

ROHACELL® News

March 2009



The Perfect Match for Aircraft Construction

The use of ROHACELL® in Sandwich Structures

Page 2

At Customer's Option

What the ROHACELL® SHAPES Department offers

Page 3

ROHACELL® and SOLIMIDE® assist taking off Flying Phoenix

First introduction of ROHACELL® foam into a Chinese own-designed airplane

Page 4

VESTAKEEP® PEEK Powders

Peak Performance for Thermoplastic Composites

Page 4

Evonik celebrates \$10 Million ROHACELL® plant opening in Mobile Alabama, USA

New facility will better serve North American customers

On November 19, 2008 Evonik Industries inaugurated its \$10 million ROHACELL® facility in Mobile Alabama, which produces innovative material used in applications ranging from wind turbine blades to satellite launch rockets. The new ROHACELL® rigid polymethacrylimide foam production plant – the first outside Europe – was built over the past 12 months. Gregor Hetzke, head of Evonik's Performance Polymers Business Unit that includes ROHACELL®, said the new plant follows a strategic decision by Evonik to bring its products closer to customers to reduce delivery times and enhance customer service.

"Demand for ROHACELL® core materials is growing, particularly in North America. Composites such as ROHACELL® continue to be an attractive global growth market and by expanding our production to North America, we hope to expand the business", Hetzke added. Mobile is an excellent location for the new ROHACELL® plant, said Tom Bates, Evonik Degussa Corporation president and Mobile Site Manager. "Mobile is an attractive site because of its location along the Gulf Coast, its easy accessibility and convenient infrastructure and its highly motivated, highly educated workforce", Bates continued.

ROHACELL® is a contributing material that increases the stiffness and strength in the composite structure for, e.g., Bell Helicopter's V-22 and 429 helicopters.

Bell Helicopter Textron, an industry-leading producer of commercial and military, manned and unmanned vertical lift aircraft and the pioneer of the revolutionary tilt rotor aircraft, is one of ROHACELL®'s strategic North American customers.

Evonik Foams, Inc., of Allen, Texas, a wholly owned subsidiary of Evonik, will operate the plant in Mobile.



The Perfect Match for Aircraft Construction

The use of ROHACELL® as core material in sandwich structures provides lower weight, higher stiffness and strength of the construction, which results to lower fuel consumption of the aircraft.



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

Table 1	Design Concept	Stiffness	Weight	Effort of Layup	Effort of Assembly
	Full Sandwich	++	+	++	++
	Skin-Sandwich	+	++	+	O
	Profile Stiffened Shell	+	+	O	+

Figure 1: Example of the improvement in stability of a ROHACELL® foam-filled stringer

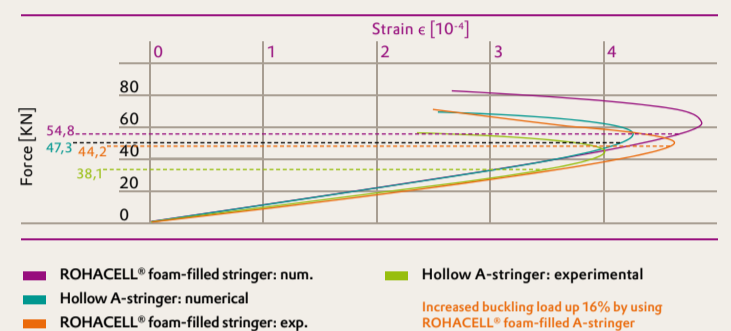
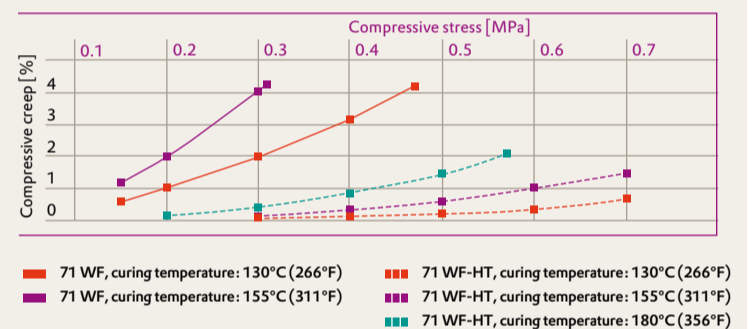
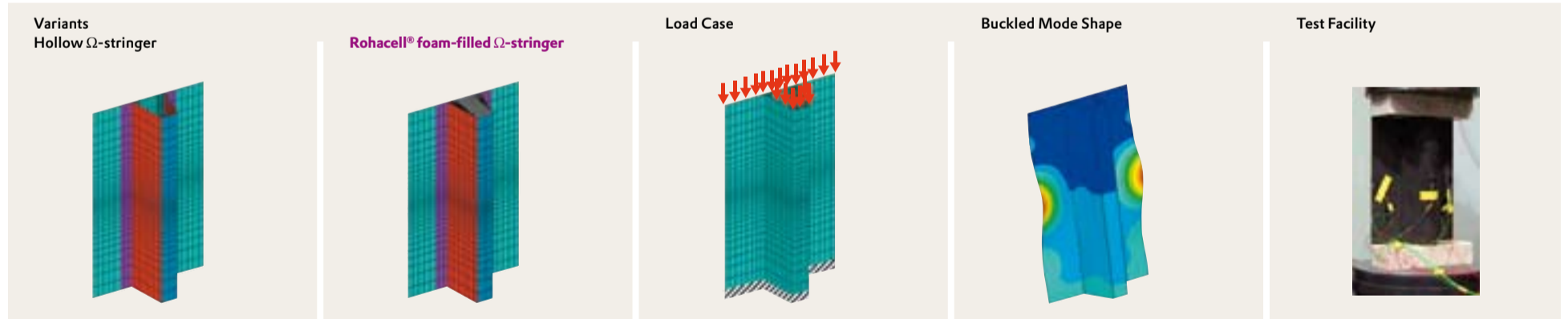


Figure 2: Compressive creep behavior of ROHACELL® 71 WF/ WF-HT (HT=Heat Treatment) after two hours



In addition to Figure 1: Force / strain diagram of hollow and of PMI foam-filled Ω -stringer stabilized shells under axial compressive load



Traditional metal structures in aircraft and automotive construction are increasingly being replaced by fibre reinforced plastics (FRP) using particularly carbon fibers as reinforcements and thermoset or thermoplastic as matrix. The CFRPs are "black gold" in the development of new aircraft; they are 80 percent lighter than steel and 40 percent lighter than aluminum. The use of these lightweight construction materials results in weight and fuel savings, and therefore also reduced CO₂ emissions. More than 50 percent of the new Airbus A 350 will consist of CFRPs.

In the area of high-performance FRPs, sandwich structures are being used next to monolithic structures. Sandwich construction is suitable particularly for components that are weight-optimized for bending and buckling loads.

A sandwich structure consists of thin face sheets of high strength, for example CFRP, on a usually thick core of low density. The face sheets absorb in-plane tensile and compressive stresses.

The core must fulfill the following functions:

- keep the face sheets apart to maintain geometrical stiffness,
- transmit the necessary shear stresses in the longitudinal and transverse directions of the panel,
- stabilize the face sheets to avoid local buckling,
- allow simple and accurate shaping by machining and/or thermoforming,
- guarantee process stability and reliability in regard to compressive and thermal stresses during the curing of the facings, and
- if necessary provide acoustic and thermal insulation.

Table 1 gives an overview of different design concepts of common sandwich structures such as the full sandwich, skin-sandwich, and profile stiffened shell.

Thanks to its excellent strength and stiffness coupled with low density, ROHACELL® PMI rigid foam can contribute significantly toward improving the strength of a component or decreasing its weight respectively. Figure 1 illustrates this using the example of an Ω -stringer whose buckling load has been determined with and without the foam filling, both numerically and experimentally. By using a ROHACELL® filled Ω -stringer, it is possible to increase the buckling load by 16 percent compared with a hollow structure.

Apart from load withstanding capability, cost considerations are the most important aspect in component design and in the planning of the

production process. Significant cost reduction can be achieved in particular by using integral structures and co-curing. This allows the lowest possible number of individual components, leading to low assembly costs and the elimination of tolerance problems in joints. Fabrication of components with a high degree of functional integration requires a stable process if subsequent problems are to be avoided and the necessary reworking reduced to the minimum.

ROHACELL® offers a series of advantages that contribute decisively to process stability and optimal performance characteristics:

- excellent compressive creep behavior up to 180°C and 7 bar (see Figure 2),
- very good weight-specific mechanical properties,
- high heat distortion temperatures up to 235°C,

- availability in low nominal densities of up to 32 kg/m³,
- compatibility with most common thermoset and thermoplastic matrix systems,
- good consolidation of the face sheets,
- excellent surface quality of the face sheets,
- 100 percent closed-cell structure to minimize unwanted uptake of resin and weight increase,
- availability of various grades of ROHACELL® such as WF, RIST, and RIMA that offer, in regard to resin uptake, optimized cell sizes for prepreg processing as well as resin infusion technique,
- easy processability with conventional machining processes and tools,
- thermoformability, and
- the dimensional accuracy in the shaping of the core allows its use as a template for preforms, prepreg packets, inserts, etc., to reduce lay-up costs.

At Customer's Option

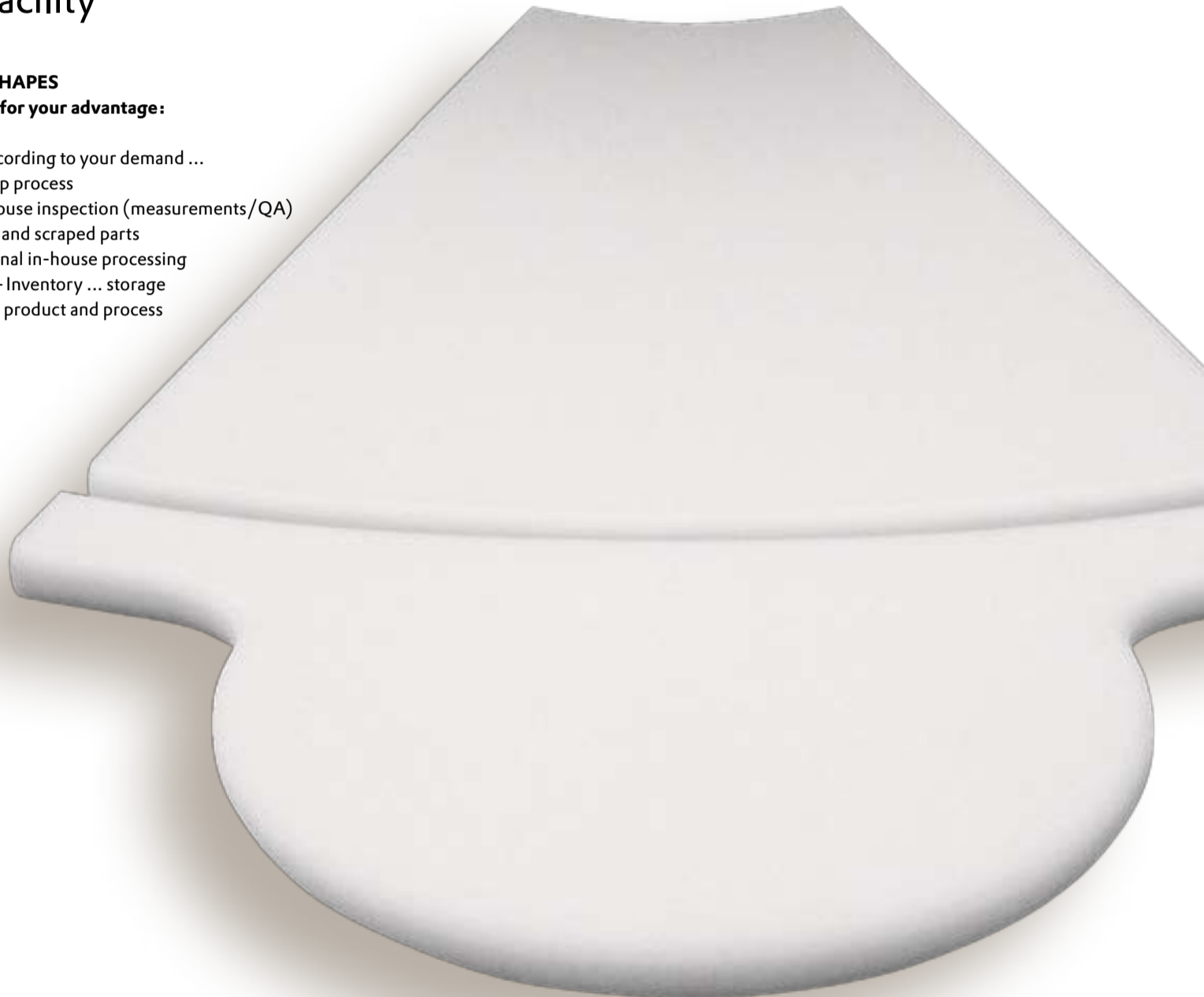
ROHACELL® SHAPES Department provides solutions to customers and extent its facility

"Solutions to Customers" is one of Evonik's leading principles and means providing customers with complete solutions, rather than just selling products such as semi-finished materials. A perfect example is the ROHACELL® SHAPES production facility. Manufacturing capacity was set up here in several stages so as to respond to the growing demand for net-shaped, ready-to-use sandwich cores.

In 2008 a latest state of the art 5 – axis – CNC machine was integrated into a 825m² new production site. This was a major step in order to fulfil the growing demand of the market. With tailor-made tooling for thermoforming ROHACELL® it is possible to realize even complex 3D configurations with optimum dimensional accuracy. The comprehensive services to customers are rounded off by custom-tailored quality management and logistics systems. These ranges from aircraft applications like thermoformed stringer profiles, NC-machined sandwich cores for engine cowlings, NC-machined and subsequently thermoformed sandwich cores for belly fairings, right up to medical technology.

The ROHACELL® SHAPES Department offers for your advantage:

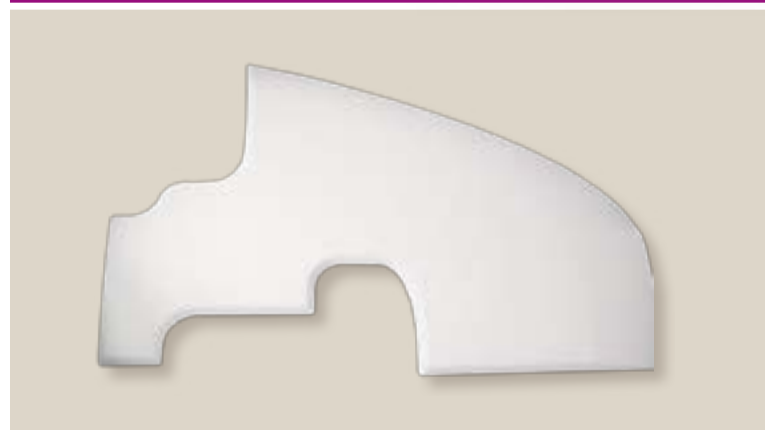
- Parts produced according to your demand ... ready for the lay-up process
- No or limited in-house inspection (measurements/QA)
- No waste material and scraped parts
- Little or no additional in-house processing
- No bound capital – Inventory ... storage
- Full assistance and product and process development



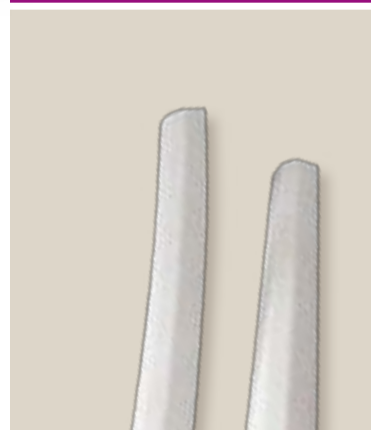
CNC machine located in a 825 m² new production location



Precisely thermoformed and net-shaped core segment for belly fairing of Gulfstream G150



Precisely machined and thermoformed profiles



Measuring device



X-ray table



Aircraft part



ROHACELL® and SOLIMIDE® assist taking off Flying Phoenix

First introduction of ROHACELL® foam into a Chinese own-designed airplane – SOLIMIDE® foam for insulation in “Xiang Feng”



China's first fully homegrown regional jet takes off in Shanghai end of November 2008 on its first test flight. Evonik's high-performance foams ROHACELL® and SOLIMIDE® contributed to its lightweight, fuel-saving structure design.

ARJ21-700, China's first domestically produced regional passenger jet, completed its successful maiden flight in Shanghai on November 28, 2008. The regional jet has adopted mature technologies as well as advanced materials of the world. Evonik has supported the so called Xiang Feng, meaning Flying Phoenix, with two high-performance foams, ideal lightweight materials for the aerospace industry: the polymethacrylimide (PMI) rigid foam ROHACELL® for structural composites and the polyimide soft foam SOLIMIDE® for insulation. This is the first time for ROHACELL® to be introduced into a Chinese own-designed airplane.

Both the winglet and flap vane of ARJ21 are using ROHACELL® foam-cored sandwich structures. The PMI rigid foam is used as a core

material in composites—a technique that bonds the foam between two cover skins made of fiber reinforced plastics. The result: extremely rigid and lightweight molded parts capable of withstanding extreme stresses. Of all foams on the market, ROHACELL® has the best ratio of weight to mechanical properties and the highest thermostability. This makes ROHACELL® an ideal lightweight material for the aerospace industry.

Besides ROHACELL® rigid foam, SOLIMIDE® soft foam is used for the ARJ 2 insulation system. It is a lightweight material with a wide operating temperature range and good fire retardant properties, as well as low smoke and toxic gas production in case of fire.

These make SOLIMIDE® the best insulation material in the aircraft.

VESTAKEEP® PEEK Powders

Peak Performance for Thermoplastic Composites

In addition to ROHACELL®, Evonik Industries now manufactures VESTAKEEP® PEEK powders (polyetherether ketone powders) and is quickly becoming a key supply-chain partner worldwide to manufacturers that use these powders to make composite UD-tapes, fabric-based prepregs, and laminates.

For over 40 years, Evonik has been producing high-performance polymers and is known for its powder technology expertise – in development, production, application, and customer service. Successful on the market for several years, Evonik has expanded its product portfolio to include high-temperature polymers. With its PEEK compounds and VESTAKEEP® powders, Evonik

has once again re-affirmed its technological leadership in high-performance plastics. Compounds and powders made of VESTAKEEP® are especially suitable for applications that must satisfy extreme mechanical, thermal, and chemical requirements.

VESTAKEEP® provides unidirectional fiber layouts or fabrics made of glass, carbon, or aramid fibers with a matrix, making it possible in turn to produce fiber composites with a thermoplastic matrix. The composites are coated by means of a powder coating or dispersion coating process. Evonik has developed powder types especially suitable for these processes and has demonstrated they can be used to manufac-

ture composites. The VESTAKEEP® 2000 powder line has earned a reputation as an ideal polymer for this application. The particle size has been custom-tailored to processes in which FP and UFP powders are the materials of choice.

Please contact us for more information about how thermoplastic composites can be used in aviation, medical, and industrial applications.

Contacts:
Dr. Christian Baron
PHONE +49 2365 492219
christian.baron@evonik.com

Geraud Apchin
PHONE +33 139 757985
geraud.apchin@evonik.com



Composite laminate with a layer thickness of 22 mm.
The Evonik logo was cut out with a water beam to demonstrate the excellent machinability.

ROHACELL®, SOLIMIDE® and VESTAKEEP® are registered trademarks of Evonik Industries AG or one of its subsidiaries. Product Line ROHACELL® is certified according to AS-EN 9100 (Quality) and ISO 14001 (Environment). Evonik Foams, manufacturer of SOLIMIDE®, incorporates the principles of ISO 9001:2000 (Quality), ISO 14001 (Environmental), OHSAS 18001 Health & Safety, Responsible Care, and Loss Control into an individually tailored, integrated management system, and is ISO 14001 certified. Business Line High Performance Polymers of Evonik Degussa GmbH, manufacturer of VESTAKEEP® polymers, is certified according to ISO:9001:2000 and ISO/TS 16949:2002 (Quality), and ISO 14001:2005 (Environment).
® = registered trademark

Performance Polymers Business Unit, Evonik Röhm GmbH Kirschenallee 64293 Darmstadt
Engineering Service PHONE +49 6151 18-1005 rohacell@evonik.com www.rohacell.com www.evonik.com

 **EVONIK**
INDUSTRIES