

Aerospace



DuPont™ Vespel® Precision Parts for the Aerospace Industry

Solving the toughest sealing, wear and friction challenges in mission-critical applications



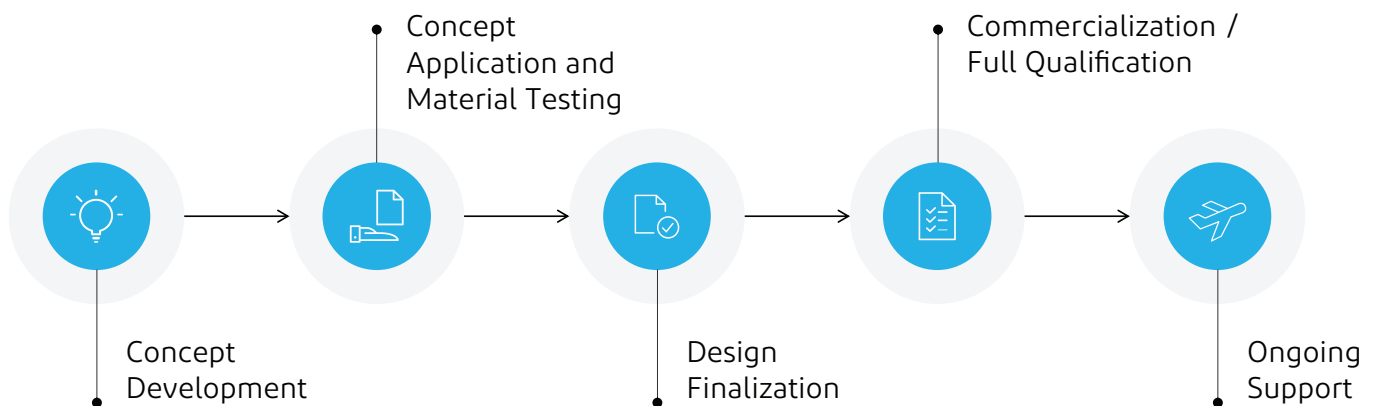
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Why DuPont™ Vespel®?

- ✓ Recognized leader in responsible business
- ✓ Your partner through design, development and production
- ✓ Solution partner of choice
- ✓ Core values - safety, sustainability and ethics
- ✓ Proven quality
- ✓ Known for delivering innovative material technologies
- ✓ World class technical support
- ✓ Culture drives quality and continuous improvement
- ✓ Proven service for more than 50 years in aircraft engines and systems

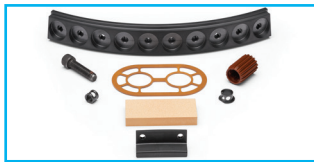
Technical support, every step of the way...



Vespel Parts in Aerospace Enable

| | | |
|---|--|--|
|  Reduced Weight |  Broad Chemical Resistance |  Low Outgassing |
|  Increased Part Wear Life |  Lower Friction |  Broad Temperature Range Stability |
|  Higher Operating Temps |  Ability to Run Unlubricated |  Cryogenic Performance |

DuPont™ Vespel® Parts And Shapes



Vespel® S

Standard

PI Parts & Shapes
Direct Formed,
Isostatic,
Compression



Vespel® ASB

Assemblies

Metal-Backed
Polymer Composites
Metal-Backed
Carbon-Graphites



Vespel® CP

Composites

Fiber Reinforced Resin
Composites
Fabric Laminates,
Sheet Molding Compounds



Vespel® CR

Chemical

Chemical Resistant
Parts & Shapes
Extrusion,
Compression

DuPont™ Vespel® Engine Solutions

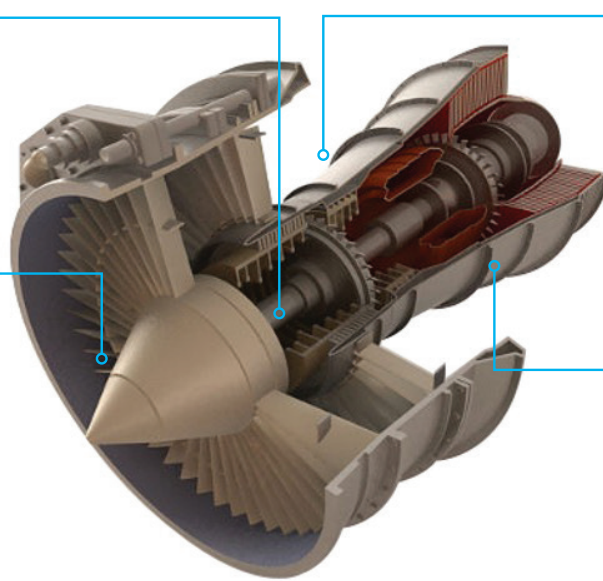
Improving performance, extending life, saving weight & lowering costs

Compressor

- Stator Vane Bushings
- Bumpers & Wear Pads
- Abraidable Seals
- Main Rotor Bumper Bearing
- Composite Shrouds

Fan

- Fan Blade Root Wear Strips
- Abraidable Seals
- Blade Spacers



Externals

- Composite Tube Clamps
- Duct Seals
- Valve Seals
- Bumper & Wear Pads
- Actuation Arm Bearings
- Bellcrank Bushings
- Locking Fasteners
- Insulators
- Spline Adaptors

Combustor & Nozzle

- Augmenter Flaps
- Nozzle Bushings

DuPont™ Vespel® Aircraft Applications

Subsystems

- Thermal & Electrical Insulators/RF Systems
- Bearing Retainers in Avionics
- Wear Pads & Wear Strips
- Oxygen System Seals
- Valve Seats (Various Systems)
- Fuel System Electrical Isolation

Nacelles

- Thrust Reverser Channels
- Slide Blocks
- Actuation System Bearings
- Slider Shoes
- Wear Pads and Wear Strips

Control / Actuation Systems

- Actuation System Bearings
- Control Surface Bearings
- Clutch Brakes
- Bushings & Guides in control linkages

Auxiliary Power Units

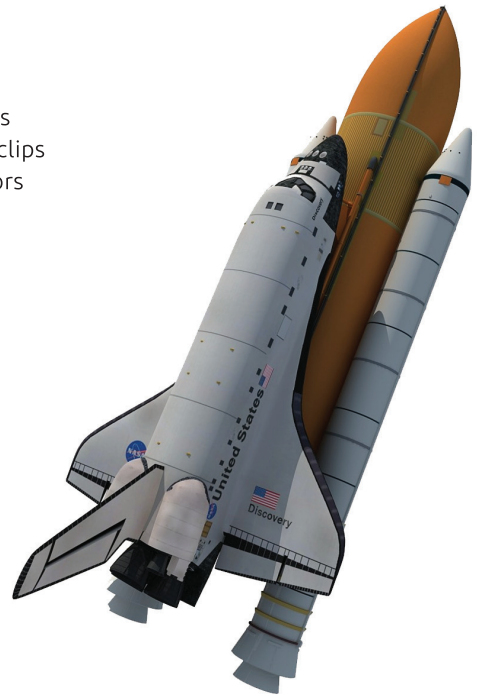
- Bushings
- Thrust Washers
- Shaft Bearings
- Seals

DuPont™ Vespel® Space Applications

Performance and stability at low temperatures with low outgassing and radiation resistance

Satellite and Spacecraft

- Camera lens retainers & centering rings
- Seals
- Locking fasteners
- Bearings
- Bushings
- Splines
- Valve components
- Thermal blanket clips
- Electrical insulators
- Thermal isolators
- Radomes



Bushing & Thrust Washers

Low cost, low friction, long life bearing solutions



Application Challenges

- High temperature
- Wear resistance
- Low friction bearing
- Tight sealing



DuPont™ Vespel® Material Solutions:

- Numerous SCP, CP, ASB, and SP grades



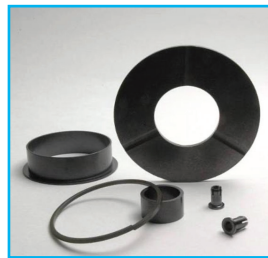
Features:

- High thermal oxidative stability
- Low coefficient of friction
- Excellent wear resistance
- CTE well matched to mating metal components



Benefits:

- Weight savings vs. metal bushings
- Protects expensive mating metal vanes and case from wear
- Efficient compressor operation
- Long life



Compressor Shrouds



Application Challenges

- High Temperature
- Wear Resistance
- Low Friction Bearing
- Tight Sealing



DuPont™ Vespel® Material Solutions:

- SCP-5050, ASB-0826



Features:

- High Thermal Oxidative Stability
- Low Coefficient of Friction
- Excellent Wear Resistance
- CTE well matched to mating metal parts



Benefits:

- Weight savings vs metal shrouds with bushings
- Protects expensive mating metal vanes and case from wear
- Efficient compressor operation
- Fewer parts to manage and assemble
- Long Life



Abraidable High Temperature Seals



Application Challenges

- Zero clearance seal
- Chemical / environmental compatibility
- Durable in harsh environment
- Capable to 600 °F/315 °C



DuPont™ Vespel® Material Solutions:

- SF-0920, SF-0930, SF-0940



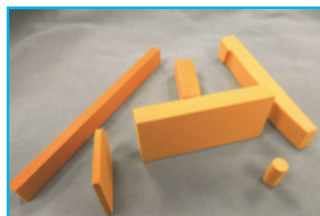
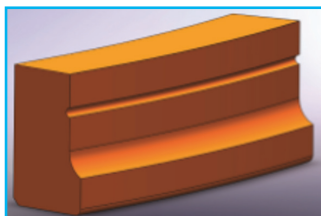
Features:

- Closed cell foam for excellent sealing and compatibility
- Capable of holding close tolerances
- Multiple densities available
- Survives temperatures to over 600 °F/315 °C and will not burn



Benefits:

- Improved compressor/fan efficiency due to near zero clearance seal
- Lower cost than typical honeycomb structures
- No treating required for mating blade tips
- Lightweight, durable designs.



Bumpers, Wear Pads, & Wear Strips

Eliminate metal-to-metal wear



Application Challenges

- Wear resistance
- Low friction
- Strength



DuPont™ Vespel® Material Solutions:

- SP-21, SCP-5050, CP-0301, CP-0664



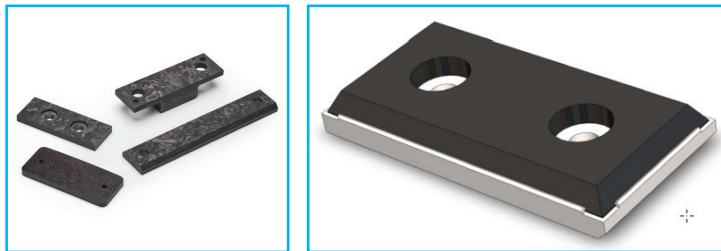
Features:

- High resistance to wear
- Low friction surfaces
- Broad geometry and material options



Benefits:

- Improved component life
- Reduced actuation force requirements
- Design flexibility – assembly options
- System weight savings
- Protects expensive case from wear



Wear Strips for Fan Blade Dovetail Root Surface



Application Challenges

- High loads
- Low friction
- Tight thickness tolerance
- Wear resistance



DuPont™ Vespel® Material Solutions:

- CP-0664



Features:

- High compressive strength
- Coefficient of friction <0.1
- Wear resistance



Benefits:

- Reduces blade stress
- Protects expensive blades from wear
- Controlled, predictable, consistent friction for blade seating
- Corrosion barrier
- Assembly protection



V-Grooves

Eliminate metal-to-metal wear



Application Challenges

- Wear resistance
- Low friction
- Shear strength / impact resistance
- Corrosion resistance
- Field maintenance



Features:

- High resistance to wear
- Low friction surfaces
- Broad geometry options



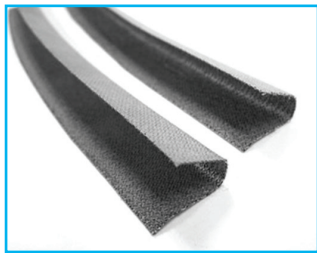
DuPont™ Vespel® Material Solutions:

- CP-0664



Benefits:

- Improved component life
- Design flexibility – assembly options
- Protects expensive components from wear
- Durability



Tube Clamps and Brackets

Save weight over metal alternatives



Application Challenges

- Light weight
- Vibration dampening
- Alignment
- Strength



Features:

- Low density
- High strength
- Meets AS1974 vibratory test requirements



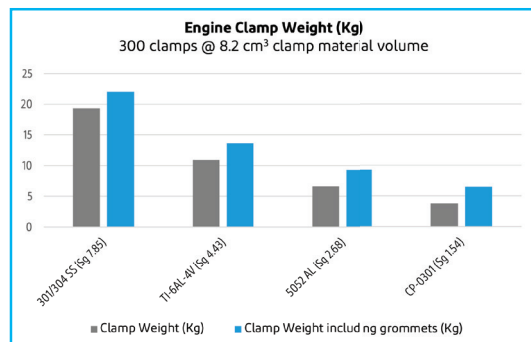
DuPont™ Vespel® Material Solutions:

- CP-0301, CP-2020



Benefits:

- Delivers >40% weight savings over metal clamps
- High strength
- Forgiving to misalignment
- Improved ease of maintenance



Thrust Reverser Components

Low friction, high load capable solutions



Application Challenges

- High loads
- Low friction across operating conditions
- Chemical / environmental compatibility
- Wear resistance



Features:

- High compressive strength
- Coefficient of friction <0.1
- Wear resistance



DuPont™ Vespel® Material Solutions:

- CP-0664 and ASB grades



Benefits:

- Controlled, predictable, low friction from first cycle on and across operating environments
- Reliable, proven performance
- Lightweight, durable designs.



Self Locking Fasteners

Reusable Torque Retention



Application Challenges

- Provide torque retention to threaded fastener
- High temperature capable
- Reusable with same torque retention



Features:

- Strength and toughness
- Thermal endurance
- Creep resistant



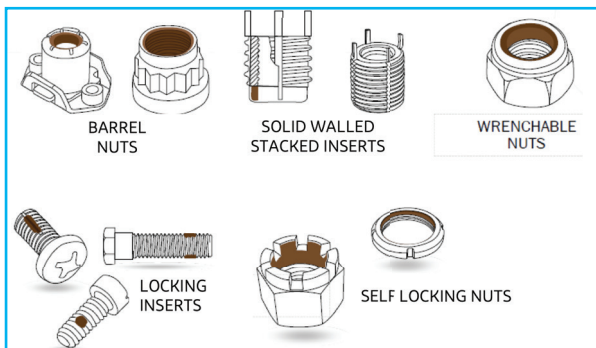
DuPont™ Vespel® Material Solutions:

- SP-1 and SCP-5000



Benefits:

- Meets torque retention requirements
- Reusable with consistent torque retention
- Integrates with metal threads in nuts and bolts
- Proven performance in critical aerospace systems
- Withstands high vibration when placed on external thread



Insulators

Reusable Torque Retention



Application Challenges

- Electrical or thermal insulation
- Loading and vibrational loading
- Environment - temperature



Features:

- Insulative properties
- Fabricate to tight tolerances
- Material toughness
- Lighter than ceramics
- Thermal endurance



DuPont™ Vespel® Material Solutions:

- SP-1, SCP-5000, SF-0920, SF-0930, SF-0940



Benefits:

- Cost savings
- Weight savings
- Thermal endurance versus engineered plastics



Our primary focus is your success

- The DuPont Support Team assigned to your project is uniquely qualified to understand your design needs
- Dedicated to meeting, and exceeding, your quality requirements
- Experienced with aerospace systems and procedures
- Focused on 100% on-time delivery
- Devoted to unparalleled performance in the field
- Vespel® aerospace-specific US manufacturing sites are AS9100D certified



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