

Sisal Fiber Carbon Strengthened Composite PCM for Superior Thermal Energy Storage

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ABSTRACT: The composite phase change material is used to the thermal energy storage. PCM is more application to reduce the problem and improve the thermal energy storage by using of composite PCM. The main material is paraffin wax is supporting a fiber carbon. It is prepared by carbonizing in automashpher by using sisal fiber carbon structure is Miskito net shape. Composite is good thermal conductivity and chemical conductivity by using carbon. Low cost of sisal fiber as main advantage is high thermal conductivity. Paraffin and carbon is good component of PCM.

KEYWORDS: phase change material; thermal energy storage system; composite material

I. INTRODUCTION

Composite phase change material is used to thermal energy storage and solar thermal energy storage collection and boiler condenser waste heat recovery. Thermal energy can be temporary storage and released process this is call phase change. Using the paraffin is solid to liquid phase transfer. More type of phase change material in thermal energy storage system. Phase change material is more application of high thermal energy storage. It is easy phase change and high thermal conductivity in composite PCMs good formation and good condition, good chemical conductivity of PCM used natural material is sisal fiber. Other PCM are high leakage problem in liquid stage. The application of PCM is thermal energy storage. Composite PCM is good performance and no leakage problem and longtime service of the composite PCMs.

A preparation of carbon is used to composite PCMs to increase the thermal conductivity. To using carbon to improve the thermal conductivity carbon is block. Easy to observed the heat. To using the low cost material to use producing carbon such as cotton cloth (or) aluminum foils carbon is producing in sisal fiber.

II. EXPERIMENT

Preparation of composite phase change material by using of sisal fiber carbon and paraffin wax Sisal fiber is 1m length to cut 10cm length. To make sisal rope is three type one 2cm diameter and other is 2.5cm and 3cm diameter. There are three sample in this experiment. The fiber well fixed by a wrapping with a cotton cloth. Samples are carbonized under the atmosphere air at 500oc. sisal fiber prepare carbon scaffolds with different size and diameter after carbonization. The diameter of samples at 1.5cm, 2cm, and 2.5cm diameter the samples are cylindrical shape it is c1, c2, and c3. The three carbon scaffold have different density of 0.068, 0.086, and 0.162g cm⁻³ respectively. Paraffin wax is provided royal scientific shop. Paraffin wax is melting at 85oc samples are dipping at paraffin. Samples observe the paraffin. It is call composite phase change material.

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Fig 1 Sisal Fibre



Fig 2 paraffin wax

To take difference scanner to test the thermal conductivity. Test are SEM, FTIR, DSC, TGA. SEM (scanning electron microscopy), FTIR (Fourier transformation infrared spectroscopy), TGA (thermo gravimetric analysis), DSC (differential scanning calorimetric)

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Fig 3 After heat treatment samples

III. RESULT AND DISCUSSION

Preparation of composite phase change material carbon is produce carbonized process. Fig 3 shows the procedure of composite phase change material. Sisal fiber is raw material of the carbon producing at carbonizing process and to take different test. SEM image is to take structure of carbon and combination of paraffin in carbon different μm shown in fig 4. In SEM image shows the mixing of sisal fibre and paraffin wax. The various images indicate the various composition of sisal fibre samples.

FTIR is to take the IR (4000- 400 cm^{-1}) good chemical conductivity Infrared spectroscopy is nondestructive technique for materials analysis and used in the laboratory for over seventy years. Infrared absorption spectroscopy is the study of interaction of infrared radiation with matter as a function of photon frequency. Fourier Transform Infrared Spectroscopy (FTIR) provides specific information about the vibration and rotation of the chemical bonding and molecular structures, making it useful for analyzing organic materials and certain inorganic materials.

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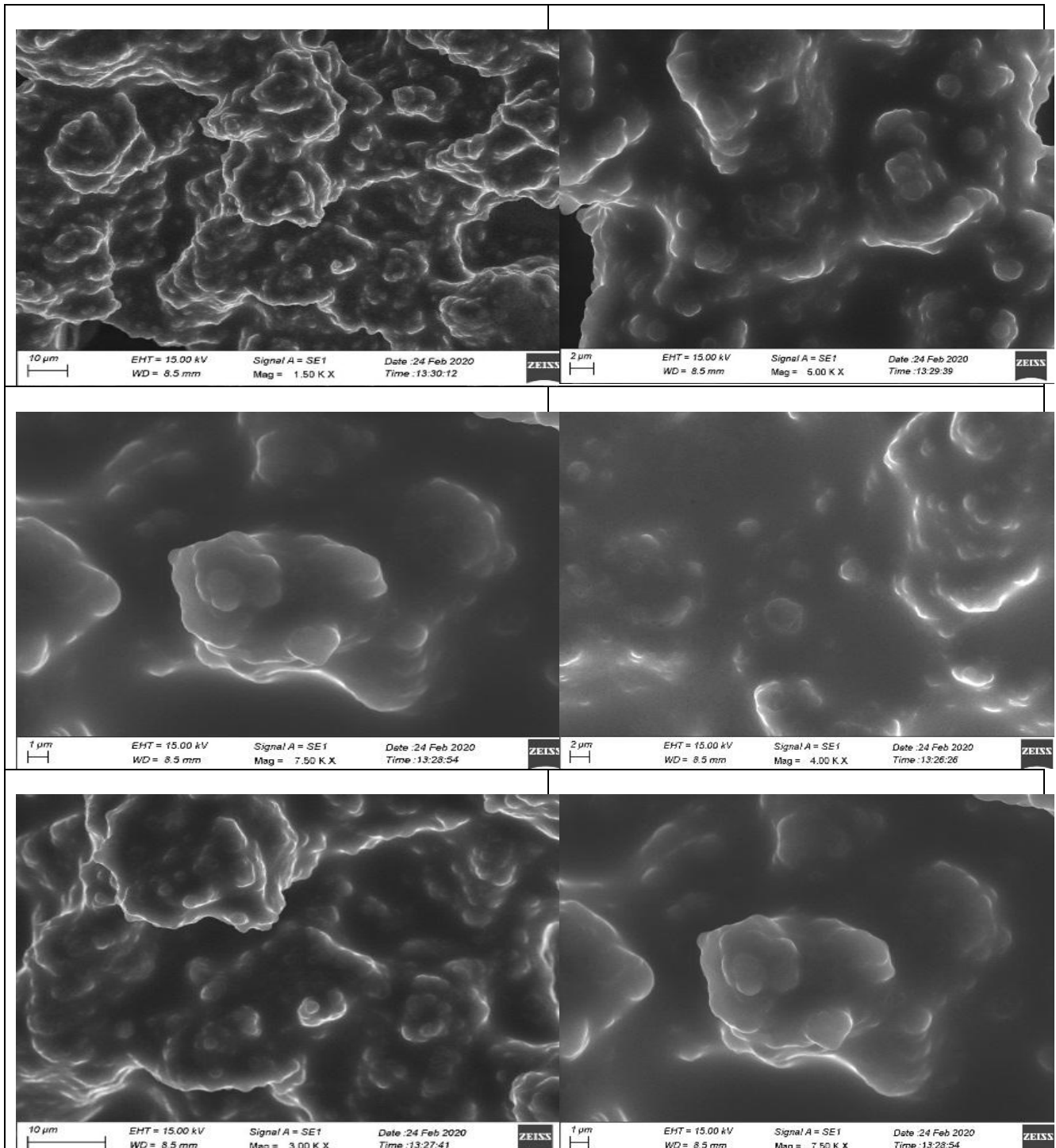


Fig 4 SEM image sample 1, 2, 3

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An infrared spectrum represents a fingerprint of a sample with absorption peaks which correspond to the frequencies of vibrations between the bonds of the atoms making up the material. Because each different material is a unique combination of atoms, no two compounds produce the exact same infrared spectrum. Therefore, infrared spectroscopy can result in a positive identification (qualitative analysis) of every different kind of material. In addition, the size of the peaks in the spectrum is a direct indication of the amount of material present. With modern software algorithms, infrared is an excellent tool for quantitative analysis.

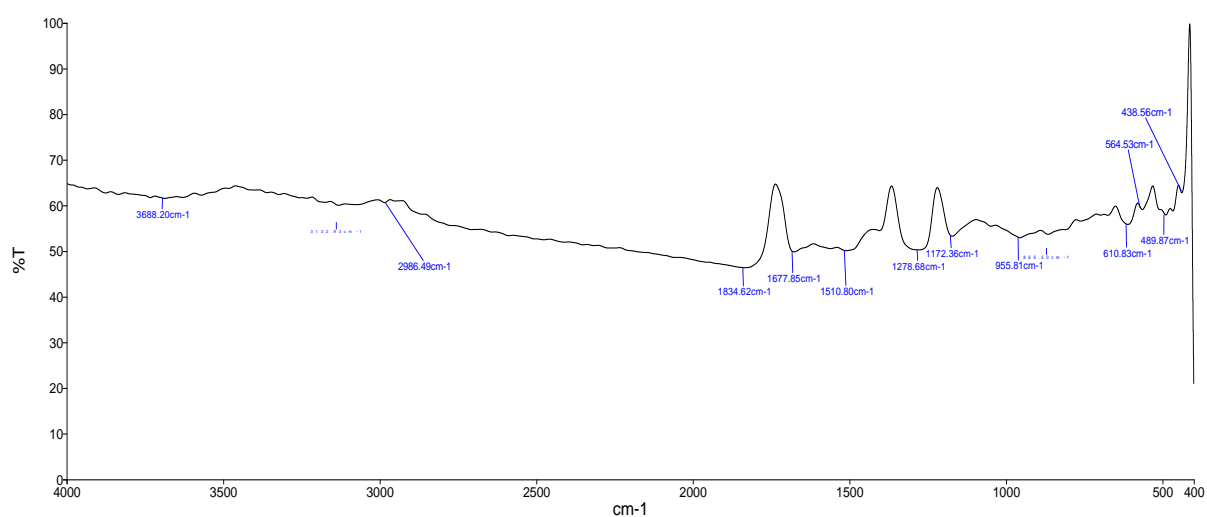


Fig 5 FTIR test sample 1

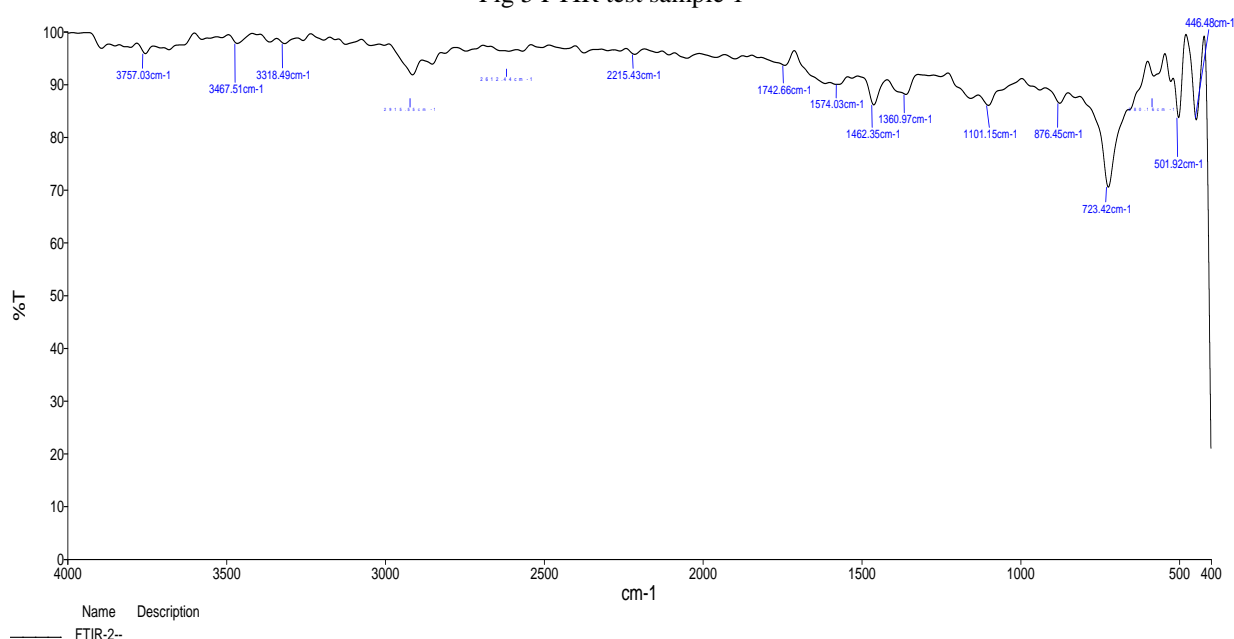


Fig 6 FTIR test sample 2

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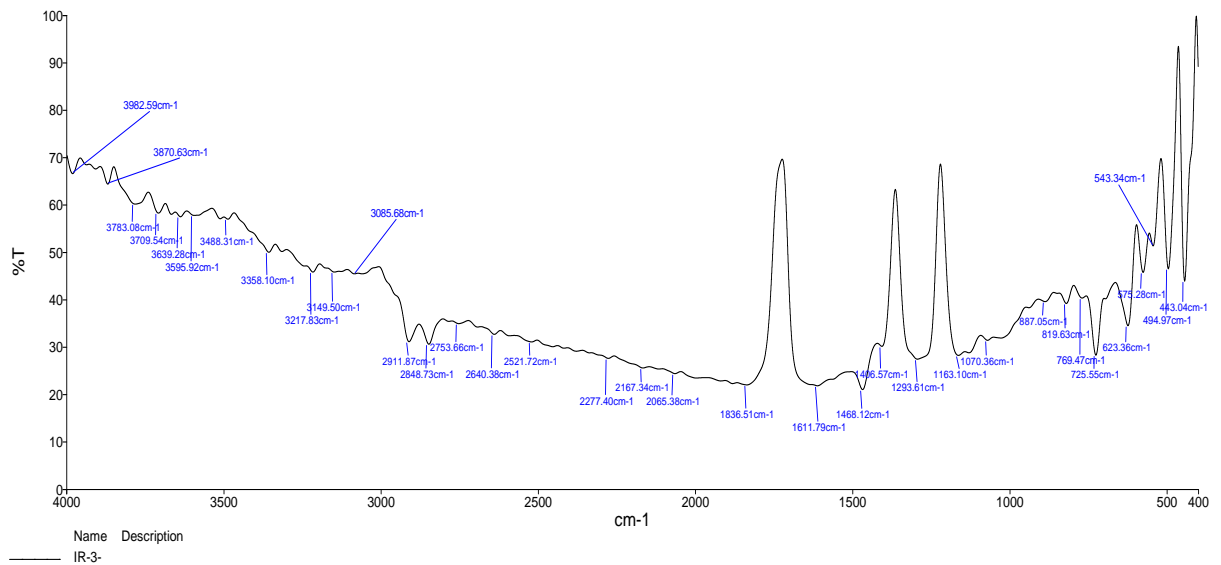


Fig 7 FTIR test sample 3

Differential scanning calorimetric is a technique determining the variation in the heat flow given out or taken in by a sample when it undergoes temperature scanning in a controlled atmosphere. With heating or cooling any transformation taking place in a material is accompanied by an exchange of heat DSC enables the temperature of this transformation to be determined and the heat from it to be quantified. Thermo gravimetric (TG) is a branch of thermal analysis examining the mass changes of a sample as a function off temperature (in the scanning mode) or as a function of time (in the isothermal mode). Thermal gravimetric analysis or thermo gravimetric analysis (TGA) is a method of thermal analysis in which changes in physical and chemical properties of materials are measured as a function of increasing temperature (with constant heating rate), or as a function of time (with constant temperature and/or constant mass loss).

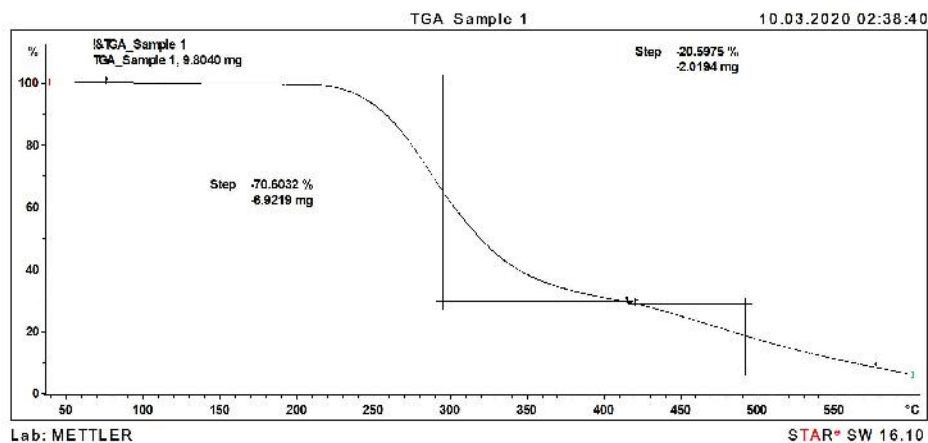


Fig 8 TGA Sample 1

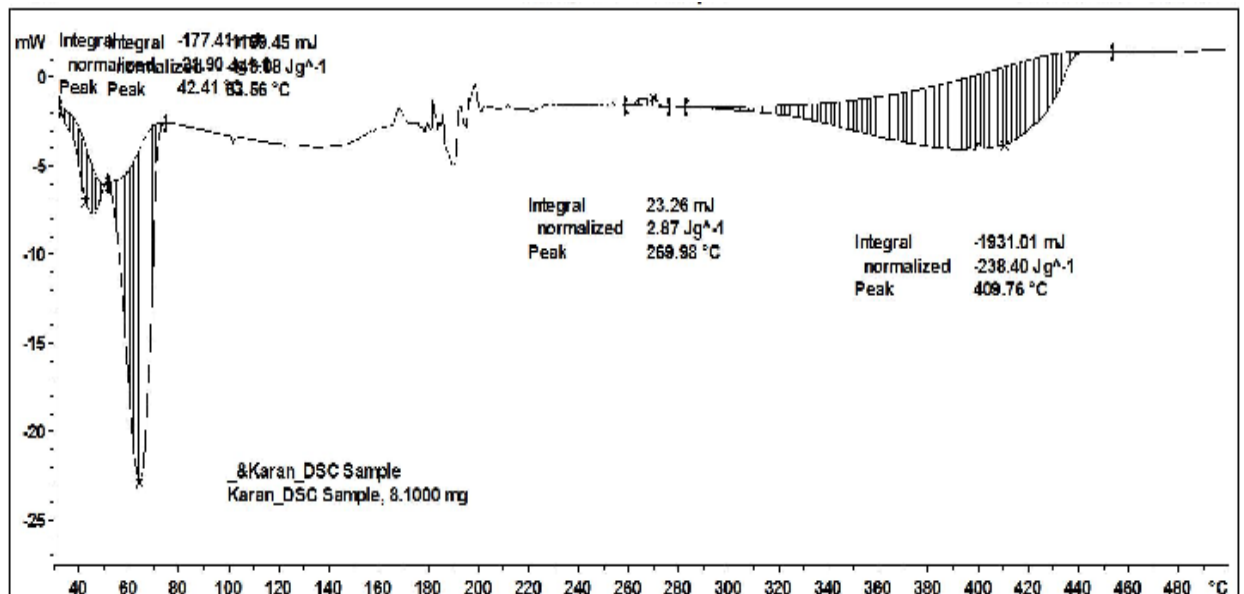


FIG 9 DSC sample 2

IV. CONCLUSION

In conclusion, composite PCMs with increased thermal storage performances were ready by vacuum incorporation of paraffin into porous carbon scaffolds that were consisted of carbon fiber bundles. The porous and honeycomb-shaped carbon fibers were ready by the direct destructive distillation of biomass sisal fibers. By pre-aligning the sisal fibers, carbon fiber bundles with thermal conductive property were obtained. Finally, the biomass staple was cheap, and thus the preparation of sisal-derived carbon scaffold was terribly simple. In addition, the fibers may well be simply formed to numerous architectures for numerous applications. All of those may promote the smart applications of sisal-derived carbon supported composite PCMs for thermal energy storage

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