Aerospace

DuPont™ Kalrez® and Vespel® Precision Parts for the Aerospace Industry

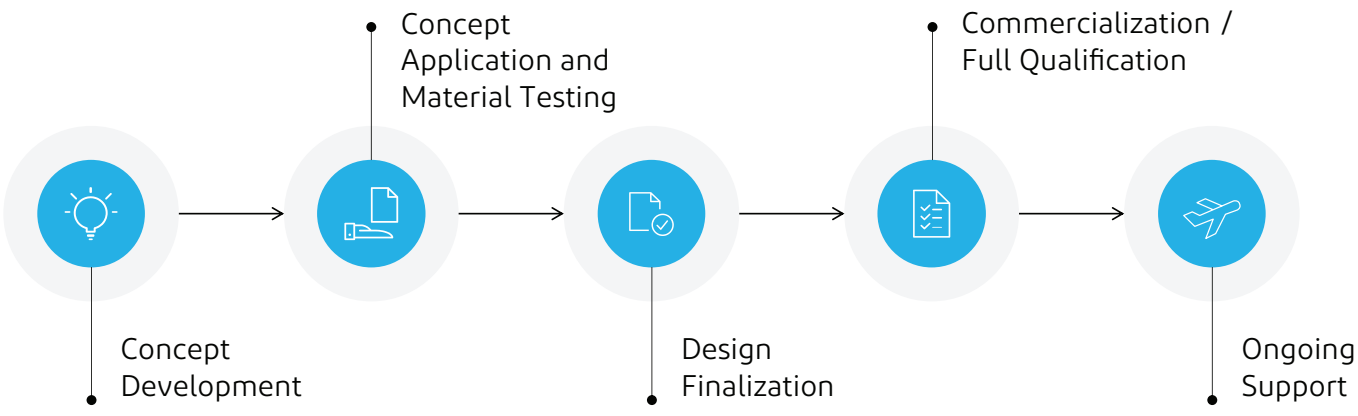
Solving the toughest sealing, wear and friction challenges in mission-critical applications

Contents

Why DuPont™ Kalrez® and Vespel®?

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

Technical support, every step of the way...



DuPont™ Kalrez® Perfluoroelastomer Seals:

For critical sealing applications in the most challenging conditions

- **Kalrez® 4079AMS – proven performance**
- **Kalrez® Aeroseal™ 7797, and 7800AMS**
  - High thermal stability
  - Low compression set
  - Improved stress relaxation
  - Improved temperature cycling
- **Kalrez® 7745**
  - NASA-approved material (NASA-STD-6001B)

Property	Kalrez® 4079	Kalrez® 7800	Kalrez® 7745	Kalrez® 7797
Hardness (Shore A)	75	75	78	90
Meets AMS 7257E	Yes	Yes	No (Hardness > 75)	No (Hardness > 75)
Max Service Temp, °F (°C)	600 (316)	617 (325)	464 (240)	617 (325)

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

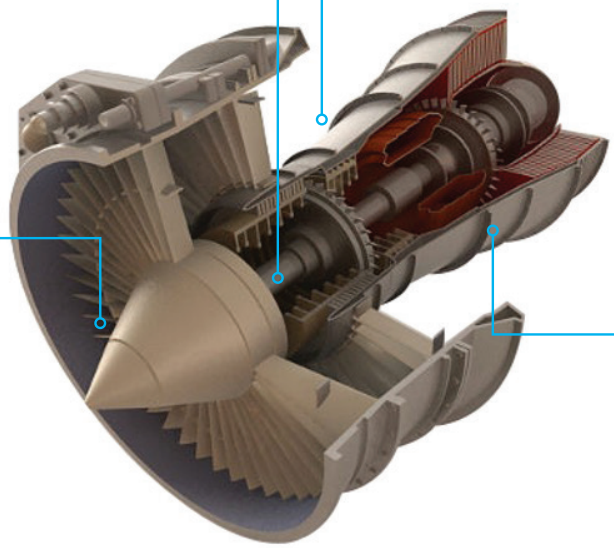
Improving performance, extending life, saving weight & lowering costs

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

Control / Actuation Systems

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

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

Auxiliary Power Units

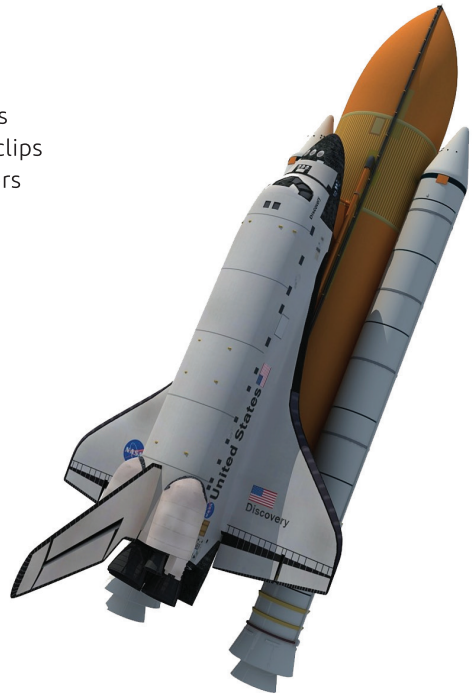
- Bushings
- Thrust Washers
- Shaft Bearings
- Seals

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

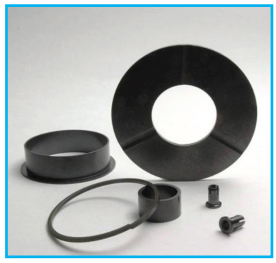


Bushing & Thrust Washers

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

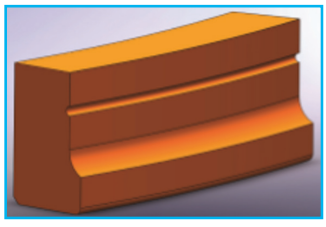
Abraidable High Temperature Seals

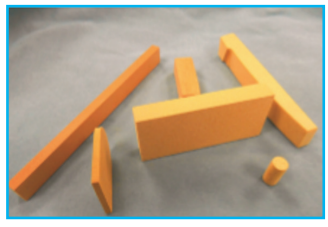
Application Challenges

- 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

Features:

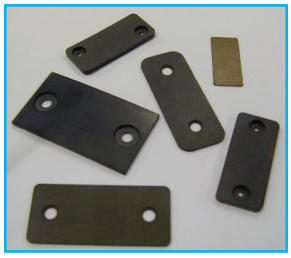
- High resistance to wear
- Low friction surfaces
- Broad geometry and material options

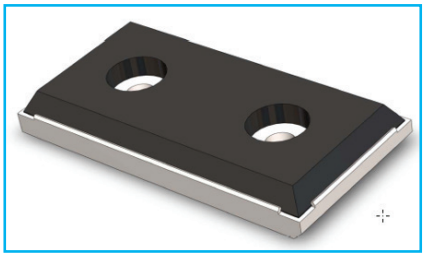
DuPont™ Vespel® Material Solutions:

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

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
- Sheer strength / impact resistance
- Corrosion resistance
- Field maintenance

Features:

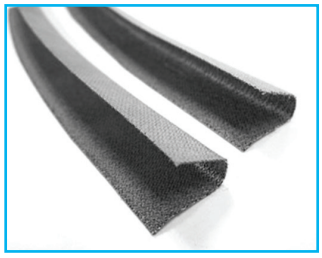
- High resistance to wear
- Low friction surfaces
- Broad geometry options

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:

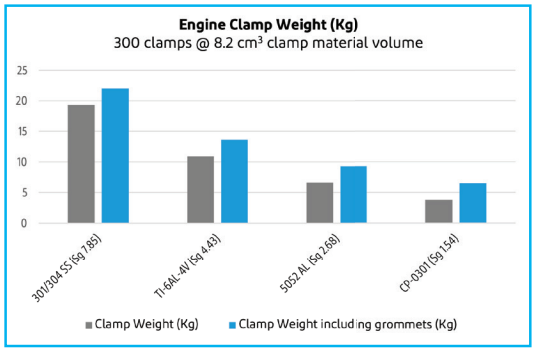
- Low density
- High strength
- Meets AS1974 vibratory test requirements

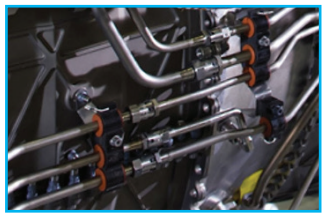
DuPont™ Vespel® Material Solutions:

- 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:

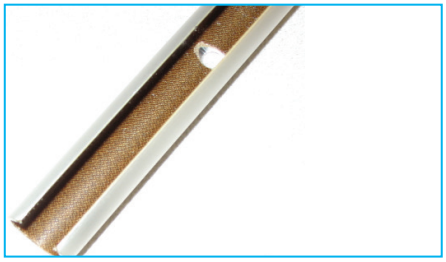
- High compressive strength
- Coefficient of friction <0.1
- Wear resistance

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:

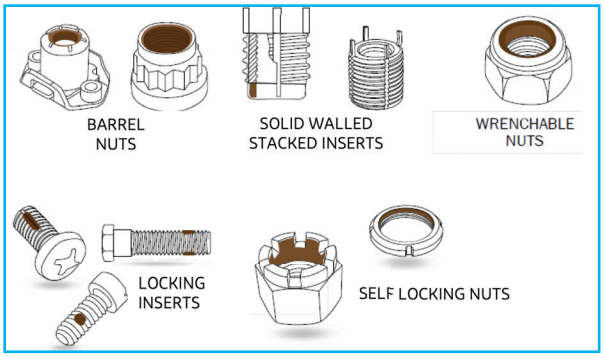
- Strength and toughness
- Thermal endurance
- Creep resistant

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

Engine Oil System Seals

Preventing Fluid Leakage

Application Challenges

- Thermal cycling from ambient to high temperature
- Suitable for use with rocket fuel such as dinitrogen tetroxide

Features:

- High temperature resistance, durable up to 325 °C
- Low compression set
- Broad chemical compatibility
- Good sealing force retention

DuPont™ Kalrez® Material Solutions:

- Kalrez® 4079AMS, 7745, Aeroseal 7797, Aeroseal 7800AMS

Benefits:

- Improved reliability of the engine operation
- Durability preventing fluid leakage
- Meets SAE AMS7257E and NASA STD-6001D standards*

*Specific grades

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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