fig. 1: SEM Micrograph of the Sample without MAH

The micrograph taken on the MAH treated samples (Figure 2) at same magnification shown the fiber breaking than pulls out at composites surfaces. A good compatibility among the fiber and matrix also detected. Effect of MAH on the good adhesion in the composites is due to the changing of fiber behave which became hydrophobic characteristics after the covalent bonding within MAH on the fiber surfaces and polypropylene was contributed. Thus it has produced adhesion and good contact between them. The enhancing effects of fiber in the matrix can be obtained with using the coupling agents (Rozman et al 2003). The increasing of mechanical properties of the boards effect after treated with coupling agents are based on the less fiber pull out and de-bonding of fiber-matrix activities (Gassan et al 1997).

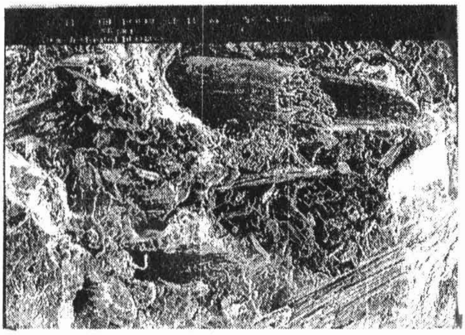

Fig. 2: SEM Micrograph of the Sample with MAH

Results of Figure 3 and 4 demonstrated the samples without treated and treated respectively. The micrograph taken on the interfacial region clearly displays a non-continuous phase (circle) resulted from the no bonding among two components in the untreated samples. As comparing, the continuous phase of MAH treated composites clearly shown. The treatment on the EFB's fiber has attributed to the chemical bonding created with the chemical component in the polypropylene. Another picture of sample treated with MAH (Figure 5) display the fiber embedded in the matrix strongly proved that the presence of MAH successfully make the connection of fiber-matrix changed.

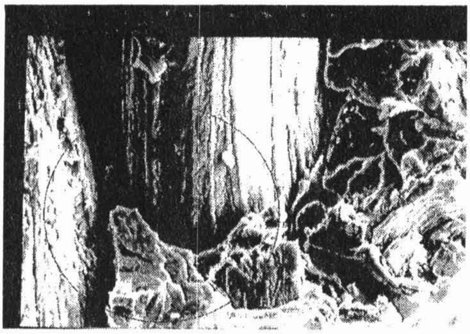

Fig. 3: SEM Micrograph of the Sample without MAH

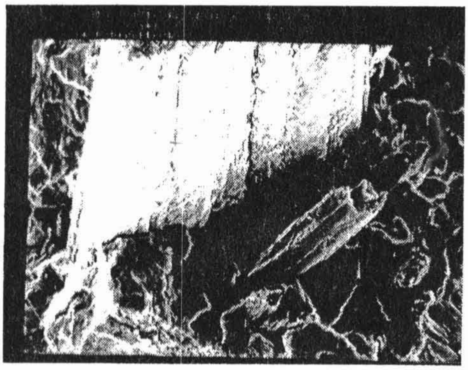

Fig. 4: SEM Micrograph of the Sample with MAH

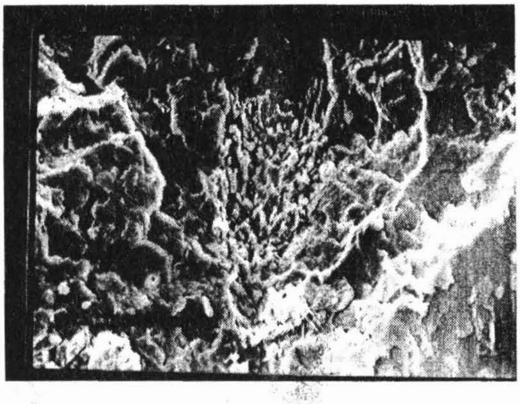

Fig. 5: SEM Micrograph of the Sample with MAH

Conclusion

A successful of the MAH chemically treatment on the EFBs' fibers was effected through the evidence of SEM analysis from the micrographs taken. The hydrophilic behavior of fiber has been changed to the hydrophobic which is compatible to the matrix with the presence of MAH which serve as bridge between these two different components.

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MOHAMAD JANI SAAD, Wood Composites Unit, FRIM, 52109 Kepong, Selangor

ROZMAN HJ. DIN, School of Industrial Technology, USM, 11800 Minden, Penang

ZAINAL ARIFIN MOHD ISHAK, School of Material Science, USM Branch, Nibong Tebal, Penang