e-ISSN 2320 –7876 www.ijfans.org
Vol.11, Iss.12, 2022
Research Paper UGC CARE Listed (Group -I) Journal

THERMAL AND MECHANICAL PROPERTIES OF POLYESTER COMPOSITES FROM SUNFLOWER OIL USING SISAL FIBRE

S. Devi and Dr. N. J. Sangeetha

[1]Research Scholar, Register Number: 19113282032004, Department of Chemistry, Women's Christian College, Nagercoil-629001, Tamil Nadu, India.

Affilated to ManonmaniamSundaranar University, Abishekapatti, Tirunelveli-627012, Tamil Nadu, India

[2]Assistant Professor, Department of Chemistry, Women's Christian College, Nagercoil-629001, Tamil Nadu, India.

Corresponding Author: E-mail: devimano2202@gmail.com

ABSTRACT

Sisal fibre reinforced polyester composites have been synthesised from poly (sunflower oil fumarate) polyester resin, acrylo nitrile, benzoyl peroxide, dimethyl aniline, triethylene glycol dimethacrylate and sisal fibre. The polyester and their fibre reinforced composites were characterised by FT-IR, swelling coefficient, mechanical properties and thermal properties. These studies revealed that the high performance of sisal fibre reinforced polyester composites with respect to the polyester neat sheets.

Key words: Polyester, Sisal fibre, Composites and Thermal properties.

I INTRODUCTION

Sunflower oil like most natural oils is composed mainly of triglyceride, and a small fraction of lecithin, tocopherols, carotenoids and waxes [1]. The most common fatty acids are palmitic acid, linoleic acid, stearic acid and oleic acid. The oils have a less content of saturated fatty acid in the medium position of the triacylglycerol [2]. The oil contains 15% saturated fatty acid and 85% unsaturated fatty acid.

Sisal fibre is mainly obtained from Agave Sisalana. The plant is originated in Central America. Largest world producer of sisal fibre is Brazil. Chemical combination of sisal fibre contains 78% cellulose, 8% lignin, 10% hemicelluloses, 2% waxes and about 1% ash [3]. It is a coarse, hard fibre, unsuitable for textiles or fabrics. It is strong, durable and stretchable, does not absorb moisture, easily, resists, and saltwater deterioration [4].

Composites materials are combination of two or more materials to give a unique properties, one of which is made up to stiff, long fibres and the other a folder or matrix which holds the fibres in place [5].Composite materials are used for automotive interior parts, fencing, window frames, decking markets [6].

II EXPERIMENTAL

2.1 Materials

Sunflower oil was commercially available in local markets. Formic acid, hydrogen peroxide, maleic anhydride, acrylo nitrile, dimethyl aniline and TEGMA were purchased from Sigma-Aldrich.

2.2 Synthesis of poly (sunflower oil fumarate) polyester resin

Sunflower oil was carried out using 30% hydrogen peroxide and formic acid, in ice water bath. The reaction was vigorously stirred at 6 hours. Then it was poured into a separator funnel and extracted with ether. The resulting product obtained as hydroxylated sunflower oil. The resulting product was reacted with maleic anhydride, sodium acetate, morpholine and the mixture was refluxed for 2 hours at 60-80^{o}C and 140^{o}C for 20 minutes under vacuum condition using rotamantle to yield a yellow transparent liquid poly (sunflower oil fumarate) polyester resin.

2.3 Synthesis of poly (sunflower oil fumarate) polyester and their composites

The polyester neat sheet and theirfibre reinforced composites were synthesised by treating poly (sunflower oil fumarate) polyester resin with triethylene glycol dimethacrylate, benzoyl peroxide, dimethyl aniline and acrylo nitrile. The neat sheet was coded as SBP. The treated sisalfibre with varying compositions (5%, 10%) added to the above mixture. The mixture was poured into the clean silicon oil spreaded glass mould. The mixture was dried in vacuum air oven at 60^{o}C for 4hours. The 5% and 10% sisalfibre reinforced composites were coded as SBPS5 and SBPS10.

III CHARACTERISATION

3.1 Spectral studies

FT-IR spectral analysis of synthesised resin and composites were analysed by KBr pellet method via Shimadzu FT-IR 8400S spectrometer.

3.2 Determination of swelling coefficient

The polyester neat sheet and their composites were subjected to swelling experiments. The density of polyester sheets and their composites were analysed using ASTM D792 method.

The swelling coefficient ‘Q’ was evaluated using the formula,

$$\text{Swelling coefficient (Q)} = \frac{\text{Weight of the solvent in swelled polymer}}{\text{Weight of the swelled polymer}} \times \frac{d_r}{d_s}$$

Where,

d_r = Density of polymer

d_s = Density of solvent

3.3 Evaluation of mechanical properties

e-ISSN 2320 –7876 www.ijfans.org
Vol.11, Iss.12, 2022
  UGC CARE Listed (Group -I) Journal

Tensile strength of the polyester and their fibre reinforced composites were evaluated in Universal Testing Machine at across head speed of 100 mm for minute using rectangle shaped samples (10 x 1 cm) punched out from polyester and their composite films as for ASTM D6100. The gauge length was set at 3cm in each test. The young's modulus, elongation at break and tensile strength were evaluated using standard methods. Shore A hardness of polyester and their composites were evaluated as per ASTM D2240. Polyester and their composites of 5mm thickness were used for hardness measurements.

3.4 Thermal properties

Thermal properties of polyester sheet and their composites were determined using differential thermal analysis and thermo gravimetric analysis.

IV RESULTS AND DISCUSSION

4.1 FT-IR analysis

The FT-IR spectra of polyester and their sisal fibre reinforced polyester composites were given in Fig. 1 & Fig. 2. The FT-IR spectra revealed the peaks at 1163.07 cm^{-1} – 1399.11 cm^{-1} due to the presence of C-O stretching of ester group and showed the absence of peak at 1644.98 cm^{-1} due to indicate the absence of double bonds. The FT-IR spectra of sisal fibre reinforced polyester composites have irregular pattern of absorption bands formed and no new bands were obtained due to the mixture of fibres.

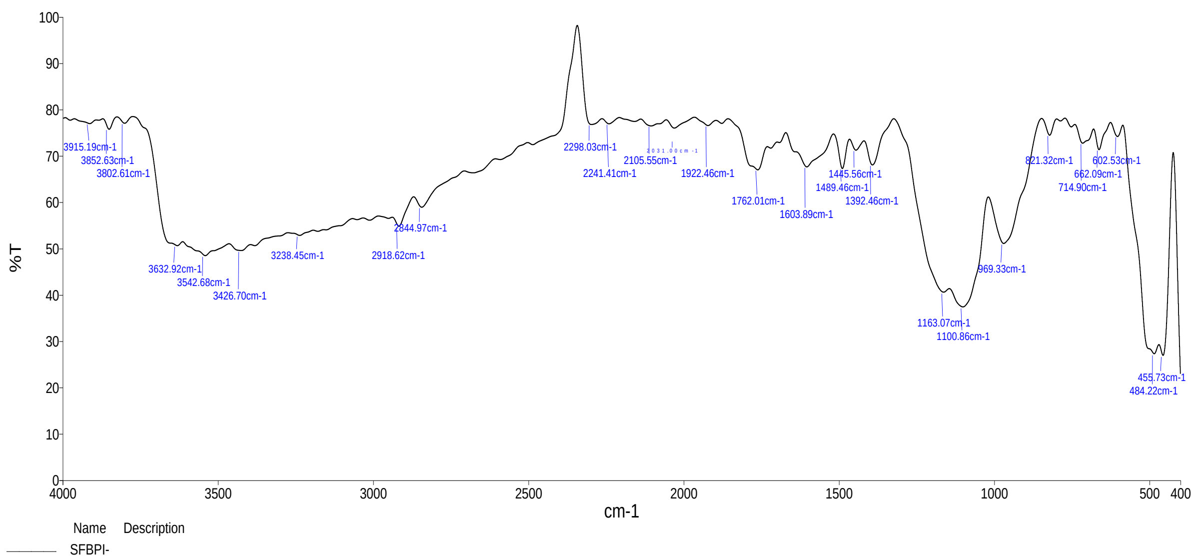

Fig. 1 FT-IR spectrum of SBP

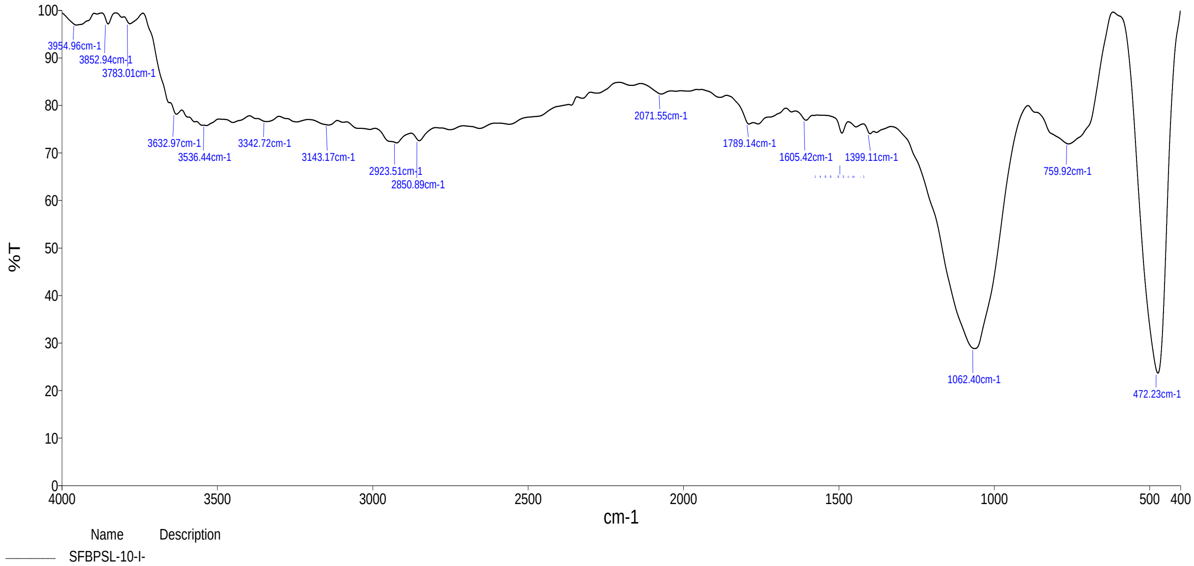

Fig. 2 FT-IR spectrum of SBPS10

4.2 Swelling coefficient

The polyester sheet and their composites weremaximum in dimethyl acetamide. They revealed that the higher swelling showed that the polyester and their composites have beencrosslinked. The higher percentage of sisalfibre reinforced polyester composites has higher crosslink density. The swelling coefficient of polyester and their sisalfibre reinforced composites are given in Table 1.

Table 1 Swelling coefficient of polyester neat sheat and sisalfibre reinforced composites

Polyester and their composites	EMK	DMA	Toluene	Chloroform
SBP	0.22	1.01	0.25	0.29
SBPS5	0.23	1.06	0.24	0.32
SBPS10	0.24	1.08	0.26	0.33

4.3 Mechanical properties

In the present investigation, the data of mechanical properties such as tensile strength, elongation at break, young's modulus and shore A hardness of polyester and their sisalfibre reinforced composites are given in Table 2. It was observed that the sisalfibre reinforced composites has higher mechanical properties than polyester neat sheet due to the presence of alkali treated sisalfibres.

The mechanical properties showed that the 10% and 5% sisal fibre reinforced polyester composites has greater tensile strength, shore A hardness and young's modulus than thepolyester neat sheet. It was concluded that as fibre content increased then the mechanical properties also increased.

e-ISSN 2320 –7876 www.ijfans.org
Vol.11, Iss.12, 2022

Table 2 Mechanical properties of polyester and their sisalfibre composites

Polyester and their composites	Tensile strength	Young's modulus	Elongnation at break	Shore A hardness
SBP	8.7	7.67	112	30
SBPS5	10.5	9.89	120	39
SBPS10	13.9	10.83	125	44

4.4 Thermal properties

In the present investigation, the TGA and DTA thermograms of polyester composites were given in Fig. 3&Fig. 4. TGA revealed that the all polyester composites have higher starting degradation temperature and weight loss. The third weight loss decomposition was about 90% in the temperature range 400˚C-500˚C due to the complete decompose of the polyester moiety of the composites of the char residue. The DTA thermograms showed an endothermic peak at 250˚C-350˚C. The second endothermic peak around 350˚C-500˚C due to the degradation of crosslinking polyester composite fragments.

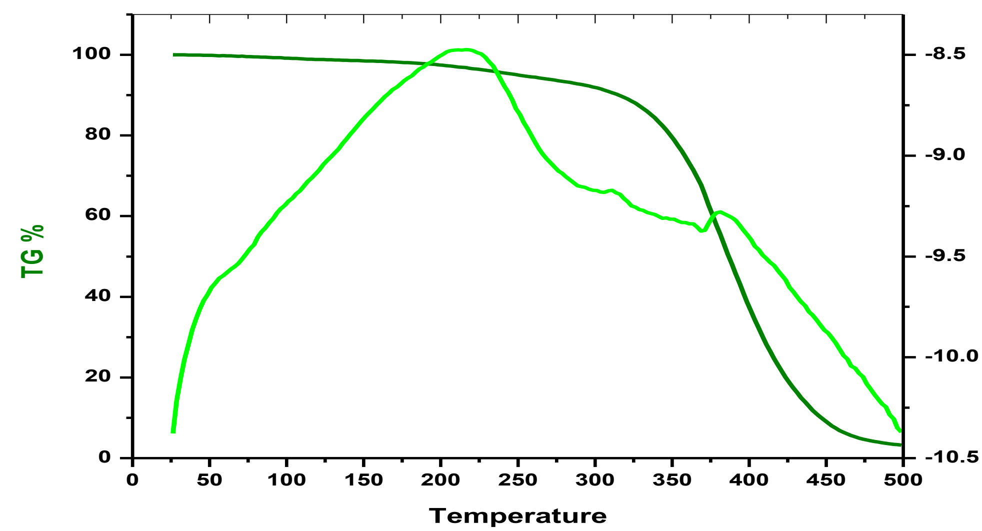

Fig. 3 TGA/DTA curve for SBPS5

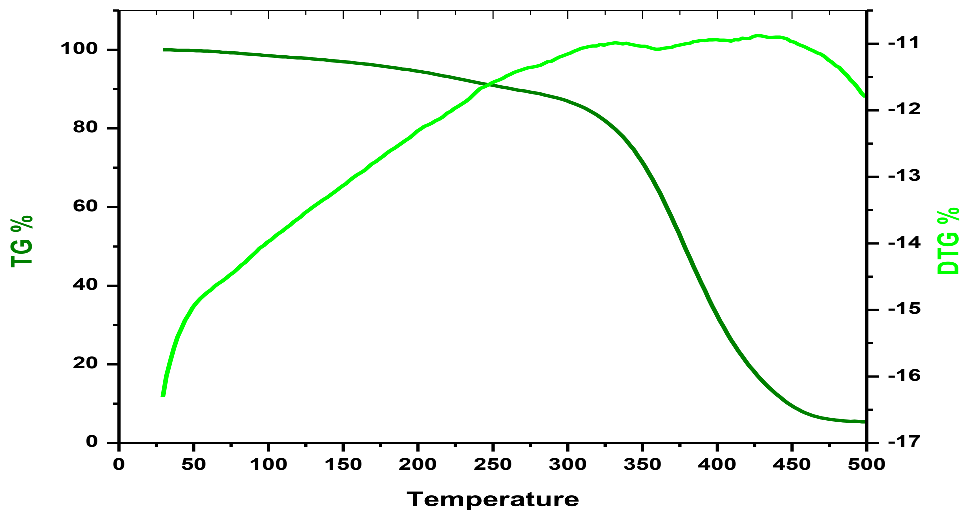

Fig. 4 TGA/DTA curve for SBPS10

V CONCLUSIONS

The synthesis of polyester sheet and their composites were confirmed by FT-IR analysis. The swelling coefficient of the polyester and their sisalfibre reinforced composites has beenmaximumin dimethyl acetamide. The percentage of fibre content increased then the mechanical properties also increased. The DTA data of sisal fibre reinforced polyester composites showed the fibre increased then the decomposition rate was increased.

VI REFERENCES

1. Bashir, T, Mashwani, ZUR, Zahara, K, Haider, S, Tabassum, S &Mudrikah 2015, 'Chemistry, Pharmacology and Ethnomedicinal Uses of Helianthus Annus: A Review', Pure Applied Biology, vol. 4, no.2, pp.226-235.

2. Garces, R, Force, EM, Salas, JJ &Caleron, MV 2009, 'Current Advances in Sunflower Oil and its Applications', Lipid Technology, vol. 21, no. 4, pp. 79-82.

3. Saxena, M, Pappu, A, Haque, R & Sharma, A 2016, 'Sisal Fibre based Polymer Composites and their Applications', Springer

4. Gurram, AM &Rao, DN 2016, 'Synthesis and Characterisation of Sisal Fibres', International Journal of Engineering and Technical Research, vol. 6, no. 1, pp. 81-83.

5. Shandilya, A, Gupta, A &Verma, D 2016, 'Banana Fibre Reinforcement and Application in Composites: A Review', Green Approches to Biocomposite Materials Science and Engineering, pp. 27.

6. Ozdemir, T &Mengeloglu, F 2008, 'Some Properties of Composite Panels made from Wood Flour and Recycled Polyethylene', International Journal of Molecular Science, vol. 9, no. 12, pp. 2559-2569.