THERMAL ANALYSIS OF NATURAL FIBER COMPOSITES USING POLYESTER RESIN

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Abstract: Fiber-reinforced polymer composites plays an important role in a variety of applications for their high specific strength and modulus. The fiber which serves as a reinforcement in reinforced polyester into be natural. In this connection, an investigation has been carried out to make use of coconut inflorescence, a natural fiber abundantly available in India. The present work describes the development and characterization of a new set of research was carried out by reinforcing the matrix (Polymer) resin with natural material (Coconut inflorescence fiber). The newly developed composites are characterized with respect to their mechanical characteristics and physical properties. The natural fibers were exposure to chemical treatment (NAOH) before reinforcement. Samples of Coconut inflorescence fiber-Polymer composite was manufactured using compression molding technique where the stacking of plies was alternate and the weight fraction of fiber and polymer was kept at 30%Coconut fiber-70%polymer and 35%Coconut fiber-65%polymer.Initially the composite plates were subjected to Differential Scanning Calorimetric analysis (DSC), Thermo-gravimetric Analysis (TGA) and followed by Scanning Electron Microscopy (SEM). In the DSC analysis, 4 samples have checked. In those 4 samples the high thermal stability had in 3mm fiber sample of the composite and it is about 352^{0}C. In the TG analysis, 4 samples have checked. In those 4 samples the weight reduced lately in the sample of 5mm composite. SEM results showed the improvement of the interfacial interaction among components in the composites.

Keywords: composites, coconut fiber

I. INTRODUCTION

A composite is combination of 2 materials during which one in every of the materials, known as the reinforcing part, is within the style of fibers, sheets, or particles, and it iis embedded with the alternative materials known as the matrix part. The reinforcing material and therefore the matrix material are often metal, ceramic, or polymer. Composites generally have a fiber or particle part that's stiffer and stronger than the continual matrix part and function the principal load carrying members. The matrix acts as a load transfer medium between fibers, and in less ideal cases wherever the hundreds area unit advanced, the matrix could even need to bear hundreds transversal to the fiber axis. The matrix is additional ductile than the fibers and therefore acts as a supply of composite toughness. The matrix additionally serves to guard the fibers from environmental injury before, throughout and once composite process. If it designed

properly, the new combined material exhibits higher strength than would every individual material. Composites area unit used not just for their structural properties, however additionally for electrical, thermal, tribological, and environmental applications.

The following area unit a number of the explanations why composites area unit designated sure as shooting applications:

- High strength to weight magnitude relation (low density high tensile strength)
- High creep resistance
- High lastingness at elevated temperatures
- High toughness

II.OBJECTIVE

- To prepare the natural fiber extraction process and chemical treatment with NaOH
- A new set of research is carrying out by reinforcement matrix , polyester resin with natural fiber
- To make a polymer matrix composites as a suitable for manufacturing technology
- To analyse Differential Scanning Calorimetric(DSC) analysis for finding phase transition of composite
- To analyse Thermo-gravimetric analysis(TGA) for finding heat flow and weight change in composite
- To take Scanning Electron Microscopic(SEM) images for checking the physical properties of composite

III.MATERIALS AND METHODS

3.1 FIBER EXTRACTION PROCESS

Fibers are available in the stack of nut of coconut tree. Coconut inflorescences are beaten with a thick round mallet until the fleshy matter is dusted off. The coconut inflorescences were conducted with chemical treatment (NaOH) for 1 hour. After treated with NaOH, the fibers were washed with distilled water and dried in sunlight for a day.

Figure 3.1 Coconut Inflorescence

3.2 CHEMICAL TREATMENT WITH COCONUT INFLORESCENCE

Fibers were treated with 5% aq. NaOH solution and washed in distilled water. Finally these fibers were washed with distilled water until the fibers were alkali free. Then the washed fibers were dried in shadow.

Figure 3.2 Treated Coconut Inflorescence

3.3 FIBER TESTING

The Coconut fibers were separated as untreated fiber and treated fiber according to the fiber diameter and surface roughness. Part of these fibers were carried out in INSTRAN5500R machine with gauge length of 50mm and cross head speed 20mm/min on both treated and untreated fibers at South Indian Research Association (SITRA) Laboratory in Coimbatore. Fiber moisture content, wax content, density, cellulose content, lignin content and tensile strain were determined.

Moisture Content: Moisture content is the quantity of water contained in a material, such as soil (called soil moisture),rock, ceramics, fruit, or wood. Water content is used in a wide range of areas, and is expressed as a ratio, of 0 to the value of the materials' porosity at saturation

Wax Content: Waxes are a class of chemical compounds that are plastic (malleable) near ambient temperatures. The wax melts above 45 °C to give a low viscosity liquid. Waxes are insoluble in water but soluble in organic, non-polar solvents.

Cellulose Content: Cellulose is the structural component of the primary cell wall of green plants, many forms of algae and the oomycetes.Cellulose is the most common organic compound on Earth. About 33.3% of all plant matter is cellulose (the cellulose content of cotton is 91% and that of wood is 41–50%).

3.4 FIBER PREPARATION

Treated fibers were chopped uniformly with different length. Lengths of fibers are 3mm, 5mm, 7mm and 9mm. The fibers were chopped for the reinforcement of the composite. The fibers and polyester resin were fabricated in the compression molding machine with different proportion. These fibers and polyester resin were mixed with the proportion of 30:70 and 35:65.

3.5 SELECTION OF RESIN (MATRIX MATERIAL)

The following resins are used for the polymer matrix composites

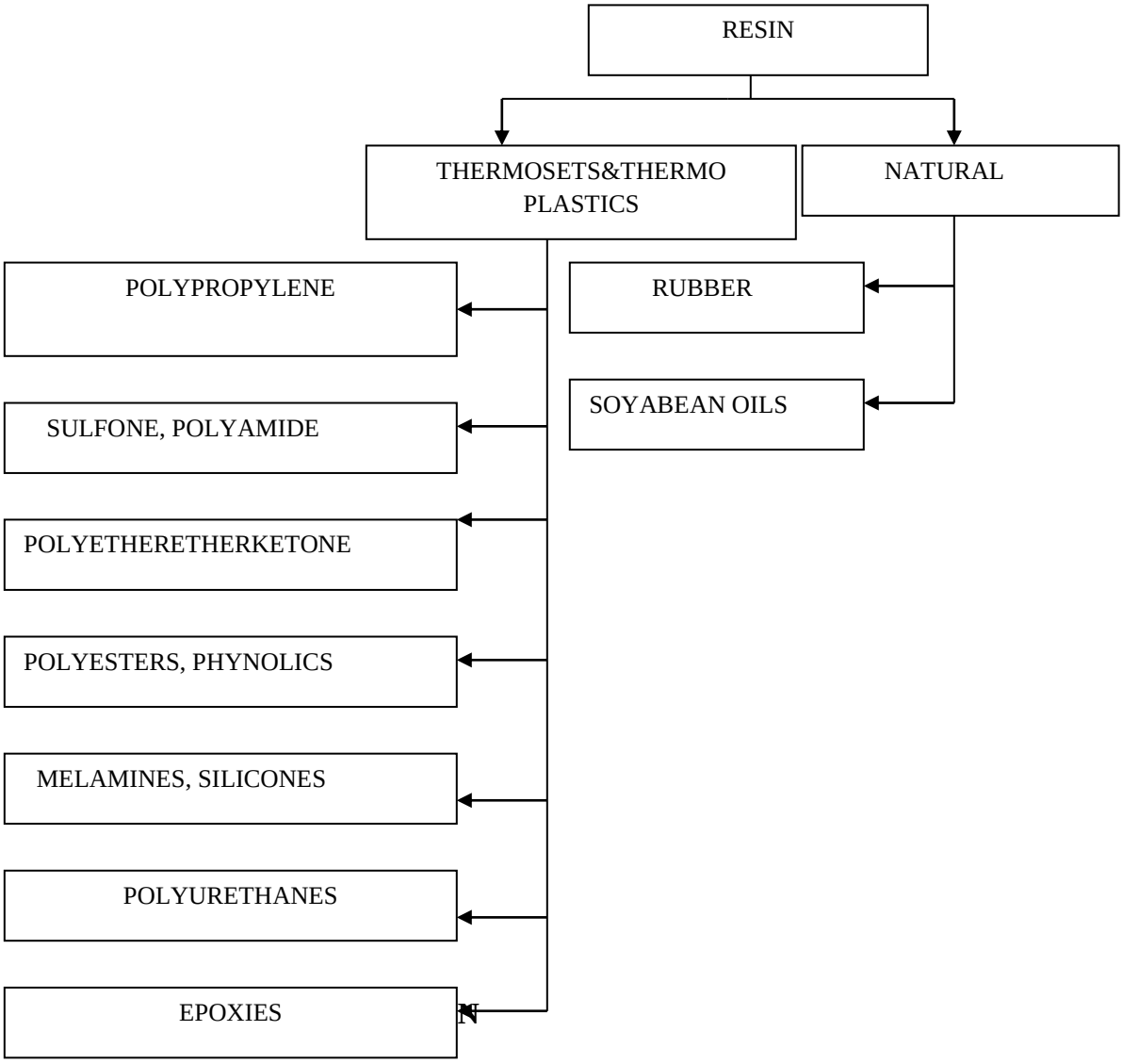

Figure 3.3 Classifications of Resins

Specimens were prepared with the mixing ratio of coconut inflorescence fibers and polyester resin 30:70 & 35:75. The coconut inflorescence fibers were cleaned, dried and chopped with different proportions 3mm, 5mm, 7mm & 9mm. The ratio of mixing polyester resin, Benzoyl Peroxide catalyst &cobalt 2-ethylhexamoate accelerator with 100:1:1. The weight fraction of fibers with particular length should be chosen and mixed in the bowl and spread uniformly on the mold (270*270*3mm). Then the mold was compressed by applying a load of 2 ton by hydraulic compression to get a single mat. Resin mixed with accelerator and catalyst is poured over the compressed fiber mat and the pressure is applied till the complete closure of mold. After 1 hour the samples were made as per the dimension of 270*270*3mm. The samples were prepared and cured at room temperature.

Figure 3.4 Compression Molding Machine

IV RESULTS AND DISCUSSION

4.1 TEST RESULTS OF COCONUT INFLORESCENCE

The various properties of Coconut fibers were determined by INSTRAN5500R machine with gauge length of 50mm and cross head speed 20mm/min on both treated and untreated fibers at South Indian Research Association (SITRA) laboratory. The wax content, moisture content, density at Room temperature, cellulose content and lignin content were tabulated for Coconut fiber.

Table 4.1 Coconut Fibers Result

TEST RESULTS

Lab Code No. Sample Particulars.:	CM5061 Coconut Fibre Treated	CM5062 Coconut Fibre Untreated
Wax content, %	0.31	0.634
Moisture Content, %	11.28	9.33
Density at Room Temperature, g/cc	1.223	1.372
Cellulose Content, %	65.29	71.90
Lignin Content , %	16.90	17.20

4.2 TEST RESULTS FOR UNTREATED FIBER

Thirty samples were randomly collected from the lot of untreated course fiber and it was cut uniformly at a gauge length of 50mm. Then it was subjected to mechanical testing in INSTRAN5500R machine with cross head speed 20mm/min and the results were tabulated.

SPECIMEN INPUT

COMPANY NAME	SITRA
INSTRUMENT NAME	INSTRON 55OOR
Specimen label	C-986
OPERATOR NAME	SN
METHOD	COCANUT FIBRE SAMPLE, UN TREATED
HUMDITY %	65.0
TEMPERATURE	21.0
Length	100.00000 mm
Rate 1	100.00000 mm/min

	Maximum Load (gf)	Tensile strain at Maximum Load (%)
1	3394.87	6.50
2	3049.21	5.78
3	3139.84	6.67
4	3176.97	4.64
5	3367.26	7.35
6	2986.68	5.53
7	3071.18	4.18
8	3098.17	7.53
9	2871.66	8.70
10	2904.87	3.37
11	2972.64	7.52
12	3466.20	8.87
13	3244.48	7.53
14	2801.43	3.46
15	3655.29	10.12
16	3363.28	6.48
17	3092.37	4.80
18	3280.34	3.99
19	3386.37	5.53
20	2804.54	7.17
21	2895.08	4.21
22	3003.50	8.17
23	2755.72	3.50
24	3380.53	2.62
25	2996.78	5.79
26	3518.85	6.30
27	3216.51	6.68
28	3197.06	8.04
29	3196.55	6.31
30	2945.08	4.37
Mean	3141.11	6.06
Standard Deviation	231.37390	1.86675
Coefficient of Variation	7.36599	30.82356
Minimum	2755.72	2.62
Maximum	3655.29	10.12

Figure 4.1 Results of Untreated Fiber

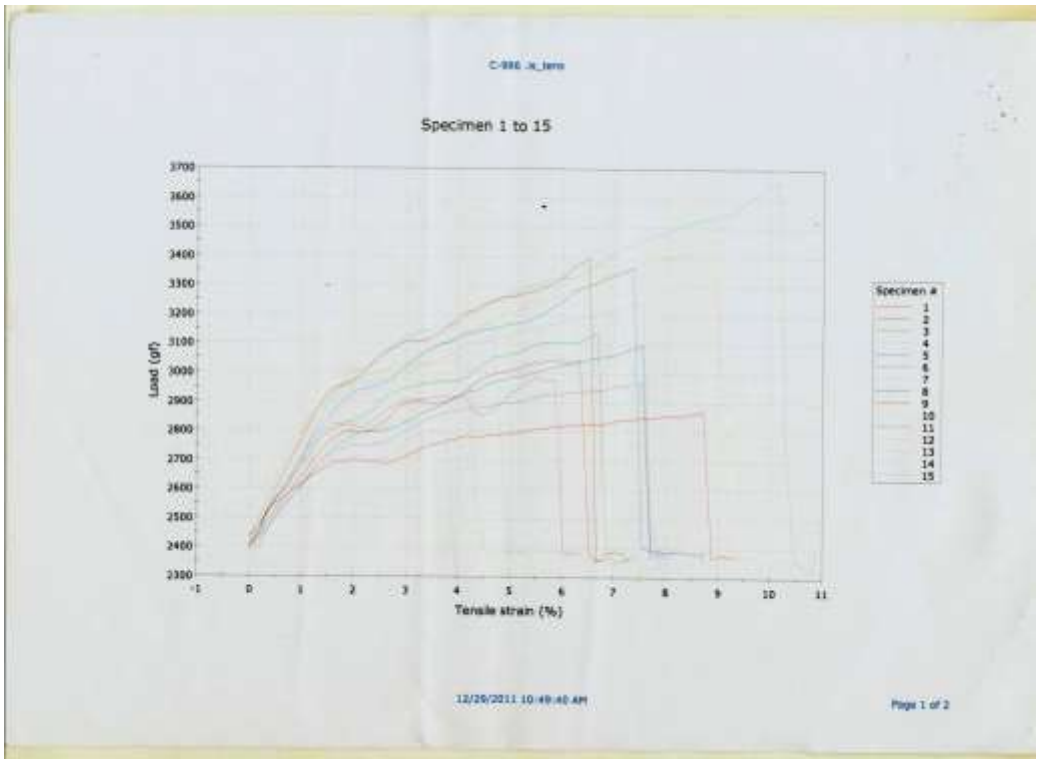

Figure 4.2 Untreated fiber specimen 1-15

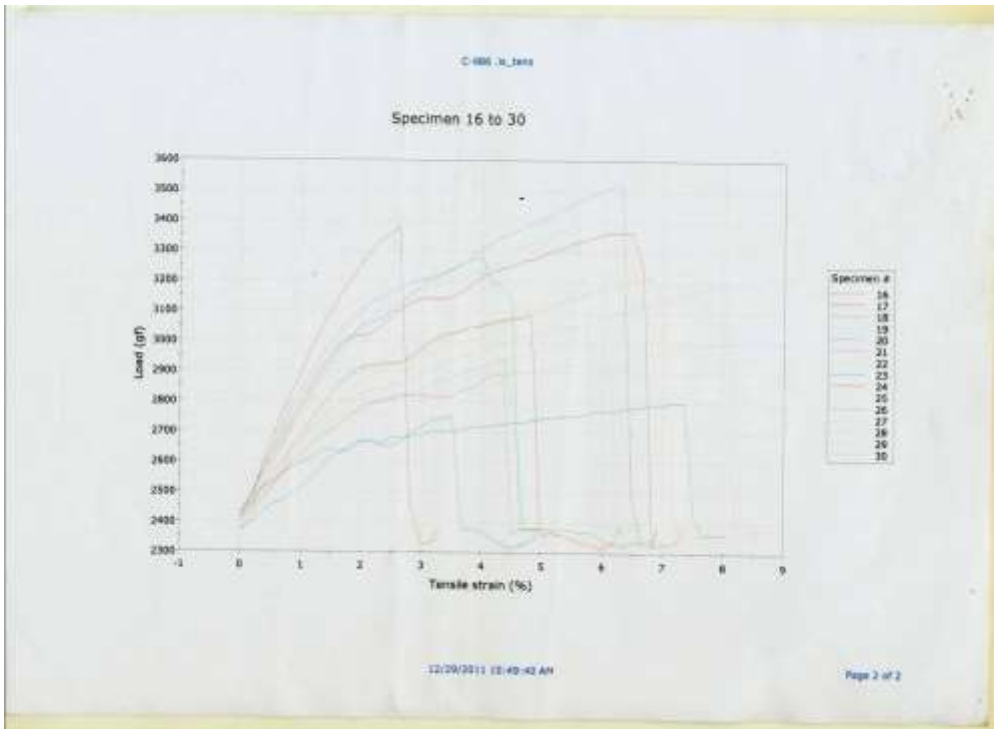

Figure 4.3 Untreated fiber specimen 16-30

5.3 TEST RESULTS FOR TREATED FIBER

Thirty samples were randomly collected from the lot of treated fiber and it was cut uniformly at a gauge length of 50mm. Then it was subjected to mechanical testing in INSTRAN5500R machine with cross head speed 20mm/min and the results were tabulated.

SPECIMEN INPUT

COMPANY NAME	SITRA
INSTRUMENT NAME	INSTRON 55OOR
Specimen label	C-985
OPERATOR NAME	SN
METHOD	COCANUT FIBRE SAMPLE, TREATED
HUMDITY %	65.
TEMPERATURE	21.
Length	100.00000 mm
Rate 1	100.00000 mm/min
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	Maximum Load (gf)	Tensile strain at Maximum Load (%)
1	3090.87	5.37
2	3169.22	5.37
3	3079.88	6.70
4	3353.34	5.87
5	3089.05	8.04
6	3847.39	10.84
7	3103.73	4.53
8	3477.34	6.51
9	3182.81	8.03
10	2680.85	4.20
11	3530.42	11.03
12	3213.92	4.67
13	3135.96	7.35
14	2788.66	4.66
15	3048.50	11.52
16	2688.23	5.00
17	3676.51	9.14
18	3671.01	8.14
19	3008.58	6.64
20	2943.39	4.66
21	3063.44	6.65
22	3072.50	11.53
23	2771.42	7.15
24	2843.37	9.35
25	3672.11	7.20
26	3065.74	7.31
27	2922.09	6.48
28	2996.33	8.15
29	3295.29	12.29
30	3208.24	7.34
Mean	3156.34	7.39
Standard Deviation	300.25874	2.29219
Coefficient of Variation	9.51288	31.01760
Minimum	2680.85	4.20
Maximum	3847.39	12.29

Figure 4.4 Results of Treated fiber

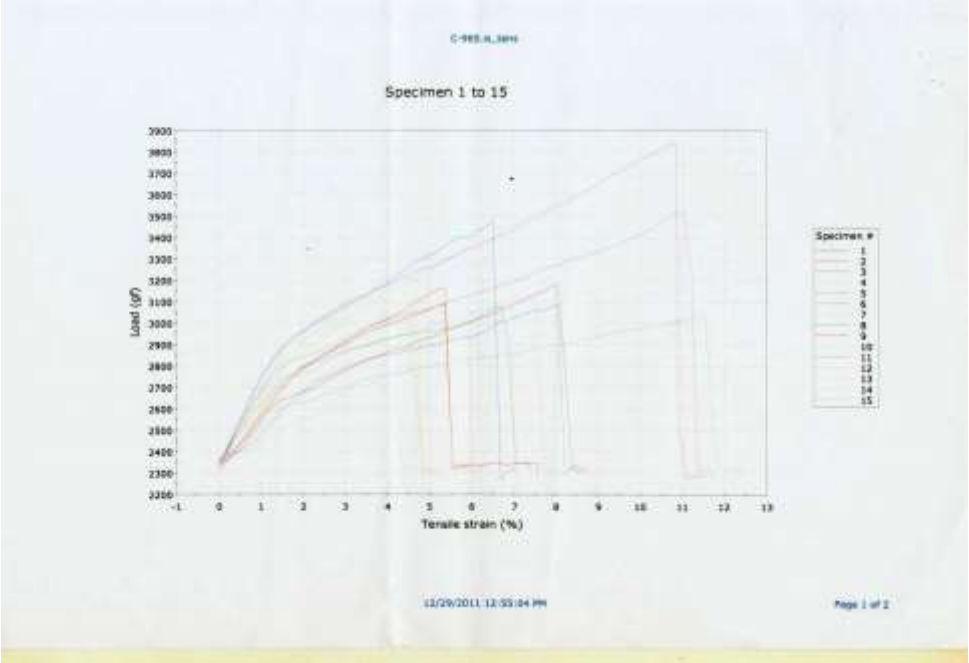

Figure 5.5 Treated fiber specimen 1-15

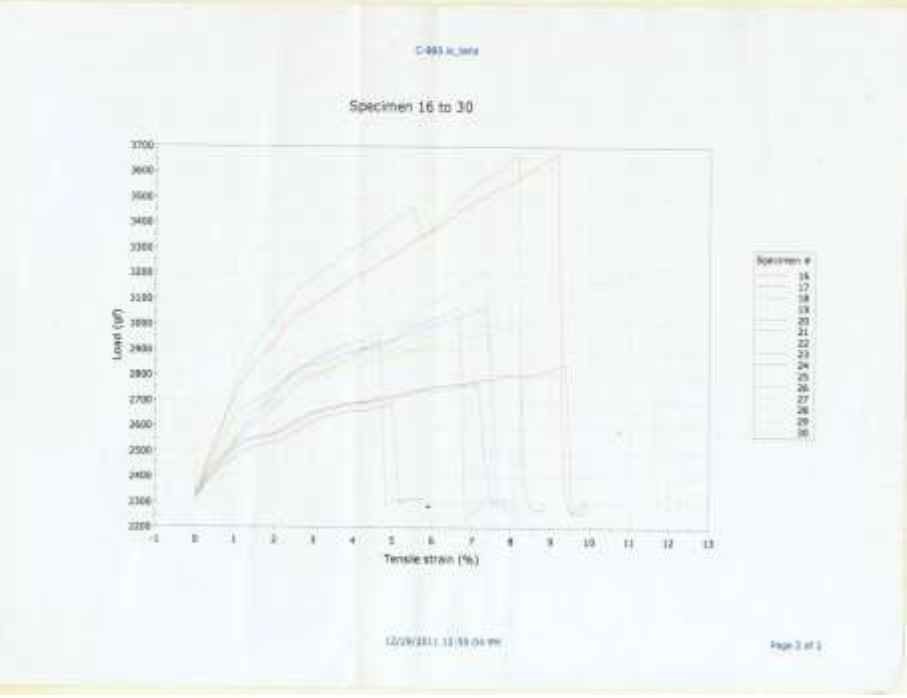

Figure 4.6 Treated fiber specimen 16-30

4.4 RESULTS OF DSC ANALYSIS

The Coconut fiber and polyester resin with the proportion of 30:70 composite was taken as sample and it is analyzed for DSC analysis. The samples of 3mm, 5mm, 7mm and 9mm were analyzed for DSC analysis. DSC analysis had been taken under the room temperature to 600^0C. Approximate decomposition of the sample is around 400^0C. The expected result for this analysis was phase transition and sample's phase changed solid into liquid. All the sample's resin phase changed approximately 230^0C. All the sample's fiber phase changed approximately 350^0C.

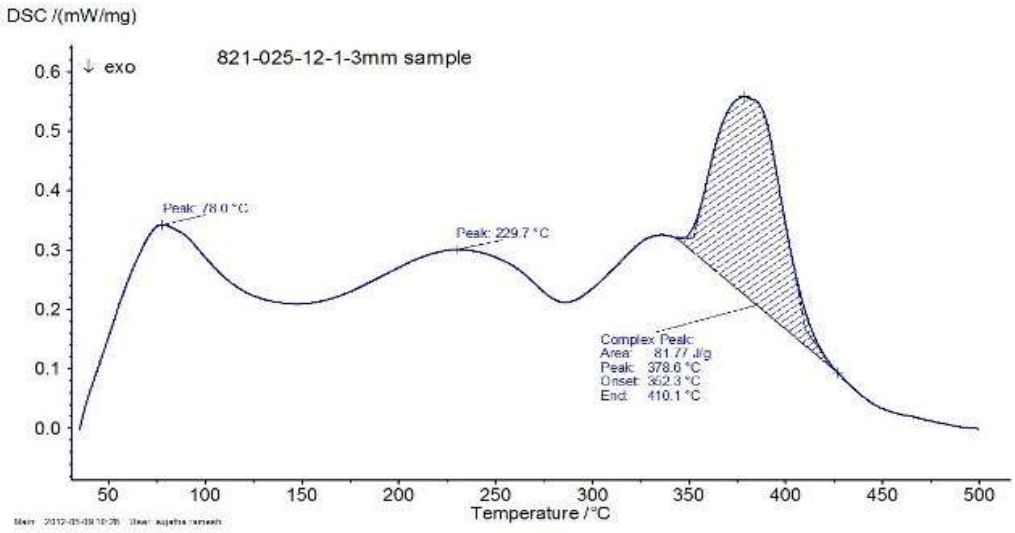

Figure 4.7 Sample of 3mm

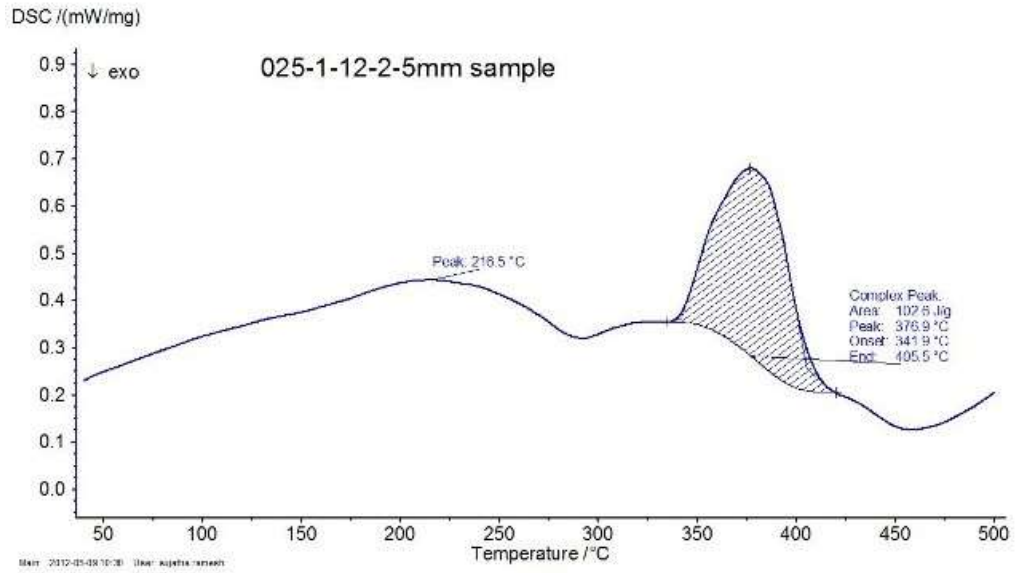

Figure 4.8 Sample of 5mm

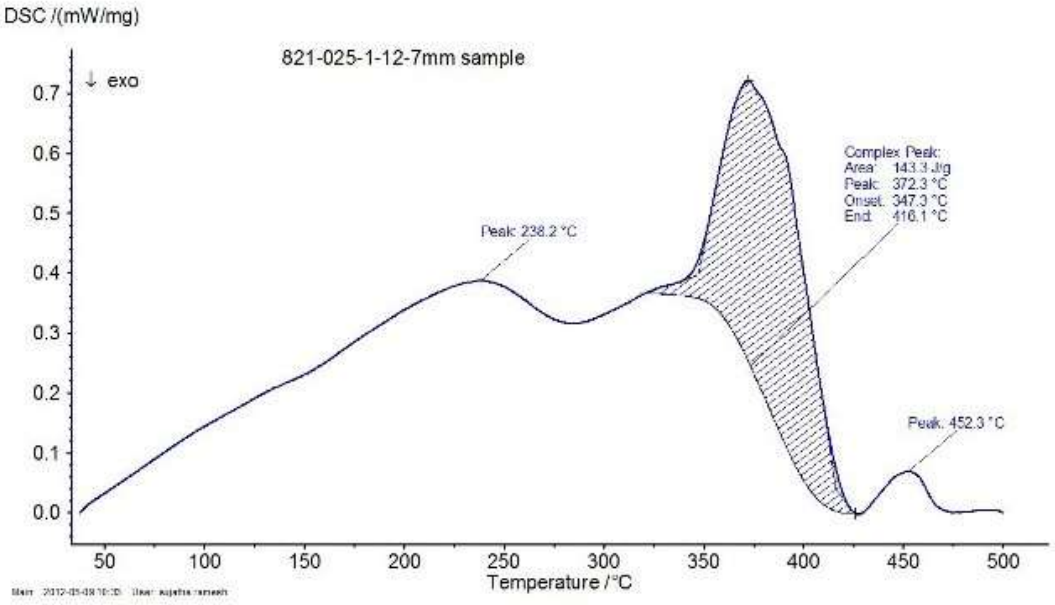

Figure 4.9 Sample of 7mm

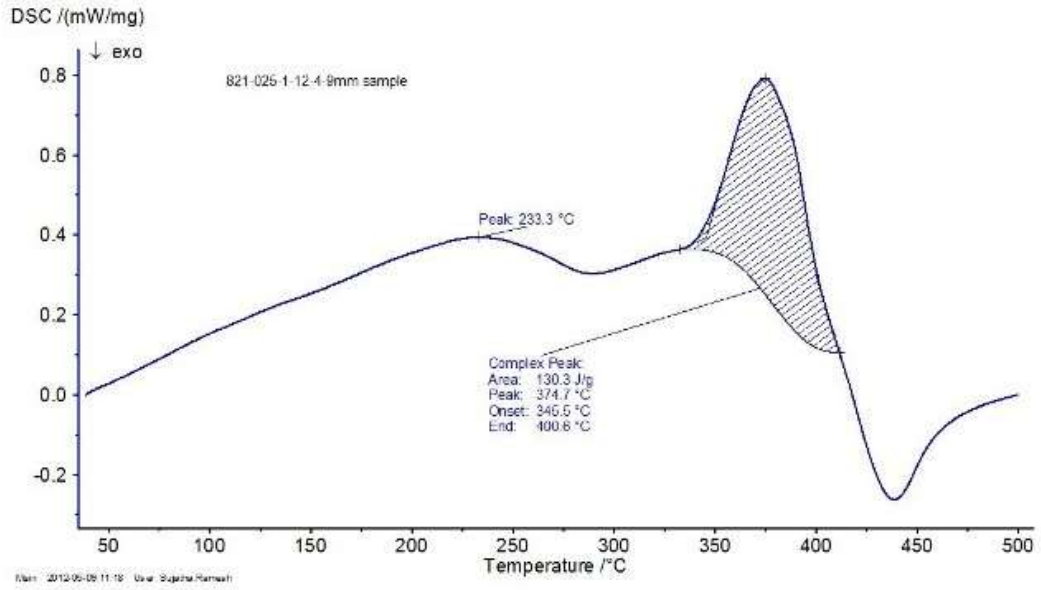

Figure 4.10 Sample of 9mm

4.5 RESULTS OF TG ANALYSIS

The Coconut fiber and polyester resin with the proportion of 30:70 composite was taken as sample and it is analyzed for DSC analysis. The samples of 3mm, 5mm, 7mm and 9mm were analyzed for DSC analysis. DSC analysis had been taken under the room temperature to 600^0C. Approximate decomposition of the sample is around 400^0C. The expected result for this analysis was decomposition and the weight change. The mass changes of the samples were started approximately 200^0C.

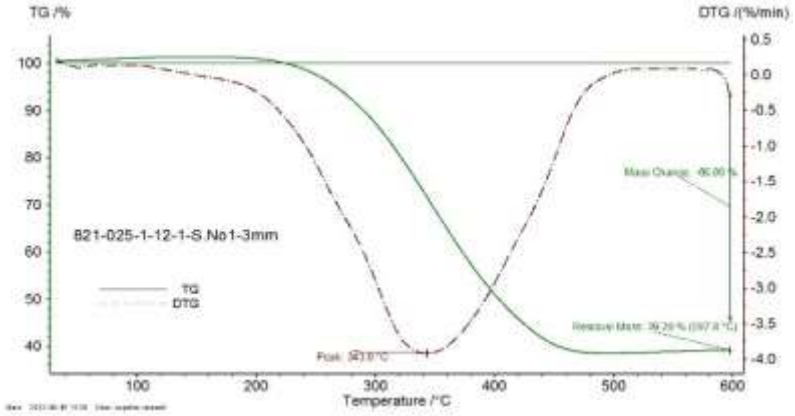

Figure 4.11 Sample of 3mm

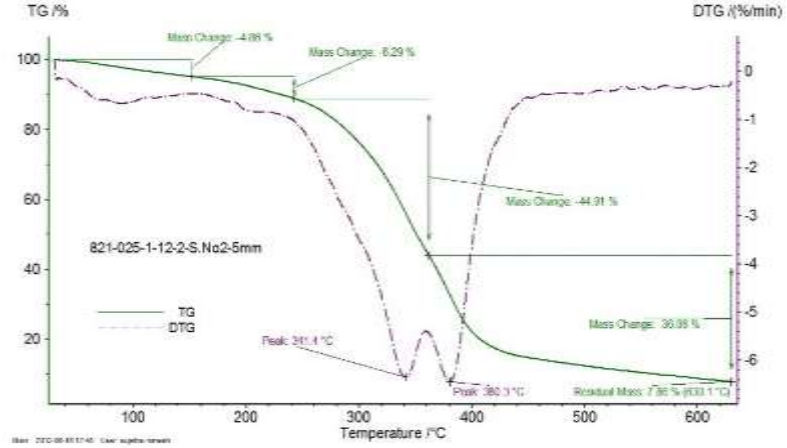

Figure 5.12 Sample of 5mm

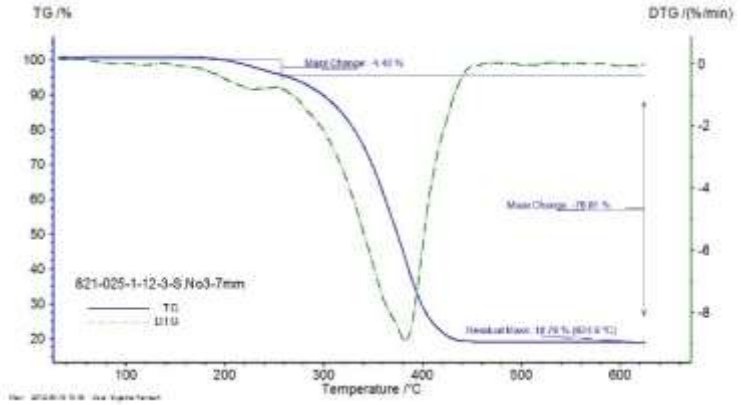

Figure 5.13 Sample of 7mm

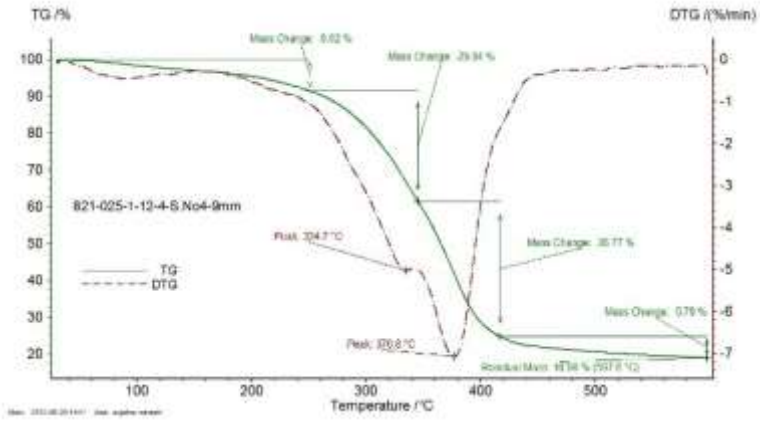

Figure 4.14 Sample of 9mm

4.6 RESULTS OF SCANNING ELECTRON MICROSCOPY

SEM micrographs of composites are shown below figures. As seen from the micrographs, the large amount of polymer adhered to the fiber surface and no gaps between polymer and the fibers were observed. This indicated that accelerators and catalyst improved the adhesion between polymer and the fibers.

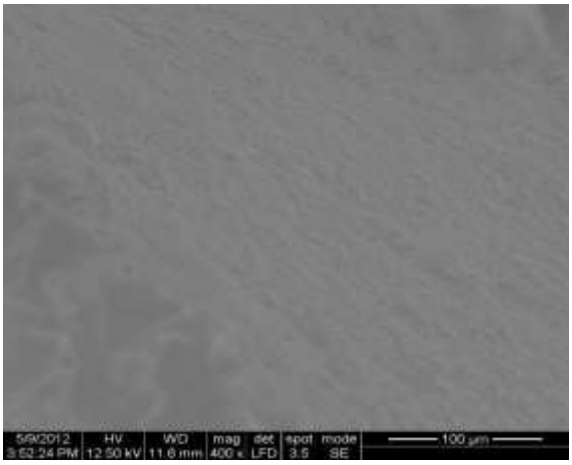

Figure 4.15 Sample of 3mm with 100 micrometer

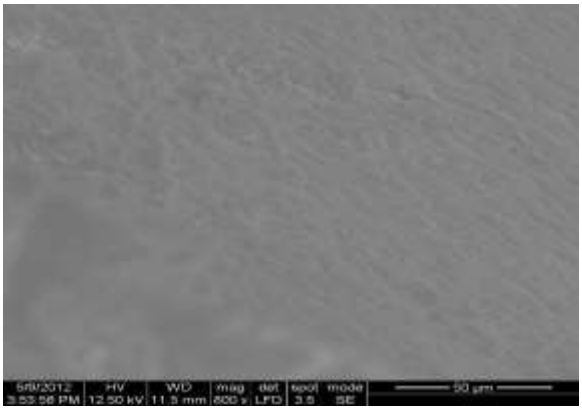

Figure 4.16 Sample of 3mm with 50 micrometer

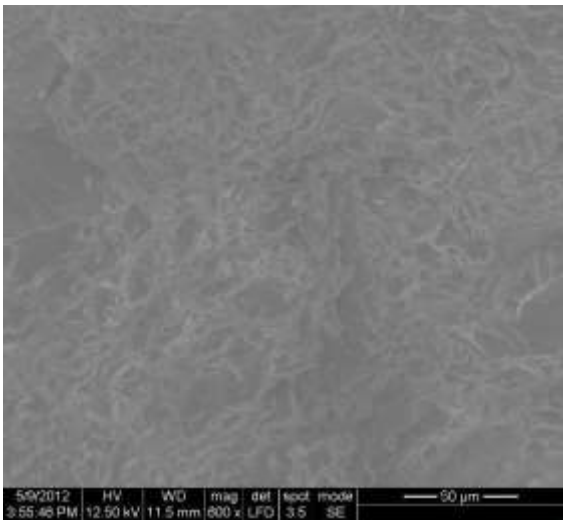

Figure 4.17 Sample of 5mm with 50 micrometer

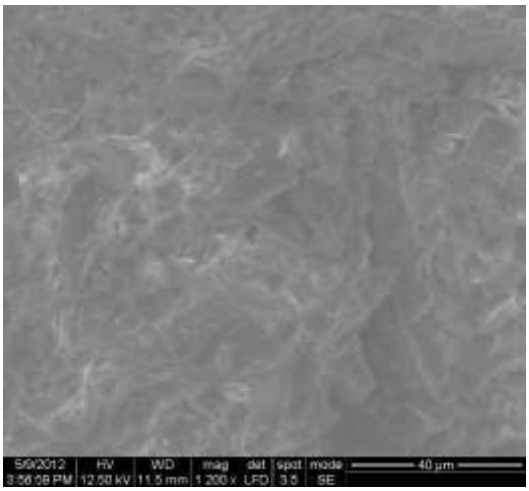

Figure 4.18 Sample of 5mm with 40 micrometer

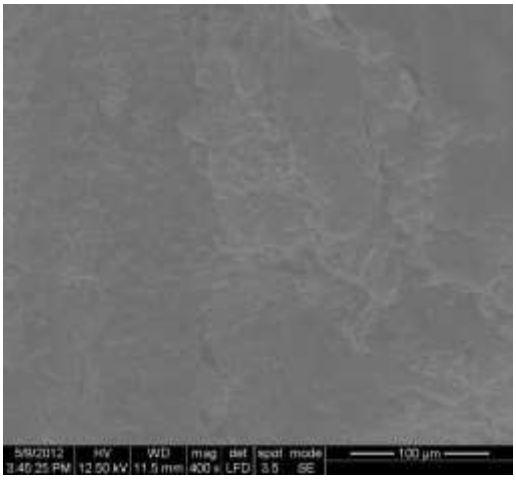

Figure 4.19 Sample of 7mm with 100 micrometer

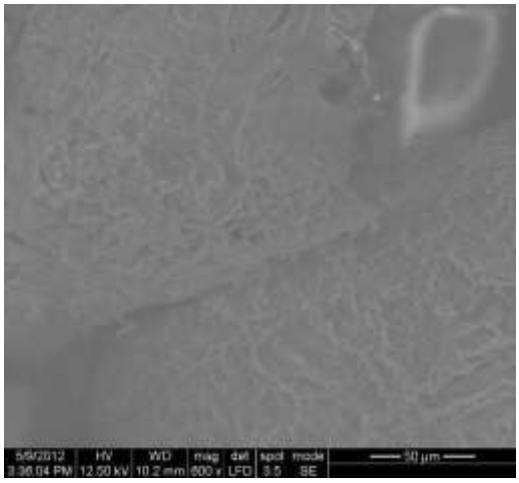

Figure 4.20 Sample of 7mm with 50 micrometer

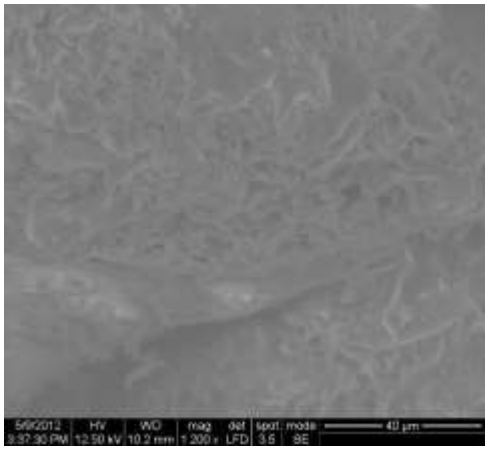

Figure 4.21 Sample of 7mm with 40 micrometer

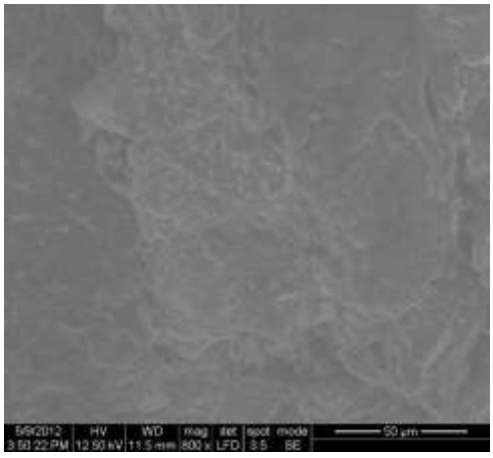

Figure 4.22 Sample of 9mm with 50 micrometer

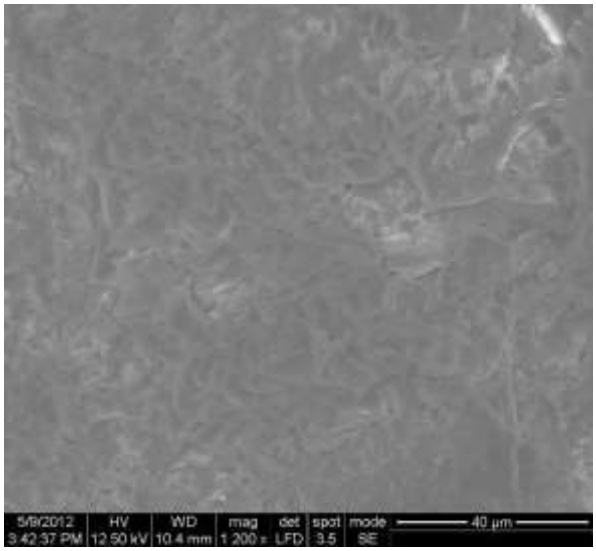

Figure 4.23 Sample of 9mm with 40 micrometer

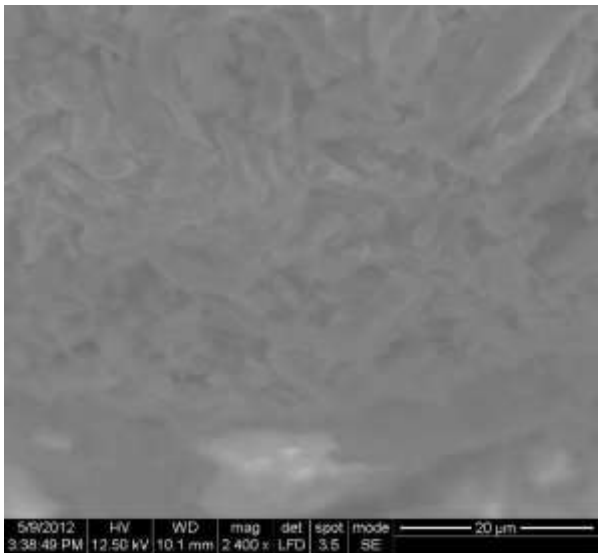

Figure 4.24 Sample of 9mm with 20 micrometer

V.CONCLUSION

This work shows of a Coconut fiber and polymer composites with different fiber lengths are fabricated by compression molding technique. Composite plates were subjected to Differential Scanning Calorimetric analysis (DSC), Thermo-gravimetric Analysis (TGA) and followed by Scanning Electron Microscopy (SEM). In the DSC analysis, 4 samples have checked. In those 4 samples, the high thermal stability had in 3mm fiber sample of the composite and it is about 352^0C. In the TG analysis, 4 samples have checked. In those 4 samples, the weight reduced lately in the sample of 5mm composite. SEM results showed the improvement of the interfacial interaction among components in the composites.

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