IN FLIGHT

EVONIK SOLUTIONS FOR THE AVIATION AND AEROSPACE MARKETS

EVONIK
POWER TO CREATE

Evonik is one of the world's leading specialty chemical companies. Our strengths include the balanced spectrum of our business activities, end-markets, and regions. Around 80 percent of sales come from market-leading positions, which we are systematically expanding. Our strong competitive position is based on close collaboration with customers, high innovative capability, and integrated technology platforms.

Evonik manufactures an ever-expanding range of advanced, long service life polymers and composite materials to meet the critical demands of the Aviation and Aerospace Industries. You'll find our high performance materials on nearly every takeoff and landing, inside and out. Evonik materials provide key OEMs and supply chain partners with the design freedom needed to engineer high quality, unique products with high fatigue performance.

We're ranked high as an innovation partner because we understand changing technical requirements and strive to offer next generation aviation materials.

Evonik supports ongoing product development efforts focused on weight reduction, impact resistance and fuel savings while lowering production costs and maintaining reliability and safety.

Evonik. Power to create.

EVONIK PRODUCTS **IN FLIGHT**

ALBIDUR®

The ALBIDUR® core-shell toughening technology for thermosetting resins used in aircraft manufacturing, like epoxy resins or cyanate ester resins, improves significantly the toughness of fiber-reinforced composite parts or structural adhesives. This improvement is provided from -100 °C up to the maximum usage temperature of the thermosetting resins. Furthermore the fatigue performance is increased significantly, thus enhancing service life. Shrink is reduced and the glass transition temperature (T_g) of toughened resins is not affected.

ALBIDUR® products consist of reactive resins, in which fully cured silicone rubber particles with a defined size of 0.1 - 3 µm are finely dispersed. These rubber particles have an organic shell structure comprising reactive groups. The typical addition levels are around 10 wt%, depending on the system to be modified.

ALBIPOX®

ALBIPOX® rubber-modified epoxy resins are used as tougheners for epoxy prepregs for aerospace applications. They increase toughness, reduce microcrack formation in fiber-reinforced composites or structural adhesives. Furthermore they improve fiber wetting and adhesion to aluminum substrates. Some specialty grades are designed as tackifiers to improve the workability of epoxy prepregs and reduce manuacturing costs. They are a vital part of the toolbox of resin formulators.

EVONIK
PRODUCTS
IN FLIGHT

COMPIMIDE®

COMPIMIDE® bismaleimide resin family represents a full range of thermosetting matrix resins and specialties developed for the production of high-performance composites, mostly for aerospace applications. Heat resistant COMPIMIDE® bismaleimide matrix resins are characterized by their high glass transition temperature (T_g), thus offering excellent performance in hot and wet conditions, retention of mechanical properties up to 250°C, superior flame and radiation resistance, low smoke and toxicant emissions, and easy processing.

Typical processing techniques include prepregging (from the melt, solution, or suspension), resin transfer molding (RTM), filament winding, compression molding, powder coating, and pultrusion. The COMPIMIDE® bismaleimide product group comprises bismaleimide monomers, toughening modifiers, and formulated bismaleimide resins.

NANOPOX®

Evonik is the leading manufacturer of surface-modified silica nanoparticles in epoxy resins. They are used in many fiber-reinforced composites and structural adhesives for aerospace applications. Modulus and strength are significantly improved. Compressive strength is increased and, most important, fatigue performance is significantly higher – thus enhancing service life.

The NANOPOX® products are concentrates of nanosilica in epoxy resins. Due to their small size and the absence of larger aggregates, the nanoparticles can easily penetrate all fiber structures without comprising the impregnation by increased viscosities. All state-of-the-art process technologies like resin infusion, RTM, VARTM etc. can be applied. Nevertheless these products are suitable for prepreg manufacturing as well.

P84®

P84® Polyimide (PI) is a high performance polymer combining excellent physical properties with high temperature and chemical resistance. As solution in polar aprotic solvents, it can be used to make anti-friction coatings or insulating layers for aerospace electronics due to its low dielectric constant or high dielectric strength. In fiber form, P84® is typically used for applications ranging from protective clothing for pilots to aerospace insulation and sealing materials.

P84 NT® Polyimide (PI) powder offers high temperature stability to 350°C, chemical resistance, high mechanical strength, low friction coefficient and minimal abrasion. Using sintering technology, it can be cost efficiently manufactured into near-net-shape components on the plane or the engine. Compounds with solid lubricants are used in tribologically demanding applications often found in aerospace environments.

ROHACELL®

ROHACELL® Polymethacrylimide (PMI) structural foam has been used in fiber-composite technology for more than 40 years. It increases the stiffness of composite structures and provides extremely robust and durable composites compatible with all common thermoset and thermoplastic polymers. ROHACELL® delivers excellent mechanical properties over a wide temperature range, even at low densities, and exhibits high temperature resistance during processing of up to 190 °C (374 °F) and pressures up to 0.7 MPa (102 psi) over several hours. Temperature resistance of up to 210 °C (428 °F) is possible in pressure-free post-cure processes.

It has unique compressive creep behavior and dynamic strength, plus a choice of varying cell sizes that can be selected for each processing method. It will not add unnecessary weight since this closed-cell foam uptakes minimal resin only in the exposed cut cells at the surface. A versatile solution offering extensive design freedom, the foam can be CNC milled, thermo-shaped or thermoformed into complex geometries. All foam combined with common resin systems is suitable for autoclave, press, vacuum infusion, RTM and VARTM.

VESTAKEEP® PEEK

VESTAKEEP® Polyether ether ketone (PEEK) is a high-performance thermoplastic polymer ideal for manufacturing long-lasting components for use in the toughest conditions. Tight tolerance parts can be produced via traditional molding and extrusion to withstand high temperature, chemical and conductive environments. Thanks to higher ductility and molecular weight, mechanical advantages such as higher elongation at break, higher impact strength and lower notch sensitivity can be achieved across elevated temperature ranges. This is a clear advantage in both fabrication and longevity. Inherent flammability properties and robust performance make it an ideal choice for aerospace applications.

VESTAKEEP® is also used as a resin matrix for thermoplastic composite unidirectional fiber tapes and fabric prepregs. Excellent fatigue, impact, and creep behavior are achievable for continuous use at elevated temperatures to 250°C. Its lower weight combined with high mechanical strength make it a suitable replacement of traditional thermosets and metals.

Additionally, VESTAKEEP® is available as a specially formulated ultra fine powder for use in Additive Manufacturing (Selective Laser Sintering). Selective Laser Sintering is layer-based manufacturing that does not use molds or tools to create parts. Improved design freedom, part consolidation, metal replacement and cost reduction are possible. High temperature VESTAKEEP® is the solution for hot air ducting, clips and brackets in a wide variety of commercial and military applications.

EVONIK
PRODUCTS
IN FLIGHT

VESTAMID®

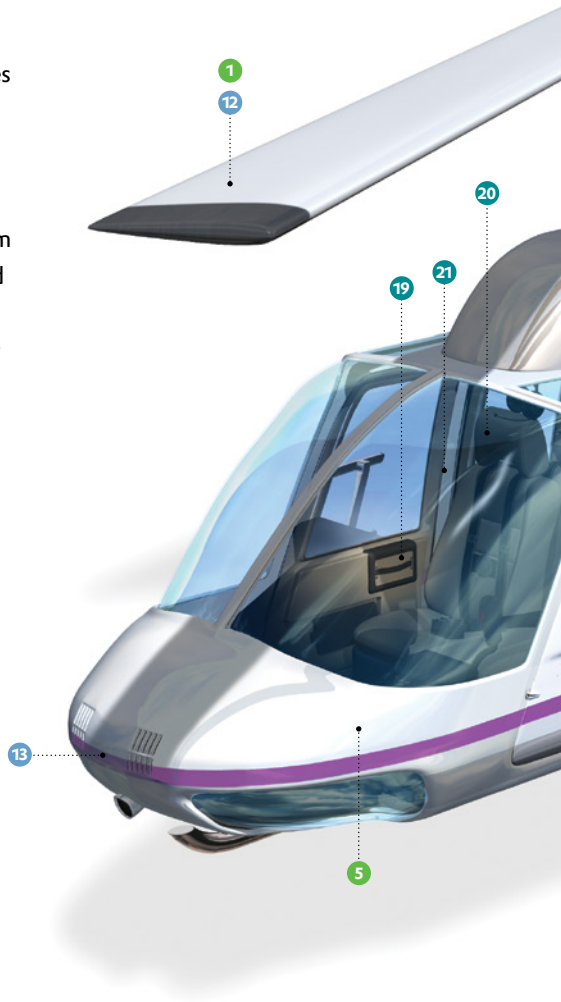
Specialty VESTAMID® heat stabilized Polyamide 12 (PA12) compounds contain a non-migrating flame retardant, free of halogens and phosphorous. In compliance with the flammability requirements of FAR 25.853 and ABD0031, they are especially suited for aircraft interior parts.

Airframe OEMs have achieved significant weight savings by replacing phenolic materials with these compounds. They can be used for extrusion and injection molding.

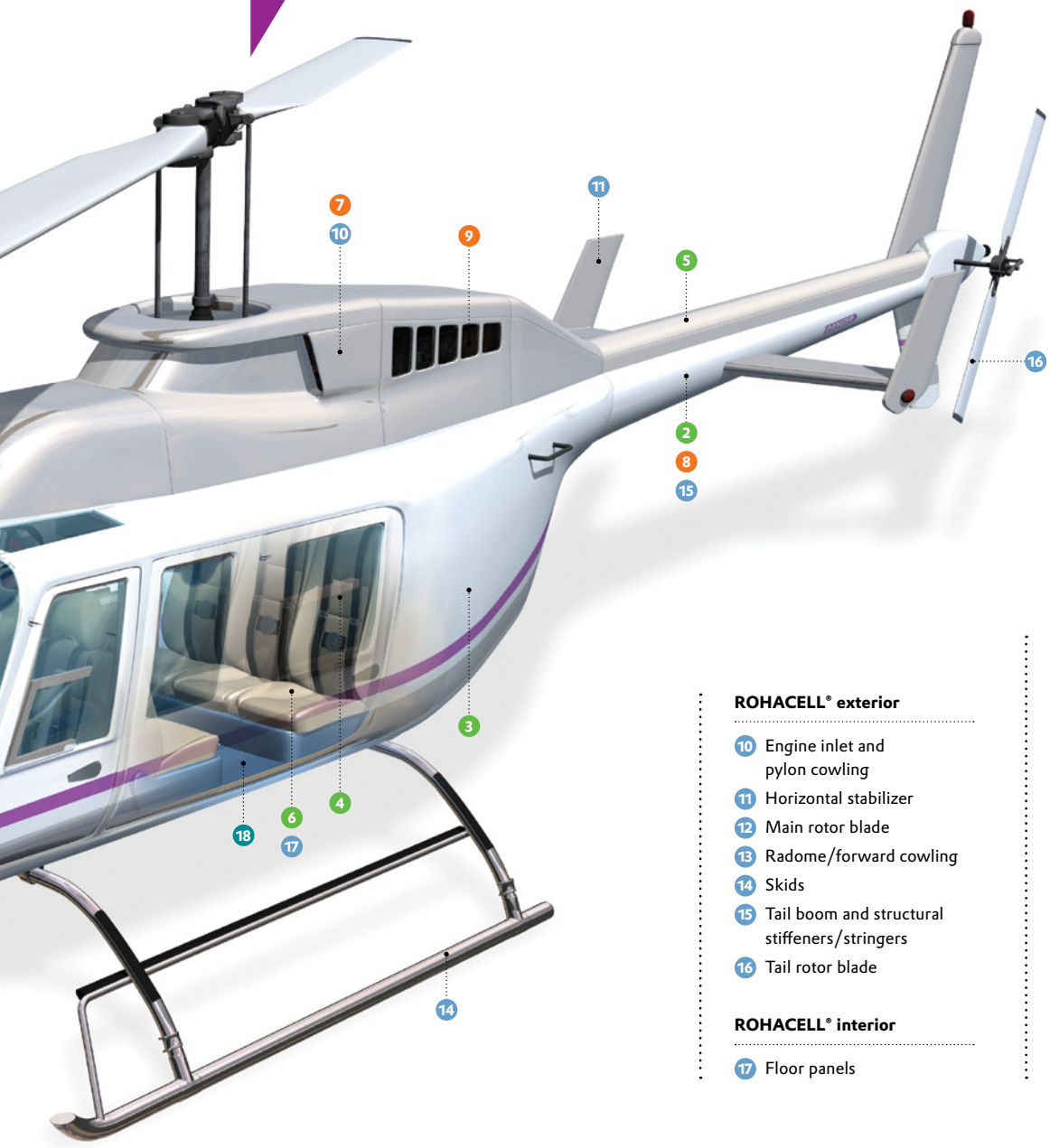
VESTOSINT®

VESTOSINT® Polyamide 12 (PA 12) are ultra fine powders for Additive Manufacturing. VESTOSINT® provides dependable quality and repeatability of processing.

It offers mechanical properties that enable complex geometry for optimum design freedom, part consolidation and simplified logistics. Ultra-flexible grades offer eight times the flexibility and five times the tensile strength versus competitive grades.



HELICOPTER APPLICATIONS



ALBIDUR®, ALBIPOX®, NANOPOX® exterior

1. Main rotor blade
2. Tail boom and structural stiffeners/stringers
3. Main cabin (prepregs)

ALBIDUR®, ALBIPOX®, NANOPOX® interior

4. Doors, walls and ceilings
5. Structural adhesives for composite bonding
6. Floor panels

COMPIMIDE® bismaleimides structural applications

7. Engine inlet and pylon cowling
8. Tail boom and skins for structural stiffeners/stringers
9. Nacelle and cowling components

ROHACELL® exterior

10. Engine inlet and pylon cowling
11. Horizontal stabilizer
12. Main rotor blade
13. Radome/forward cowling
14. Skids
15. Tail boom and structural stiffeners/stringers
16. Tail rotor blade

ROHACELL® interior

17. Floor panels

VESTAKEEP® exterior

18. Secondary structures/flooring

VESTAKEEP® interior

19. Latches, handles, hinges and mechanical parts

VESTAMID® interior

20. Interior profiles/rub strips

VESTOSINT® interior

21. Additive manufacturing: brackets, clips and ducts

AIRCRAFT APPLICATIONS

ALBIDUR®, ALBIPOX®, NANOPOX® exterior

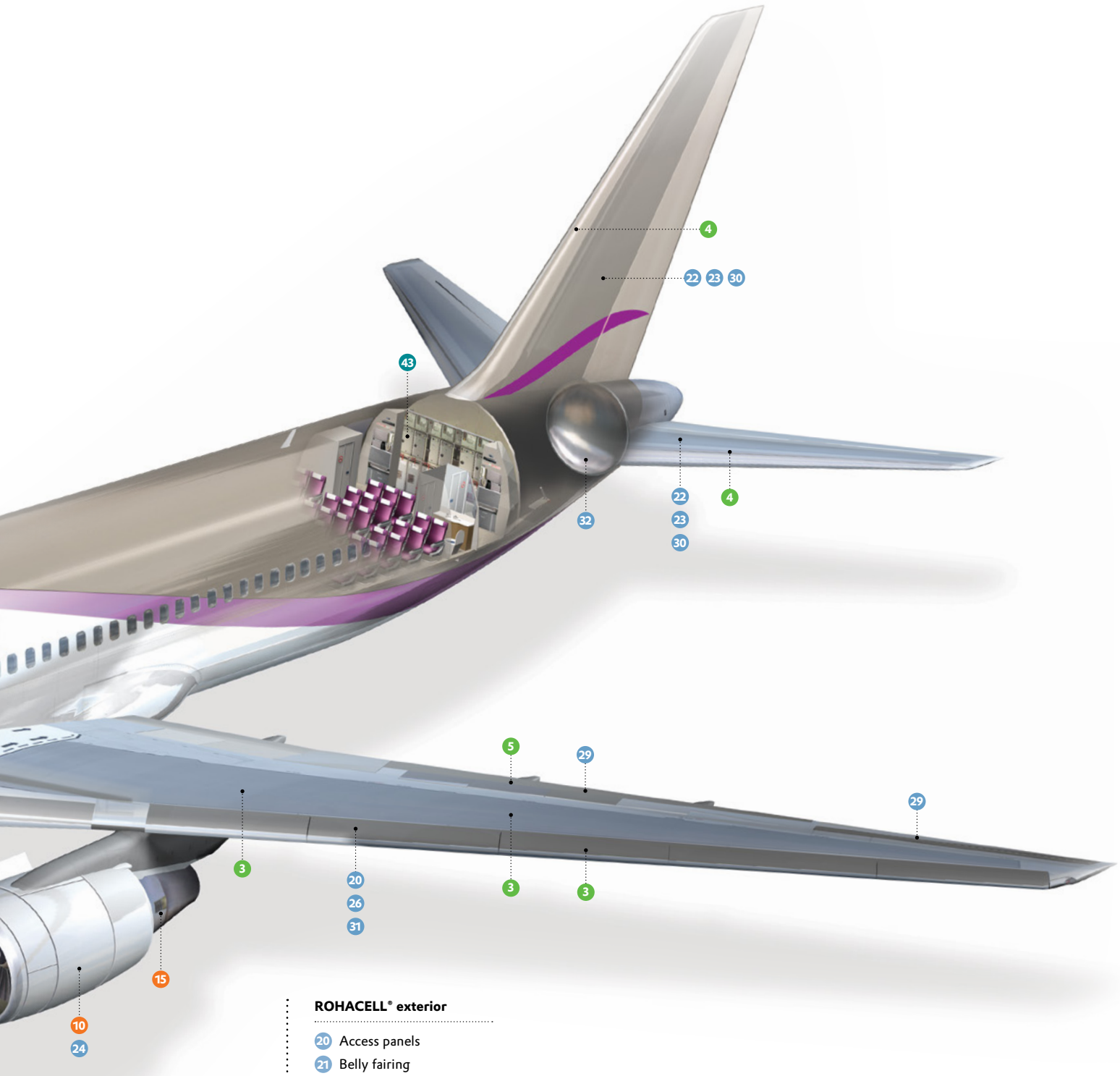
1. Toughening agent for composites
2. Fuselage (prepregs)
3. Wings (prepregs, structural adhesives)
4. Tail fin (prepregs, structural adhesives)
5. Hydraulics (filament winding)

ALBIDUR®, ALBIPOX®, NANOPOX® interior

6. Toughening agent for composites
7. Structural adhesives for aluminum and composites
8. Primary floor structures (laminates)
9. Secondary floor structures

COMPIMIDE® bismaleimides structural applications

10. Engine cowling/doors
11. Flap fairings
12. Radome
13. Leading edge
14. Nacelle
15. Engine inner fixed structures: thrust reverser/ soundproof panels/ ducting



P84® NT powder exterior

- 16 Sealings, bearings, bushings and guidances
- 17 Toughening agent for composites

P84® interior

- 18 Anti-friction/insulating coatings electronics
- 19 Sealing materials

ROHACELL® exterior

- 20 Access panels
- 21 Belly fairing
- 22 Dorsal fin
- 23 Empennage leading and trailing edges
- 24 Engine cowling doors
- 25 Flaps
- 26 Flap track fairings
- 27 Landing gear doors
- 28 Radome
- 29 Spoilers/ailerons
- 30 VTP tip and panels
- 31 Wing leading and trailing edge panels
- 32 Aft pressure bulkhead

ROHACELL® interior

- 33 Access panels

VESTAKEEP® exterior

- 34 Aileron
- 35 Fuselage
- 36 Leading edge/J-nose
- 37 Nacelle

VESTAKEEP® interior

- 38 Additive manufacturing For high temperature applications
- 39 Ducting, cable ties and sheathing
- 40 Hinges, latches, handles and mechanical parts
- 41 Secondary floor structures

VESTAMID® interior

- 42 Interior profiles/ rub strips

VESTOSINT® interior

- 43 Additive manufacturing: brackets, clips and duct

Evonik foam products and matrix resins continue to play a vital role in the global space launch vehicle construction market.

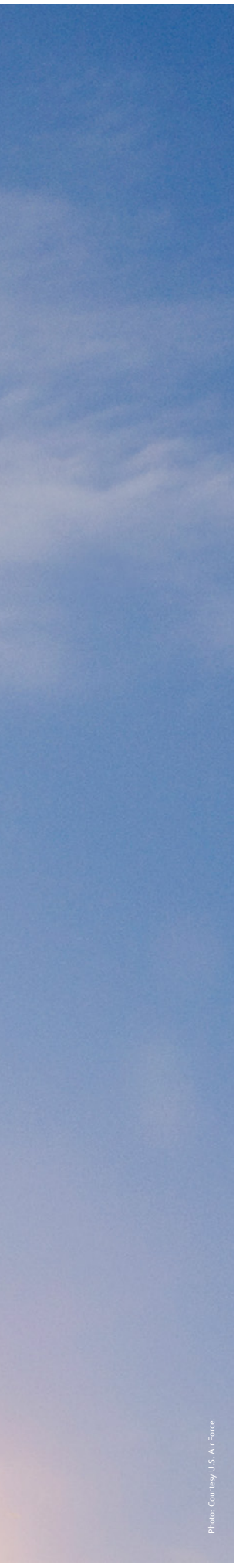


Photo: Courtesy U.S. Air Force.

EVONIK PRODUCTS **IN SPACE**

COMPIMIDE®

Extensive applications of COMPIMIDE® bismaleimides in the modern spacecraft design include both structural parts and thermal protection/insulation in launch carriers, satellites, and multiple reentry vehicles.

ROHACELL®

ROHACELL® foam cores offer unparalleled strength-to-weight ratio. It's the preferred core designed in and specified for producing high performance sandwich composite structures in launch vehicles including payload and payload adapter fairings, interstages, nose cones and thermal protection shields.

For more information on these products please contact us.

COMPIMIDE®

Tim Pohlmann
Rodenbacher Chaussee 4
63457 Hanau-Wolfgang
Germany

PHONE +49 6181 59-8755
tim.pohlmann@evonik.com
www.evonik.com/composites

NANOPOX®, ALBIPOX®, ALBIDUR®

Stephan Sprenger
Charlottenburger Straße 9
21502 Geesthacht
Germany

PHONE +49 4152 8092-36
stephan.sprenger@evonik.com
www.nanopox.com

P84®

Dieter Danzer
Werkstrasse 3
4860 Lenzing
Austria

PHONE +43 7672 701-2867
dieter.danzer@evonik.com
www.p84.com

ROHACELL®

Alexander Roth
Kirschenallee
64293 Darmstadt
Germany

PHONE +49 6151 18-4818
alexander.roth@evonik.com
www.rohacell.com

VESTAKEEP®, VESTAMID®, VESTOSINT®

Varun Kumar
Paul-Baumann-Straße 1
45772 Marl
Germany

PHONE +49 2365 49-5730
varun.kumar@evonik.com
www.vestakeep.com
www.vestamid.com
www.vestosint.com

Evonik Industries AG
Rellinghauser Straße 1-11
45128 Essen
Germany

PHONE +49 02365 49-9878
FAX +49 02365 49-809878

www.evonik.com
www.evonik.com/composites

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