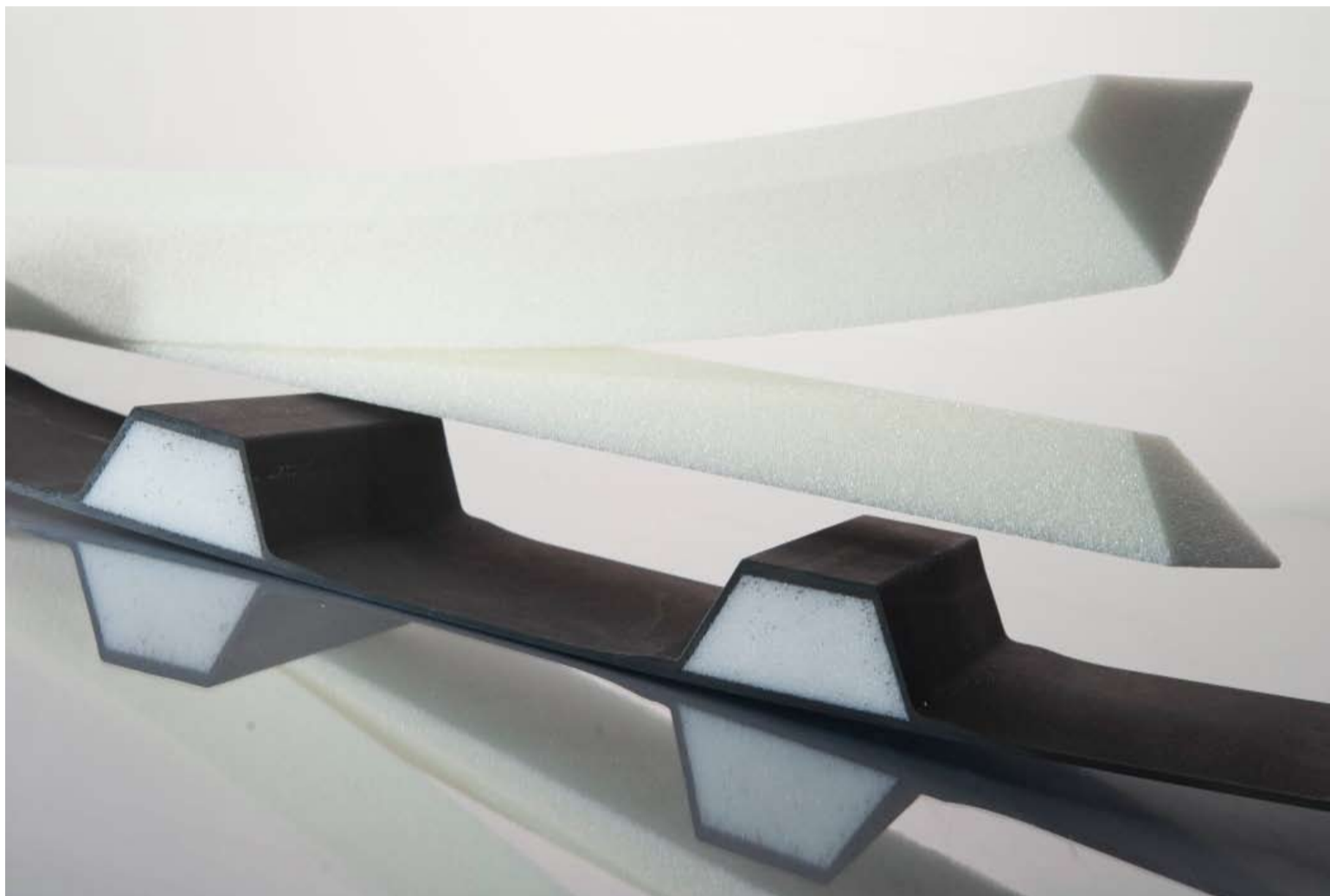


ROHACELL® News

April 2010



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ROHACELL® HP combines the advantages of XT and RIMA grades

ROHACELL® is well known as a core material for sandwich structures. Used in such applications, it minimizes weight and imparts higher stiffness and greater strength.

In addition to its use in typical structural sandwich designs – full sandwich and skin sandwich – ROHACELL® can be used as a non-structural manufacturing aid for profile-stiffened shell designs, in particular for omega stiffeners, for example (see table 1, page 2).

Typically, T, C, Z, and omega profiles are used in aircraft design. Their main function in the thin monolithic shell is to increase the stiffness. Buckling is the most critical load case and must be avoided. Locally positioned profiles improve buckling resistance, for example, in the pressure bulkhead of the A340. To keep costs down

and avoid secondary bonding processes, a manufacturer needs to have complex tooling concepts to be able to create the CFRP profile in one shot. Three-dimensional shapes, height adjustments, and, in general, any integral design function make a one-shot process nearly impossible.



ROHACELL® HP combines the advantages of XT and RIMA grades



Table 1



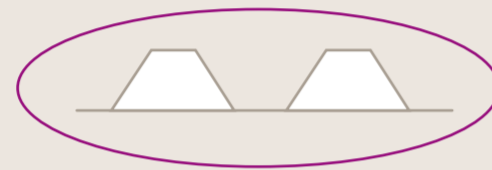
Full sandwich

The structural component is completely filled with the core material. The core geometry is adapted to the subsequent component shape.



Skin-sandwich

The structural component is hollow. The skins are reinforced across each surface by a layer of core.



Profile stiffened shell

Foam-filled stringers run along the component surface.

- ROHACELL®
- Face sheet, e. g. CFRP
- ++ Very good
- + Good
- o Satisfactory

Design concept	Stiffness	Weight	Effort of layup	Effort of assembly
Full sandwich	++	+	++	++
Skin-sandwich	+	++	+	o
Profile stiffened shell	+	+	+	++

ROHACELL® HP: the perfect solution for your composite design

Using a ROHACELL® core in an omega-profile is the perfect solution: the core acts as a tool. Although it remains in the profile, the weight is negligible. For example, the stiffener used in the A340's pressure bulkhead takes less than 2% of its weight if built with ROHACELL® 31HP-HT.

The typical core requirements are the following:

- easy to machine, cut, or thermoform into shape.
- rigid in shape for an efficient lay-up process (binder, stitching, braiding, prepreg lay-up manually, or by machine)
- high creep compression for a one-shot process to consolidate the skin during the curing process
- supply in mold pressure (closed mold process)
- easy to NDT
- low resin uptake
- low weight

To meet all these requirements, we have combined the ROHACELL® XT grade, well known for its superior creep performance, with the ROHACELL® RIMA grade, with its fine cells, to ensure the minimum possible resin uptake. The result is our ROHACELL® HP grade, which meets requirements perfectly while reducing total costs significantly.

Total cost of a typical door manufactured with ROHACELL® HP vs. honeycomb

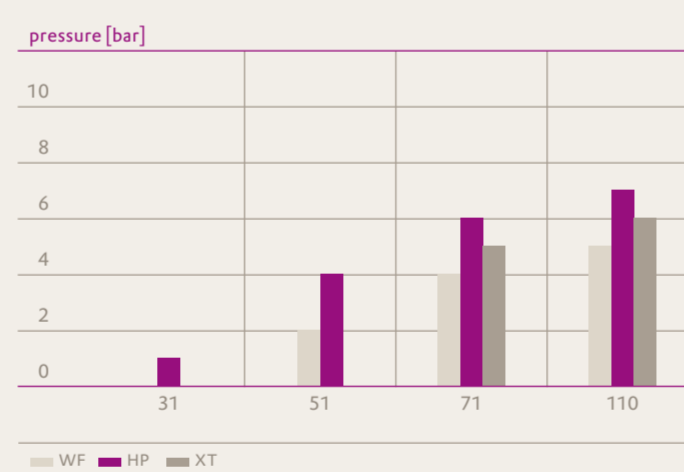
ROHACELL® HP offers customers a technical and cost-effective solution. An analysis of costs for a typical aircraft door show a cost saving of up to about 30% with ROHACELL® compared to honeycomb as the core material.

Summary:

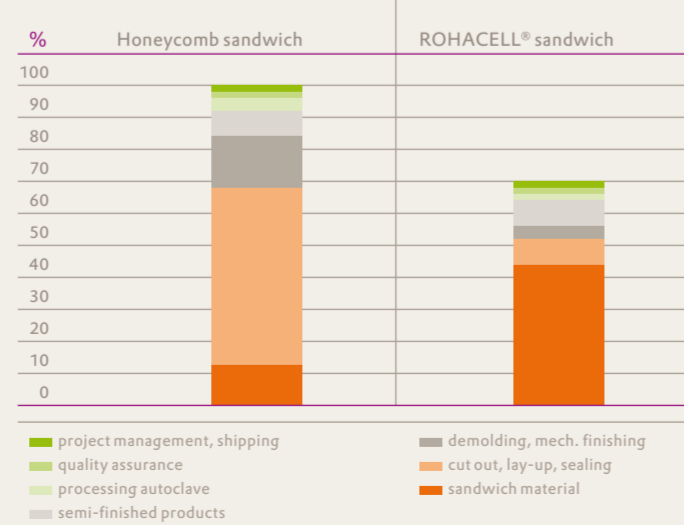
- ROHACELL® HP offers a robust process due to high creep performance
- The ready-to-use ROHACELL® parts from our SHAPES department drastically lower lay-up work
- The one-shot curing process saves autoclave-costs and increases the tooling capacity
- The good surface quality allows painting without much sanding and filling
- High quality through our certified quality assurance system

ROHACELL® HP: the perfect solution for your composites designs.

Creep comparison (180°/2h/curing pressure)



Production cost comparison (typical aircraft stringer application)



ROHACELL® and Madshus skis

A winning combination at 2010 Winter Olympics



Biathlon superstar Ole Einar Bjørndalen relies on top skis from Madshus with ROHACELL® as core material.

At the 2010 Winter Olympics in Vancouver, Canada, top athletes who were equipped with the latest state-of-the-art skis made by Madshus, a Norwegian cross-country ski manufacturer, won a combined total of 12 gold, 9 silver, and 11 bronze medals in the biathlon, cross-country, and Nordic skiing competitions.

For many years, Madshus has been using high-performance ROHACELL® PMI foam cores as an integral part of their high-end ski design. According to Madshus' development manager, Gunnar Bjertnaes, Evonik's

ROHACELL® high-performance rigid foam has outstanding dynamic properties. Because of its malleability, it also has excellent processing properties. "This sandwich core material, made in Darmstadt, has allowed us, moreover, to reduce the weight of the skis—which is a crucial factor," Bjertnaes explains. An athlete has to expend additional energy for each gram of extra weight.

Evonik's high-tech material is extremely strong and rigid – properties attributable, not least, to the even distribution of small air bubbles in the foam structure. The highly rigid PMI

foam can be durably combined with all conventional plastics by means of bonding or pressing, which creates composites capable of taking extreme punishment. The foam thus serves as an ideal material for skis, making them light, yet robust. The sandwich composite with which the skis are made improves their flexibility and dynamics while keeping their weight to a minimum. The foam's high heat-distortion durability and excellent creep-compression resistance make it possible to shorten production times considerably, too, an important consideration for ski manufacturers.

Apart from ROHACELL® foam, the Madshus ski also features decorative surfacing based on PLEXIGLAS® film. This optically brilliant film can be processed in a variety of ways, and since it is comparatively thin, it too contributes to the low weight of the ski.

The entire ROHACELL® and PLEXIGLAS® team would like to congratulate Madshus and all athletes who use Madshus skis for their outstanding performance at the 2010 Winter Olympics in Vancouver!



ROHACELL® PMI foam cores are an integral part of the high-end ski design.



ROHACELL® – for genuine lightness

Have you seen our new ROHACELL website www.rohacell.com? We offer you an overview of all our ROHACELL® grades, their properties, their main applications, their approvals, and how to process them. Please have a look and see how we can support you with our competence, our solutions for your

problems, and our engineering services. Of course, you can download a lot of interesting information. And if you have any question, feel free to contact our representative in your region. The direct contact is given on our website. Nice to hear from you soon!

Material novelty

High-performance PPA – the matrix material the industry is waiting for



Evonik not only offers the structural foam ROHACELL® for composites but also thermoplastic matrices. Matrices for composites have so far been mainly thermoset matrices used in established processes that draw on many years of experience. Used with the same reinforcing fibers, thermoplastic matrices allow significantly shorter cycle times in component production, can be stored indefinitely at room temperature, absorb less water (depending on the matrix), and are particularly suitable for medium- and large-scale production. Also particularly noteworthy are the simpler bonding technique (fusion) and the significantly higher continuous working temperatures (up to 200°C, depending on the polymer) and impact tolerance of components with a thermoplastic matrix. In VESTAKEEP® (PEEK) (presented in the Newsletter 2009) and VESTAMID® L (PA12), Evonik offers thermoplastic polymers that have proven their worth as matrices and can be selected for different requirements in regard to continuous working temperature and mechanical properties. Prepregs (preimpregnated reinforcing materials) in the form of coated woven fabrics and unidirectional tapes are sheet products produced using Evonik matrices. These polymers are available as granules, powders of various particle size distribution, and films for further processing by melt impregnation, powder coating, or suspension impregnation, and even for the film stacking process.

And now we present you our new development: VESTAMID® HTplus (PPA), the polyphthalamide (PPA) matrix

VESTAMID® HTplus is a PA10T-based copolyamide that has a number of benefits over other PA6T-based PPAs:

- produced up to 50% from renewable sources
- lower water absorption
- better dimensional stability
- higher hydrolysis resistance
- improved processing window

For composite applications Evonik has developed a VESTAMID® HTplus PPA grade with very low viscosity, providing for good fiber impregnation. With a glass transition temperature of 125°C and a processing window of about 300°C, this is a high-temperature matrix for aircraft and automotive applications when combined with carbon, glass, or aramid fibers.

The VESTAMID® HTplus composite grade is available in granular or powder form, the latter of which has a particle size of 60µm. Both melt and powder products attest to this matrix polymer's excellent impregnation behavior. If you will be using a film stacking process for manufacturing composite parts or sheets, we can provide a suitable film of the requisite thickness.

Comparison of a standard PPA with the special grade recommended for composite laminates



— Standard PPA — VESTAMID® HTplus

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