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★★★★★ FIVE STAR CHAPTER

ASM International, Pune Chapter

Chapter News Letter

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EDITORIAL...

Happy New Year 2016!!!

We at ASM International – Pune Chapter are especially excited due to arrival of new year. We are organizing Mega Event M&MT 2016 in the February on 24th & 25th. We have been working tirelessly since early part of 2015 to make this event a mega success. All of us will get a chance to meet best minds in Material field & get an opportunity to witness latest innovation in the field of Materials. GME- 2013 had an overwhelming response, thus to better accommodate all the participants, we will be organizing event at 6500 sq ft venue at Hyatt – Regency, Nagar Road, Pune..

ASM International has recognized our website and now it has been linked to global website, it is also available in your Member's section page at www.asminternational.org.

Looking forward to meet you at our mega event M&MT-2016.

L. D. Deshpande
Editor

From Chairman's Desk

Greeting from Pune Chapter of ASM International !!

We are pleased to inform you that the Conference and the concurrent exhibition which Pune Chapter has organized on “Materials and Manufacturing Technologies” with special focus on Automotive Power Trains on 24th and 25th February 2016 at Hotel Hyatt Regency, Nagar Road Pune, has progressed well.

We have received more than 15 Technical papers from well known authors, 9 of them from Germany, Italy, France and USA. The topics range from Plasma Nitriding to Vacuum heat treatment, Instrumentation, Lubricants and quenchants. The unique feature of the conference would be a special session on Field Failures of power train components, where Experts with more than 25 years of practical experience would discuss the case studies and offer solutions.

More details about the entire event are available on our Website www.asmpunechapter.com and the attached brochure. With such a strong technical content and opportunity to interact with world known technical authorities in diverse fields, we expect that more than 200 delegates would attend the proceedings.

The concurrent exhibition has also invoked encouraging response with about 20 exhibitors with confirmed bookings and another 10 in the pipeline. We, therefore, are confident that the event would meet all expectations of the participants with guaranteed take-away from the conference.

Advancements in Shot Peening Technology by Mr. Steven E. Ferdon

A technical presentation on advancements in Shot Peening Technology was arranged by ASM Pune Chapter on 14th Oct 2015. There were nearly 100 participants for the talk.

Mr.Ferdon, Global Director of Engineering Technology, Cummins Fuel Systems spoke on the advantages of Shot Peening in overcoming fatigue failure. He spoke at length on the new developments like ultrasonic shot peening and its advantages over conventional Shot Peening. There was a lot of enthusiasm shown in this talk, which was reflected in the questions & answers session.

Steve Ferdon giving his talk

The Question and Answer Session

Felicitation

A grand felicitation programme facilitating Dr. P.G..Renavikar and Mr. .K.C.Gogate on their completion of 75 years of age was arranged by ASM Pune Chapter on 14th Oct 2015,

Dr.Renavikar and Mr.K.C.Gogate were felicitated by the Chairman, Past Chairmen of ASM Pune Chapter, Chairman,ASM India National Councill and well-wishers.

Dr P.G..Renavikar has been the past Chairman of ASM Pune Chapter, Past Chairman, ASM India National Council.He is very active in ASM activities..He has chaired many ASM, Pune forums, and a guiding star for all ASM Pune activities.The recently concluded three day session on failure analysis owes all its success to Dr. Renavikar.

Mr.K.C.Gogate is another stalwart of ASM, Pune Chapter. He is the longest serving member of ASM, Pune Chapter.He is very active in all ASM events, and has been the Convener for many a successful events of ASM, Pune chapter.

Dr. Renavikar being felicitated by Mr. Galagli

Mr. Gogate being felicitated by Mr. Arora

New Member Felicitation

We welcomed 21 new members who have joined our chapter in the recent past. The image shows Mr. L.D. Deshpande with the mementos.

Mr.C S Anwalikar of Bajaj Auto Limited receiving the award from Steve Ferdon

Basic and Advance Heat Treating

3 Days Proficiency Improvement Program on Basic and Advance Heat Treating was held at
ARAI Forging Industry Division, Chakan, MIDC, Pune from 12th to 14th October 2015.This program was held jointly by ASM, Pune Chapter and ARAI, Pune.
Renowned speakers having more than twenty years experience in heat-treatment delivered the lectures. Nineteen delegates participated in the program
The training program consisted of metallurgical & operational background of heat treatment process. It explained the basics of HT process, process controls, and how structures & mechanical properties can be achieved. It also elaborated process problems & their remedies, in addition to quality control procedures.
The course was designed for participants having little prior metallurgical training but having a basic understanding of engineering concepts. The course covered practical heat treating of carbon, alloy, stainless , tool steels and non ferrous materials.

Participants for the Basic and Advance Heat Treating Program

We are happy to announce that due to persistent efforts of ASM International – Pune Chapter & Indian National Council (INC), membership fee for New Individual Membership has been drastically reduced from $127 to $64 and for Individual Membership -Renewal it has been reduced from $107 to $54. I urge you to make use of this golden opportunity to enhance your ASM Membership benefits. I also urge you to spread the word, so that many deserving professionals in the field of Materials would benefit from this membership fee reduction. To join ASM International – Pune Chapter use membership form available on our website www.asmpunechapter.com

Failure Analysis

3 Days Proficiency Improvement Program on Failure Analysis was held at ARAI Forging Industry Division Chakan, Pune from 7th. To 9th December 2015.

The programme was held jointly by ARAI,Pune and ASM Pune chapter.

The present training programme was designed to cover the theory as well as the practical aspects of Failure Analysis. The course covered three principal topics of interest viz i) Procedure analysis, ii) Failure mechanisms, iii) and failure in product forms & components. Causes of failures were explained with easy to understand discussion on stress application and distribution. Various case studies of failure and their elimination were discussed.

The course was designed for participants having no prior metallurgical training, but have basic understanding of simple chemistry and physics.

There were 34 delegates for the course.

Participants for the Program on Failure Analysis

A session in progress

Technical Article
Jute Fibre Based Composite for Automotive Headlining

ABSTRACT

With increased awareness about environmental issues, the trend of automobile industry is to use 'Recycled' or 'Biodegradable' or 'Energy Recoverable' material. As a part of this programme, to make the vehicle 'Green' in nature, many automobile OEMs have taken the initiative to make use of natural fibre composite in their vehicles. Natural fibre based composite has been successfully proven for less critical as well as for semi-structural applications in an automobile. These typical applications are insulations, headlining, carpets, door pad etc.

There is a demanding task for automotive OEMs to meet 85% Recyclability and 95% Recoverability targets by year 2015. To meet the RRR (Reuse, Recycle & Recover) and the ELV (End of Life) regulatory requirements, increased use of natural fibre based composite/ biopolymers is unavoidable. Natural fibre can offer potential advantages such as weight saving and improve overall green rating of the vehicle. Use of renewable resources can also encourage thermal recycling.

This paper describes the application of jute based composite for 'Headlining', where the properties of jute based composites are compared with those of conventional polyurethane foam + glass fibres based headlining.

To address the limitation of lower strength of jute fibre, the basic substrate design of jute composite was optimized so that it offers properties equivalent / comparable to those of conventional polyurethane foam + glass fibre based material. In the proposed jute based composite, jute fibres are mixed with Polypropylene fibres to get stiffness for the substrate. The GSM (Grams per Square Meter) of jute based composite was selected in such a way that it addresses all the end product requirements such as flexural strength, adhesion, flammability, environmental resistance, thermal conductivity etc.

INTRODUCTION

Use of natural fibre based composite has a high potential. Natural fibres are bio based fibres from animal and plant origin. Many automotive OEMs have been working on natural fibre based composite to make their vehicle environmental friendly. The natural fibre composite material can be designed to alter the end product requirements. The methodology for development of natural fibre based automotive component can be useful to promote such type of materials.

To develop natural fibre based composite, the following challenges are to be faced:

- Meet stringent regulatory / safety requirements.
- Difficulty in meeting performance targets in terms of durability, strength, thermal resistance, weathering test etc.
- Manufacturability and processing related challenges
- Availability of fibres and its continuous supply.
- Non-uniformity in the properties of fibres.
- Control of fibre length and orientation.
- Fluctuation in prices depending upon the global demand and production.

However, considering the obvious advantages of natural fibre based composite, and the need to develop such type of materials, following steps were used for the development of the natural fibre based composite:

1) Identifying type of natural fibre

There are various types of vegetable fibres such as seed fibres (for example cotton), leaf fibres (for example banana, sisal), stem/ bast fibres (for example jute, hemp) etc [1,2]. The most commonly used vegetable fibres are cotton, flax and hemp. Comparatively jute, sisal, bamboo and coconut fibres find very limited applications in industry.

The factors below are considered for development of natural fibres based composite.

A) MATERIAL AVAILABILITY:

It is important to ensure abundant availability of the selected type of natural fibre before considering any application of natural fibre based composite in automobile industry. From the cost point of view, it is also important to have the local production of these fibres. The production and availability of the fibre depends upon geographical, environmental and climatic conditions.

As per the reports, India is the world leader in the production and utilization of the jute fibre [3]. India also has know-how about cultivation of the jute fibre.

Since ancient times, jute fibre was used for typical applications such as ropes, twines, textile, paper, household applications etc. Initially the fibre spinning process was by hand-mills. However after successful trails of fibre spinning machines, the jute industry flourished.

Jute fibre harvesting and cultivation

Jute is a rain-fed crop and it requires a warm and humid climate with temperature between 25° C - 38°C. Its cultivation is concentrated in Bangladesh, India, China and Thailand. Jute cultivation is concentrated in the region covering Bangladesh and West Bengal - India.

Jute cultivation involves following steps.

After sowing the seeds, which is generally done in rainy reason, harvesting is done after 3-4 months (i.e. after plants flower). Stalks are cut and tied into bundles. These bundles are soaked in water for fermentation. This process is known as 'Retting'. The bundles are then separated and fibres are stripped from the stalk. These fibres are washed in running water and dried [4]

Considering abundant availability of jute in India,

this fibre was identified for further development of natural fibre based composite.

B) PROPERTIES AND INFORMATION ABOUT JUTE FIBRE

Jute fibre is a natural vegetable type fibre having silky appearance and also known as 'Golden Fibre'. They can be spun into coarse string threads and hence find applications in packaging such as ropes, sacks and gunny bags. This fibre is renewable in nature and is biodegradable and recyclable. Jute fibres have low thermal conductivity and good compatibility with other thermoplastic fibres. Jute requires very low energy for processing and hence it is very attractive material for polymer composite. Jute fibres have good resistance against chemicals.

Properties of Jute fibres in comparison with other types of fibres are mentioned in Table 1.[5]

Table 1. Properties of jute fibre in comparison with other fibres

Fibre	Density (g/cm^3)	Tensile Strength (MPa)	Young's Modulus (GPa)	Elongation At break (%)	Specific Tensile Strength ($MPa/g.cm^{-3}$)	Specific Young's Modulus ($GPa/g.cm^{-3}$)
Jute	1.3-1.45	393-773	13-26.5	1.16-1.5	286-562	9-19
Flax	1.5	345-1100	27.6	2.7-3.2	230-773	18
Ramie	1.5	400-938	61.4-128	1.2-3.8	267-625	41-85
Sisal	1.45	468-640	9.4-22.0	3-7	323-441	6-15
Coir	1.15	131-175	4-6	15-40	114-152	3-5
E-glass	2.5	2000-3500	70	2.5	800-1400	28
S-glass	2.5	4570	86	2.8	1828	34

Limitations Of Jute Fibre / Jute Fibre Based Composite:

Before identifying the typical automobile component for jute based campsite, it was felt necessary to know the disadvantages or limitation of the jute fibre so that some modifications/ corrective actions can be taken in anticipation at the design stage itself.

Disadvantages of jute fibre are:

- Poor weathering resistance.
- Low mechanical properties in wet condition.
- Typical odor during processing and also on the end used product
- Microbiological attacks.
- Hard and unattractive fibre.
- Necessity of storage of fibres under control humidity
- Not recommended for electrical applications due to high moisture content.
- Poor wettability with other resin.

2) Identifying Suitable Component For Automotive Application

Jute based composites find applications in packaging, building where high strength and load bearing is not important. Jute composites for non-structural applications promise excellent potential. Potential application of jute would be semi-structural components such as seat upholstery, pillar trims etc.[6]

It is common practice to make jute fibre based composite by, blending jute fibres with

Polyethylene / Polypropylene fibres or by using thermosetting resin as binder.

Considering limitations of jute fibres, such as poor weathering, bad odor, mouldability, 'headlining substrate' is identified for development of jute fibre based composite.

For headlining, there is top fabric which is adhered on the substrate and hence jute fibres directly would not be exposed to the weathering. In addition, though jute based composite is unattractive, it is covered from one side with the top fabric which is the seen part of the headlining.

3) Component level requirements for headlining

i) Headlining should have good adhesion between various layers and have wrinkle-free surface:

As per the design of the headlining, there is a top fabric which covers the substrate. If the substrate is planned to be made up of jute fibre, then this substrate should have good adhesion with top fabric.

ii) Headlining should be easily moldable and should take the required shape:

The substrate along with top fabric should be moldable. It should take the shape of the mould. The design of the Headlining should be such that it has limited draw.

iii) Headlining should have thermal insulation:

Headlining also acts as an insulating layer and reduces the cab temperature from outside sunlight heat.

iv) Headlining should have good stiffness and mechanical properties.

These properties have to take care of headlining during storage, transportation and use.

v) Headlining should meet vehicle level RRR (Reuse, Recycling and Recover) requirements:

Material is preferred to be 'Green' in nature and preferably should be biodegradable.

vi) Headlining should meet weathering test requirements:

Since the top polyester fabric would be directly exposed to weather, jute fibres based substrate will not directly get exposed to weather.

4) Comparison with Existing Material of Headlining i.e. Glass fibre + PU foam based

i) General properties: The most popular design of headlining consists of Polyurethane foam and glass fibre. Generally in headlining, glass fibres are used for getting strength and rigidity. Jute fibre has lower density, (approx 1.3 – 1.4 gm/cc) and hence lighter than glass fibre (Density approx 2.5 g/cc). Stiffness of glass fibre is 1.5 to 4 times than that of jute fibre. Tensile strength and young's modulus of jute is lower than those of glass. It is also known that jute fibres show good compatibility with other fibres including polypropylene [7], polyester, rayon etc. The lower stiffness of jute fibre based substrate can be addressed by mixing the jute fibres with Polypropylene fibres.

ii) Environmental impact during manufacturing and disposal

As per new RRR and ELV regulations, it is the responsibility of an automobile OEM to dispose the vehicle at the end of its life.

For efficient disposal of materials, an organized waste management system is required. As per standard practice of ELV - disposal, all fluids, batteries, tyres, glasses and major plastic parts are generally recycled. Disposal of small plastic components, elastomers (except tyres), electrical components, fabrics etc is a global problem.

In case of glass fibre + Polyurethane foam based headlining; the material is non-recyclable and non-recoverable. This material is generally incinerated

or landfilled. However incineration or landfilling of glass fibres is an environmental hazard.

In comparison, jute being natural fibre is biodegradable in nature. The natural fibres reduce environmental hazards even after landfilling. Besides this, jute fibres are very safe to handle, process and use as compared with glass fibres. Glass fibre manufacturing also requires high energy consumption than jute.

EXPERIMENTAL

A) Material construction

Figure 1(a) shows the construction of conventional Polyurethane and glass fibre based headlining. There are seven different layers of materials namely, Polyester Fabric, Polyethylene film, Glass fibres, PU Foam, Glass fibres, Polyethylene film and process fabric. Based on the stiffness requirement, GSM (Grams per square meter) of the layers varies.

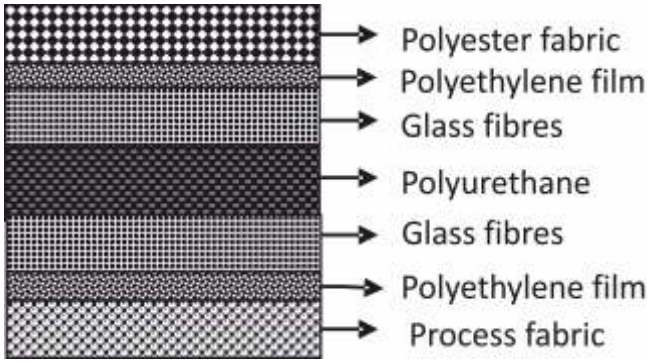

Fig. 1 (a). Construction of Conventional Headlining.

Figure 1(b) shows the construction of Jute based headlining having only two layers. Its substrate is made up of Jute and Polypropylene fibres which are needle punched. A top non-woven fabric layer is adhered on it.

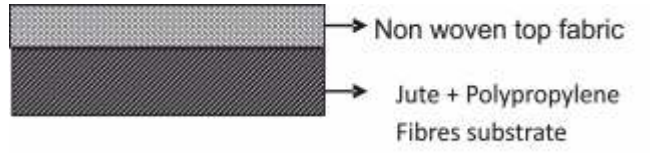

Fig. 1 (b). Construction of Jute Based Headlining.

B) Material properties of substrate

I) GSM

For all type of insulations such as carpet, headlining, cab insulation etc, GSM is an important criterion to be considered.

NVH and Air Conditioning performance, stiffness of the material improves with GSM. However with an increase in the GSM, the cost and the weight of the material also increase. Higher GSM material also leads to difficulty in moulding.

Hence it is important to optimize the cost and performance of the material by selecting an appropriate GSM value. To finalize the GSM of Jute based substrate, samples of 650, 850, 1150 and 1350 GSM were made. The GSM values for the top fabric was kept constant and only the GSM of the substrate was varied. Samples of jute composite with various GSM were tested for flexural tests.

ii) FLEXURAL STRENGTH

Flexural strength is the ability of a material to resist deflection under load. The formula for calculating flexural strength test is as follows

$$\text{Flexural strength} = (3 \times F \times L) / (2 \times b \times d^2)$$

Where, F is load (force) at the fracture point

L is length of the support span

b is width

d is thickness

Flexural strength test is carried out on the jute based substrate having different GSM values. Three point bending test is carried out by cutting strips of 150 mm x 25 mm from the composite material. Sample thickness of 100 mm was made by piling the samples on one another. The formula 1 was modified to

$$\textbf{Flexural strength} = 3 \times F(20) \times L / 2 \times b \times d^2$$

Where F (20) is load measured at 20 mm

deflection.

The details of three point bending test are as follows:

Span length: 50 mm

Thickness of sample: 16 mm

Width of sample: 50 mm

Loading rate: 10 mm/min

Machine used: Instron

Table 2 gives the flexural strength test results for jute fibre based substrate as a function of GSM.

Sample GSM	Measured GSM	Flexural Strength (N/mm^2)
700	748.244	0.43
850	837.016	0.45
1150	1041.6	1.60
1500	1475.98	1.61

Table 2: Flexural Strength as a Function of GSM.

For comparison purpose, flexural strength test is also carried out on the conventional material (i.e Polyurethane foam and glass fibres combination).

Figure 2 shows the flexural strength comparison of Jute fibre based composite and conventional Polyurethane + glass fibres.

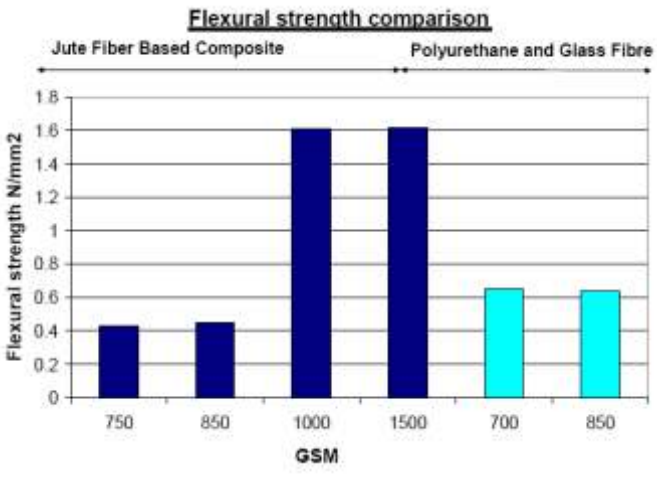

Fig. 2. Flexural strength comparison between conventional (PU + Glass fibre based) material and Jute fibre based composite

Remarks

1) At lower GSM, conventional material (Polyurethane Foam+ glass) shows a higher value of flexural strength as compared with Jute fibre based composite. It can be noted that to match the stiffness properties of Polyurethane + glass fibres, jute fibre based composite will require higher GSM.

2) Flexural strength of Jute fibre based composite was found to improve significantly when GSM value is increased from 800 to 1000

3) Based on above, the 1000 GSM value was selected for jute fibre based composite headlining for carrying out further trials for development purpose. Jute fibre based composite was tested and subjected for long duration tests to evaluate and determine the performance and suitability for headlining.

iii) Thermal conductivity

Thermal conductivity properties give information about the ability of a material to conduct the heat. Since headlining as a component also contributes in A.C performance, thermal conductivity test was carried out on the jute fibre based composite with 1000 GSM. The results of thermal conductivity were compared with conventional PU foam and glass fibre based material of headlining.

Thermal conductivity is defined as:

$$k = (H \times L) / [A \times t(d)]$$

Where,

k is thermal conductivity

H is voltage x current x power factor

A is area

t (d) is difference in the temperature between top and bottom plate.

L is thickness.

A test was carried out by placing the test sample of actual thickness between two metallic plates. One plate is kept at high temperature and other at room temperature. The temperature difference between the two plates was measured. The thermal conductivity values of Jute fibre based composite & PU + Glass fibre composite was measured at various temperatures. Figure 3 gives the comparison of the thermal conductivity between jute fibre based composite and Polyurethane foam+ glass fibre composite.

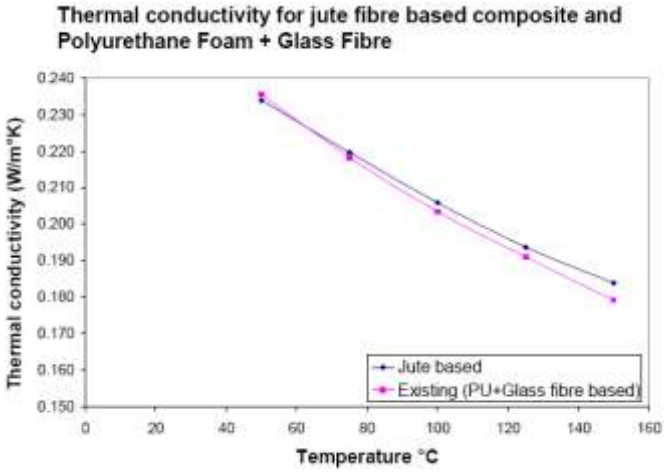

Fig. 3. Thermal conductivity comparison between jute fibre based composite and Polyurethane foam+ glass fibre composite.

Remarks: Thermal conductivity values of existing PU foam + Glass fibre based headlining and Jute fibre based composite with 1000 GSM are almost comparable.

v)Environmental Test

Automobile interior components are always tested for high and low temperatures. Low temperature requirements for performing the tests are selected based on ambient temperature condition. However, for high temperature selection factors such as greenhouse effect, sun load factors are to be considered. In an automobile, sunlight pass as a medium through windshield glass, door glass, rear glass etc. But infrared light having longer wavelengths are unable to escape from the glass. Due to trapping of the long wavelength infrared rays in the passenger compartment results in more heating and cabin temperature increases.

Considering this phenomenon, automobile OEMs carry out temperature mapping under worst conditions. The high temperature requirement is generally selected from the temperature mapping exercise. Based on the design of the vehicle, the number of doors, the surface area of the glass etc, the temperature conditions in the cabin change.

The Jute fibre based headlining was assembled on the mating part and was subjected to following temperature cycles. Inputs from temperature mapping were taken to design the test cycle.

a) High temperature test: At + 90°C for 24 hrs.

b) Low temperature test: At -30°C for 16 hrs.

c) High temperature test: At +90°C for 48 hrs

d) Humidity: At + 40°C,95% RH for 48 hrs

e) Low temperature test: At - 30°C for 8 hrs

f) Humidity: At + 40°C, 95% RH for 24 hrs

At the end of the test, the sample was inspected and observations noted. The sample showed no cracks or deformation or separation of layers. The top fabric was intact and was firmly adhering on the jute fibre based composite substrate. This has met the environmental test requirements

v) Adhesion test

In check the adhesion between top fabric and jute based substrate after moulding, the peel strength was carried out. Refer figure 4 for the details. A sample of 25 mm wide and 125 mm long was cut and load required to separate top fabrics from Jute fibre based composite was measured. The adhesion of top fabrics with the substrate was found to be 58N/25mm, which can be considered as very good adhesion.

vi) Flammability test:

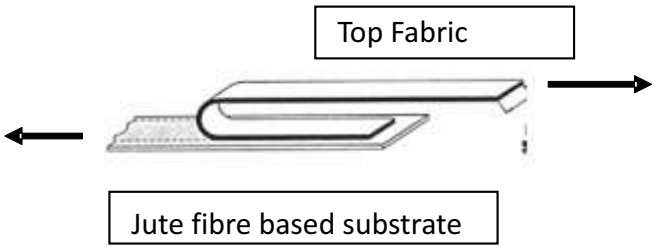

Fig. 4. Details of peel strength test

vi) Flammability test:

For automotive interiors components, flammability test as per FMVSS 302 or GS 98 is a regulatory requirement. Basically jute fibre is considered as fire retardant. However, the burning of Jute fibre based composite could be different due to presence of Polypropylene fibre and top fabric.

This flammability regulation is a safety measure which seeks to reduce the likelihood of injury or death that may result from a vehicle fire. The test is for measurement of burn rate of the material. In case of vehicle fire, the burn rate of the material of the component should be such that, occupants get sufficient time to escape from the vehicle in case of vehicle fire.

The Jute fibre based composite was tested for flammability test as per FMVSS 302 and GS 98 standards. The average burn rate of 12.80 mm/min was observed as against requirement of 102 mm/min (max) as per FMVSS 302 standard and 250 mm/min (max) as per GS 98 standard. The Jute fibre based composite was found to be slow in burning and meets the regulatory test requirements.

CONCLUSIONS

The natural fibre based composite for automotive interior is growing and demanding market. Use of natural fibre composites would increase in future due to enforcement of various environmental regulations, as natural fibre materials offer low environmental impact.

Though a lot of research is available on natural fibres based composite, its commercialization and actual implementation on the vehicle is always challenging for automotive OEM. The typical challenges are availability of the natural fibres, uniformity in properties, high moisture absorption leading lower mechanical properties, selection of compatible resins / fibres to enhance the mechanical properties to meet the end product requirements.

Based on the study, Jute fibre based composite with 1000 GSM was found to be meeting all the end product requirements and hence is very attractive material for headlining. Jute fibre based composite can be considered as an alternative to glass fibre based composite , as it offers potential advantages of weight saving, cost saving and has an ecological advantages of using renewable resources. Jute fibres are compatible with Polypropylene fibres, which enhance the stiffness and the mechanical properties of the composite.

With the selection of type of natural fibre, identifying an automotive component and by altering the design parameters to suit the manufacturing process, it is possible to make use of various types of natural fibres composites to meet the cost and the performance targets.

FUTURE WORK

Natural fibre based composite is considered as green material based on its environmental impact during usage. Being bio-degradable in nature, disposal of these composites does not cause damage to environment. However it would be necessary to study the environmental impact during manufacturing and processing of these fibres. It is necessary to give green rating to the natural fibre only after in-depth LCA is carried out.

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Amita Sathaye did her B.E in Polymer Engineering. She has over 20 years experience in Polymer material selection, Automotive testing & validation, advance polymers for weight reduction, new polymer technologies, Environmental regulatory compliance (ELV/RRR/REACH), Adhesives & Sealant.

She has six international Papers to her credit. She has filed for three patents & given many international presentations.

Know Our Members

Mr. Sushan Chakravorty is presently the General Manager and Heading the HTC or Heat Treatment Components Division of LOI Wesman Thermprocess Private Limited, Calcutta. He is a B.E.(Electrical) from Jalpaiguri Government Engineering College, North Bengal University, West Bengal and P.G.D.B.M from Indian Institute of Social Welfare and Business Administration (I.I.S.W.B.M), Calcutta.

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