DEVELOPMENT OF A NEW COMPOSITE MATERIAL WITH IMPROVED STRUCTURAL AND ACOUSTICAL PROPERTIES FOR AUTOMOTIVE INTERIORS

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Introduction

The use of thermoplastic composites is growing rapidly in the automotive interiors segment. Headliner systems are getting more modular and use of audio-visual and other electronics is increasing. With the introduction of the FMVSS 201 requirements for head impact, the conventional substrate technology used today is becoming costly. In this paper, we present the development of a new type of thermoplastic composite material with enhanced acoustic and semi-structural properties. This new substrate material of glass/PP is manufactured using a proprietary process and is available at various weights and glass contents. The material can be molded to shape and the special re-lofting characteristics of the composite allow parts of varying thicknesses to be molded in a single shot. This allows greater design flexibility as both stiffness and acoustics can be controlled to meet today's changing requirements in automotive interiors. This new composite is usually made in three weights—800, 1000 & 1200 gsm, although it is possible to make it in both heavier and lighter weights if required. The composite is usually supplied with a scrim on one side and an adhesive film on the other. Headliners made from the composite have a much simpler structure than conventional polyurethane headliners (Figure 1).

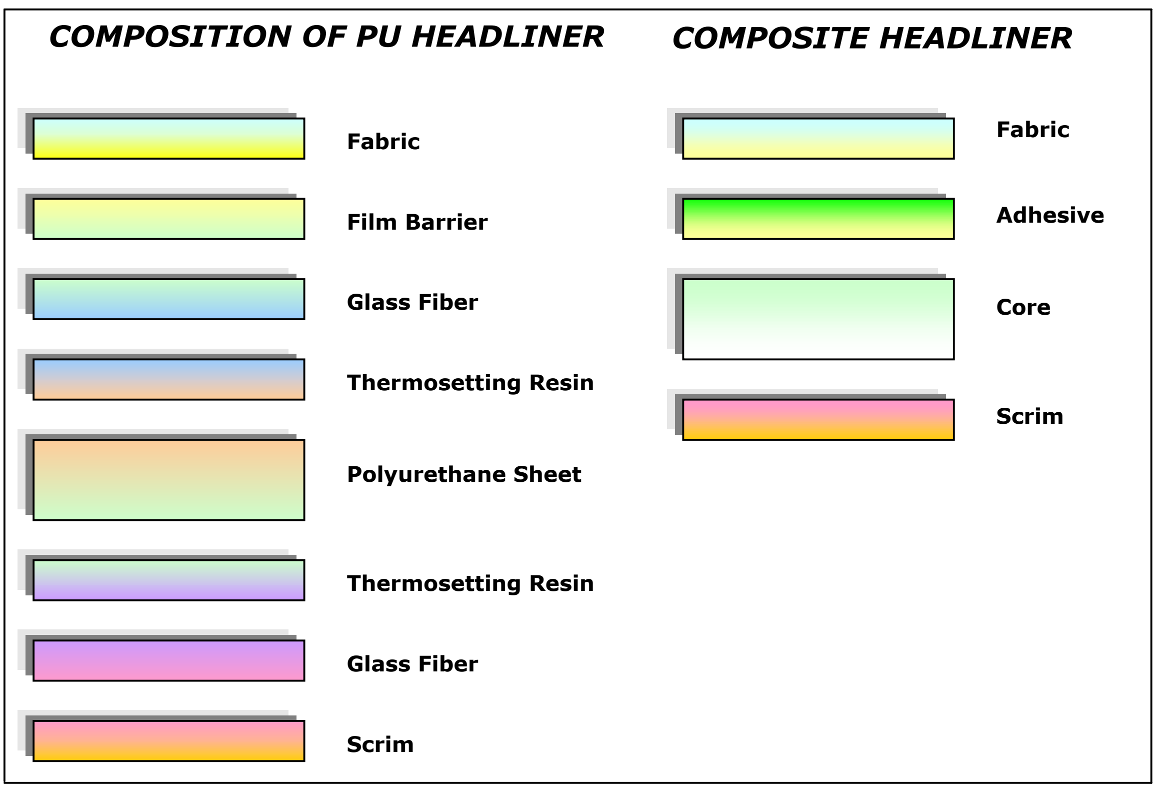


Figure 1 Comparison of Composite and DPU Structured Headliners

The type of adhesive film can be changed according to the type of fabric to be attached or the specific application required. This material is thermo-formable and capable of being molded on tools with deep draw and sharp corners. The composite can be heated by the more conventional contact heating but better cycle times can be attained when using forced air and IR heating methods.

Processing the New Acoustic Composite

The composite is easy to process when compared to other lamination processes. The blank, which can be heated by contact heat, forced air or IR equipment is shuttled into the mold along with a fabric. The hot strength of the material is sufficient to allow large blanks to be safely heated and shuttled into the mold. The molds are usually maintained at 110°F to allow for consistent processing at start up. The part can then be formed and trimmed by automated methods such as water jet trimming. Figure 2 shows typical headliner process comparisons between the composite and polyurethane.

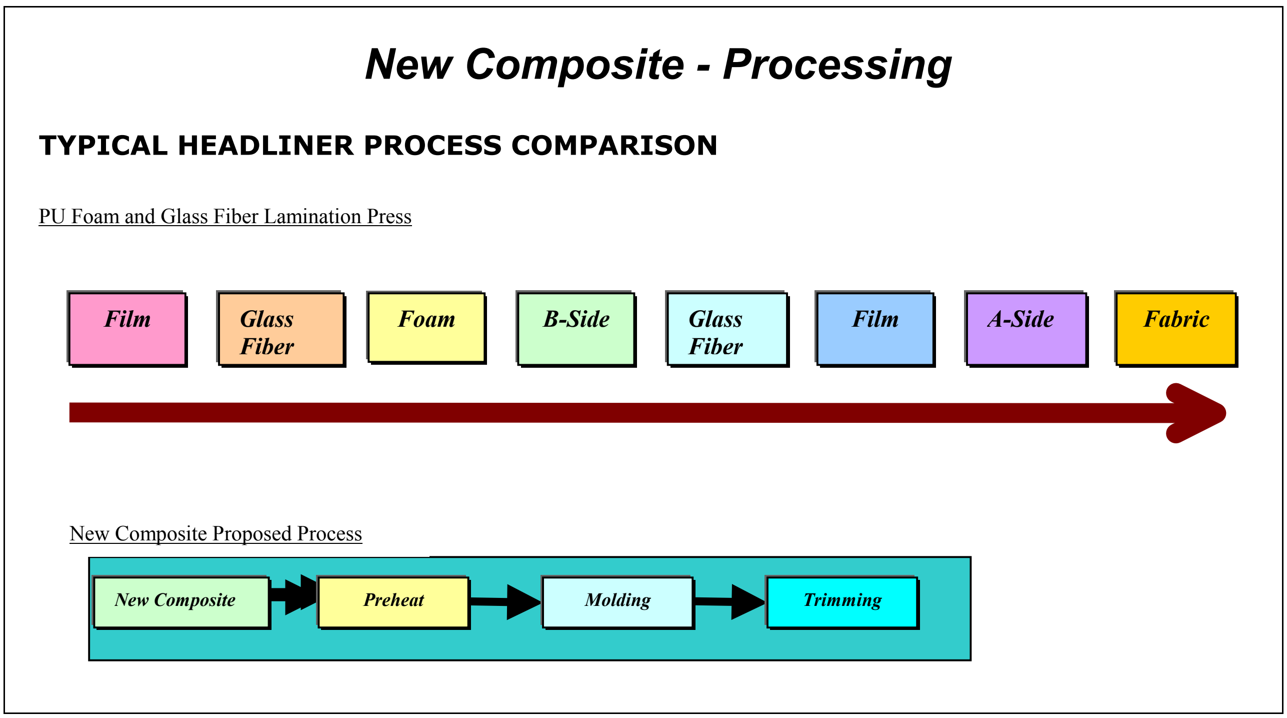


Figure 2 Headliner Processing Comparison

Lofting properties

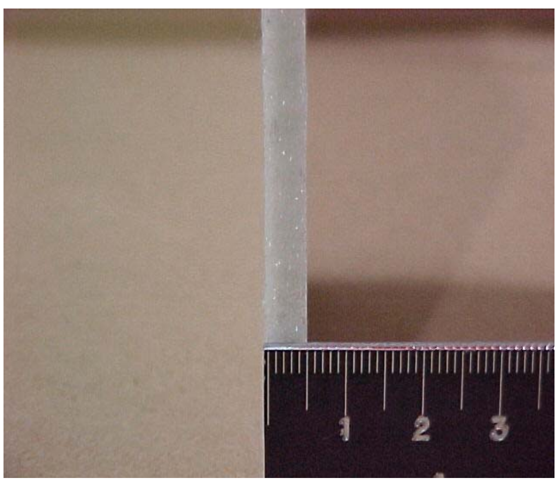
One of the unique properties of the composite is its lofting capability. As supplied, the composite varies from 4 mm to 7 mm thick, however, on heating the material lofts to more than twice its original thickness. This is of particular use when molding parts with different cross-sectional thicknesses. A complex part with different cross-sectional thicknesses can be molded in a single shot. Table I shows the lofted thickness compared to initial thickness of various weights of composite.

Table I. Lofting of Composite after Heat Treatment

	Thickness	
Basis Weight	Initial	Lofted
(gsm)	(mm)	(mm)
800	4	10-12
1000	5	12-14
1200	6	15-17
1400	7	17-19

Differential Construction

The composite can be molded to produce automotive headliners with selective properties in particular locations. This composite may be molded thicker in specific areas which require special head impact criteria (HIC) considerations while thinner locations may give areas of greater modulus and strength in order to hold attachments and inserts. Figure 3 shows an un-lofted sample of the composite at a basis weight of 1000gsm. This sample shows the initial sheet thickness after lamination of the adhesive and scrim layers to the glass/polypropylene core. Figure 4 shows the same composite sheet after lofting at 390° F.



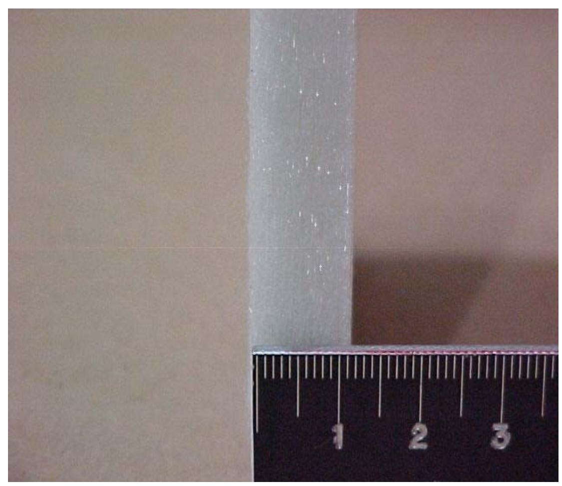


Figure 3 Composite @ 1000 gsm un-lofted (mm)   Figure 4 Composite @ 1000 gsm lofted (mm)

Mechanical Properties of Composite

The composite is manufactured in such a way as to minimize the difference between machine direction properties and transverse direction properties. This can be of great advantage during manufacturing and assembly of parts. Table II shows the molded properties of a sample of 800 gsm composite in both the machine and transverse directions when tested for flexural modulus according to J949.

Table II Flexural Modulus of Composite in both Machine & Transverse Directions

Flexural Properties of Composite @ 800 gsm					
Machine Direction			Transverse Direction		
Thickness	Peak Load	Flex Modulus	Thickness	Peak Load	Flex Mod
mm	N	MPa	mm	N	MPa
2.94	17.1	1048.3	2.94	17.8	964.1

Often modified J949 test methods are used to evaluate product stiffness. Such a modified J949 test expresses the stiffness in N/mm. Typical values for parts molded from the new composite and dry polyurethane are shown in Table III and plotted in Figure 5.

Table III Stiffness of New Composite Compared to Typical DPU

Stiffness (N/mm)		
Thickness	New Composite	Dry Polyurethane
(mm)	(N/mm)	(N/mm)
6	19.42	14.61
5	12.39	10.32
4	7.65	6.96
3	5.87	4.42

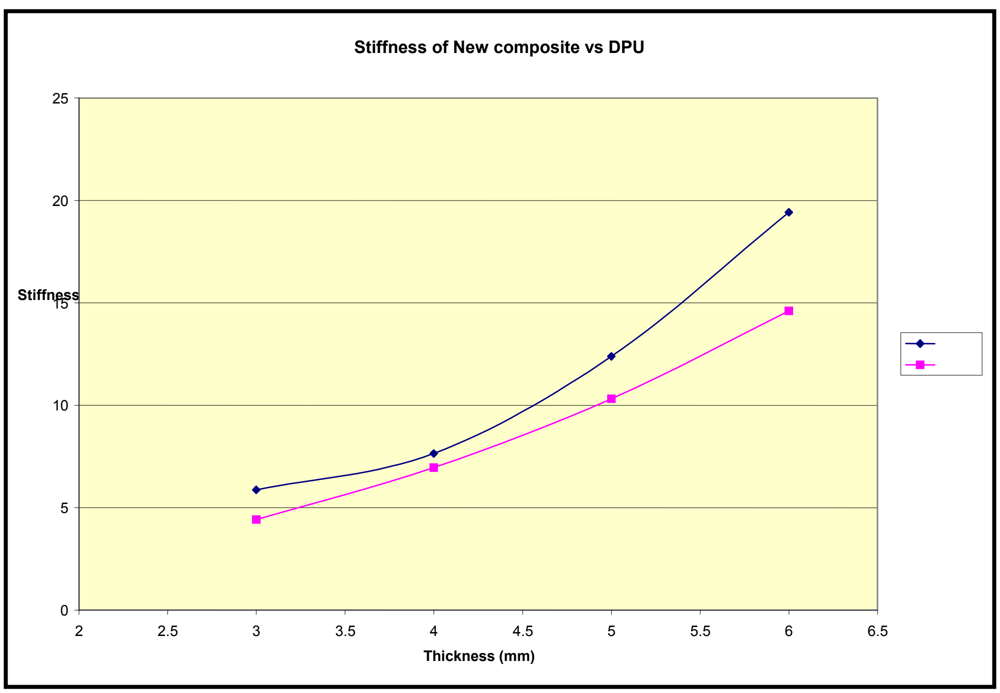


Figure 5 Comparative Stiffness of PP/Glass Composite to DPU

Acoustic Properties of Composite

The composite can be manufactured to show a range of acoustic properties. By modifying such properties as weight and material formulation, different acoustical properties can be achieved depending on the specific application requirements. Figure 6 shows the difference in Normal Incidence Absorption Coefficient between the composite at 1000 gsm and the composite at 800 gsm.

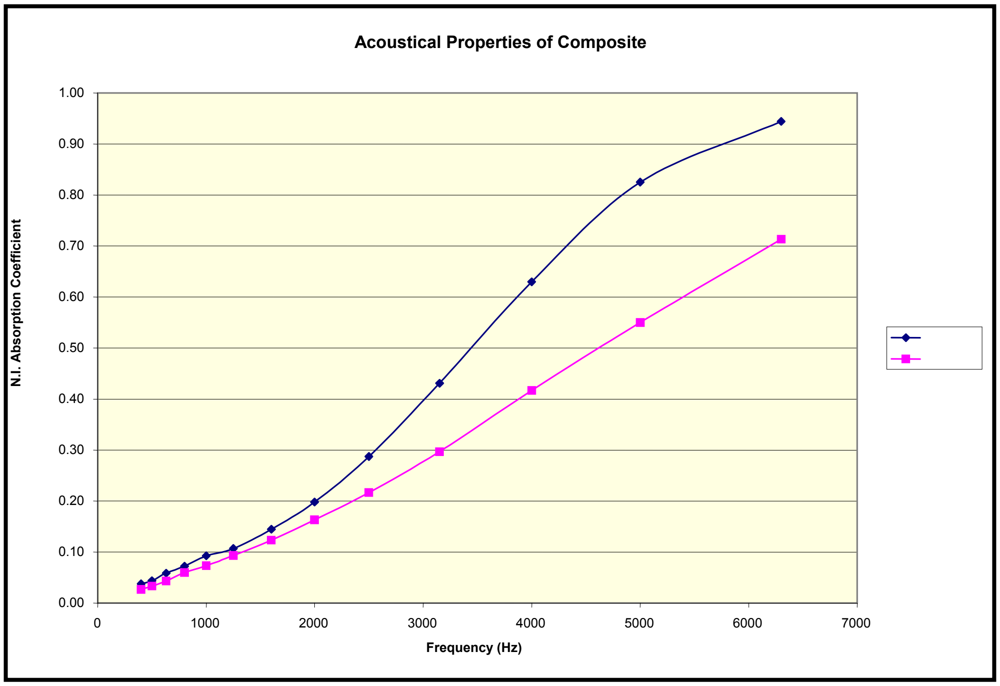


Figure 6 Normal Incidence Absorption Coefficient of Different weights of Composite

In general the composite has very good air flow characteristics, however, in certain applications it may be required to be impermeable to air. This is accomplished by the use of selected barrier films and special construction techniques. Thus the composite can be used in applications which require no air flow at all as well as applications which require good air flow.

The composite not only has directionality in the machine and transverse direction but also in the z-direction which gives enhanced acoustical properties. Figure 7 shows how the composite gives good acoustical properties whether laminated with perforated or non-perforated adhesive films where Film A is perforated and Film B is not.

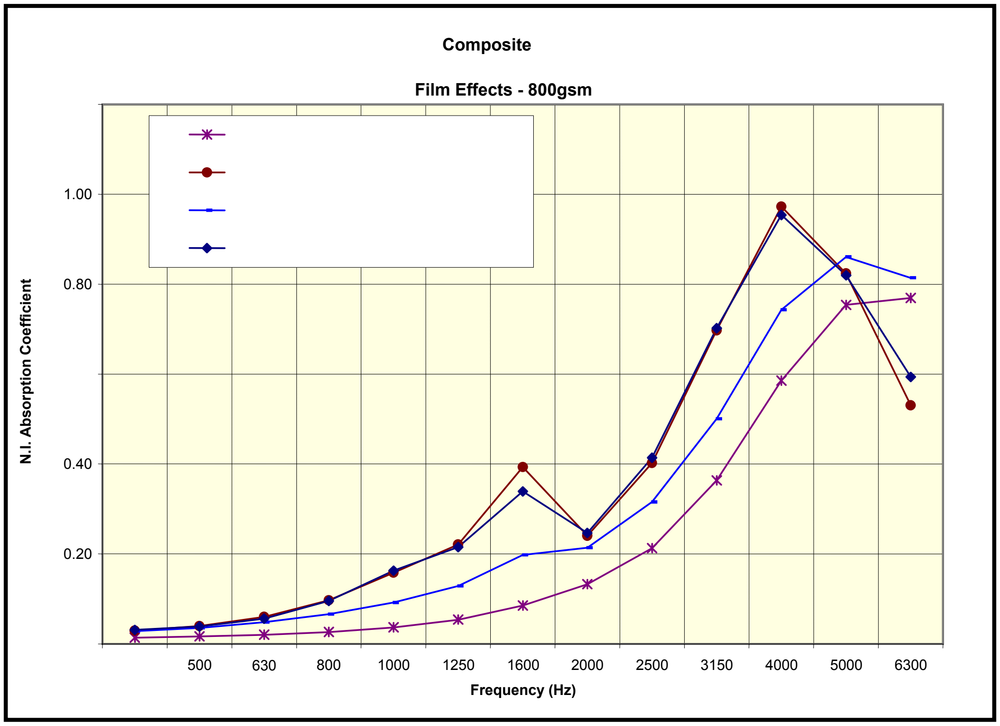


Figure 7 Composite with Different Adhesive Films

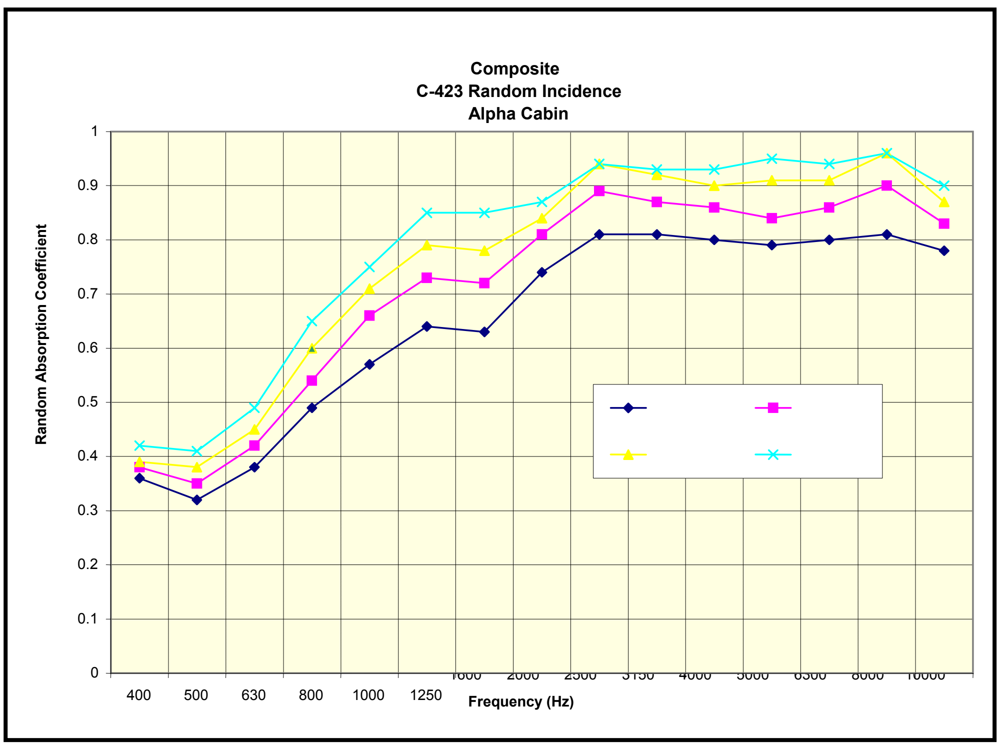


Figure 8 Alpha Cabin Evaluation of Composite at Different Weight

The composite with its high loft and high weights shows good absorption characteristics when tested in the Alpha cabin according to ASTM C423, see Figure 8.

Summary

The new composite is a glass/polypropylene low density semi-structural material which is capable of being molded, by a variety of different processes, into automotive headliners. The ease of use and simplicity of processing make this composite a material of choice for many applications. The flexibility of construction and formulation make this new composite an adaptable material suitable for acoustical as well as semi-structural applications.

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