

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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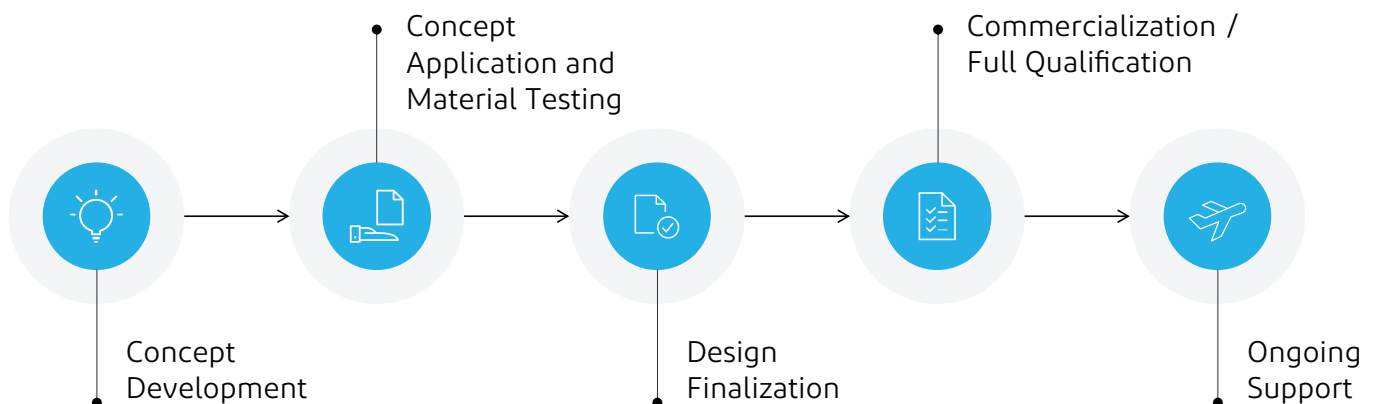
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## Why DuPont™ Vespel®?

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

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## 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

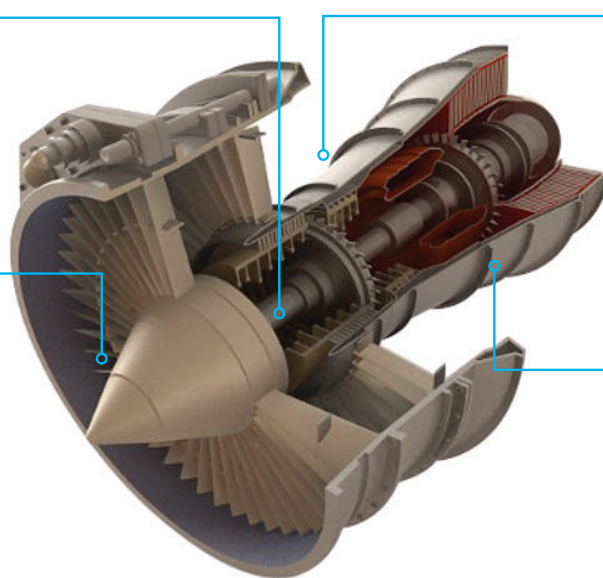
Improving performance, extending life, saving weight & lowering costs

### 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



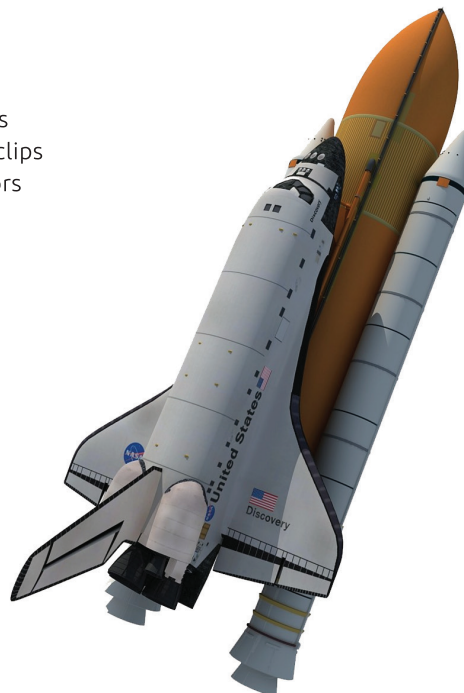
## DuPont™ Vespel® Space Applications

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



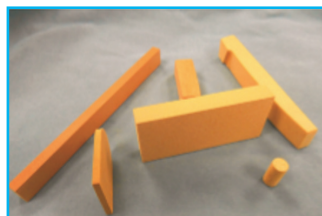
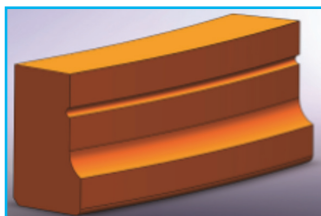
### Application Challenges

- 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



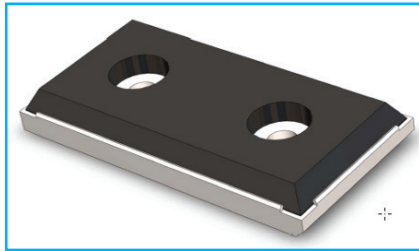
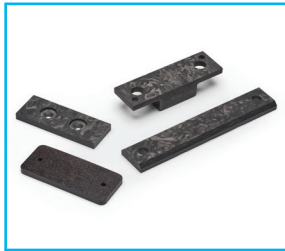
### Features:

- 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



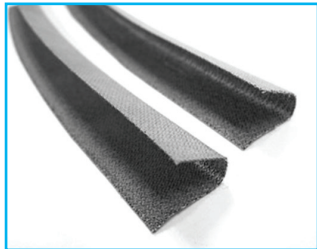
### DuPont™ Vespel® Material Solutions:

- 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



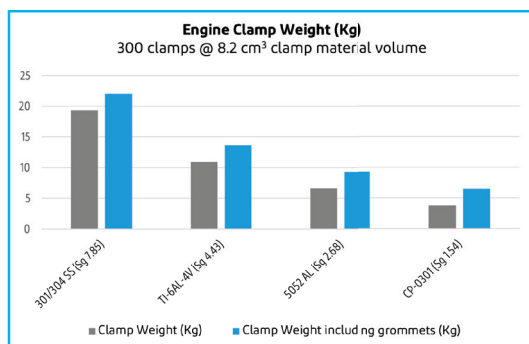
### DuPont™ Vespel® Material Solutions:

- 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



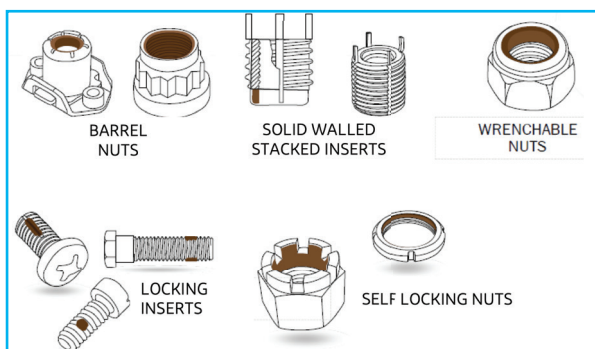
### DuPont™ Vespel® Material Solutions:

- 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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