



# Vespel<sup>®</sup>

polyimide parts and shapes

## Introducing the New Generation in High-Temperature Components

Polyimide parts and shapes made of DuPont Vespel<sup>®</sup> ST have what it takes to meet more challenges in high-temperature applications.

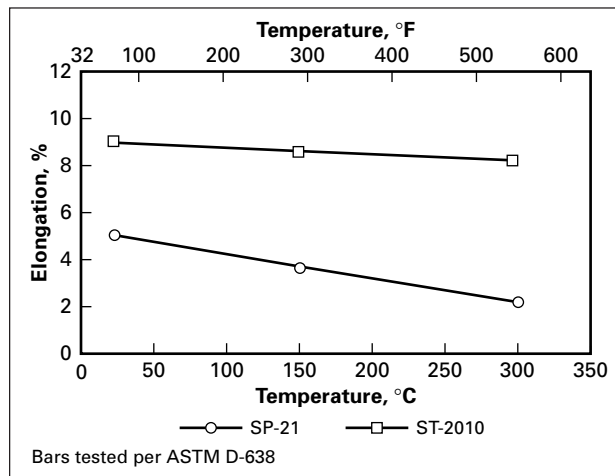
- Superior toughness
- Higher temperature capabilities
- Increased strength
- Improved chemical resistance
- Low friction
- Minimum wear
- Excellent electrical properties
- Low thermal and electrical conductivity
- Will not melt

As a replacement for composites, ceramics, and other high-temperature materials, Vespel<sup>®</sup> ST can often save costs while improving performance.

### Superior Toughness

Parts made of Vespel<sup>®</sup> ST have about double the elongation of earlier SP polyimides (**Figure 1**). Impact strength (notched Izod) is about 50% higher (**Table 1**).

**Figure 1. Elongation vs. Temperature—SP-21 vs. ST-2010**



### Higher Strength

Components made of Vespel<sup>®</sup> ST are stronger than comparable SP parts, both in tension and ultimate compression, as shown in **Figures 2 and 3**.

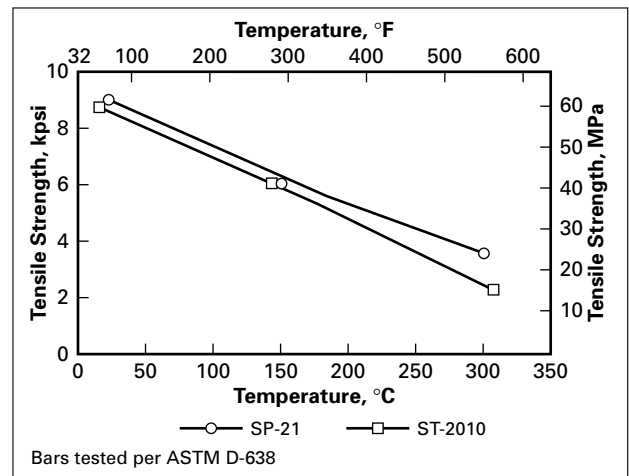
### Higher Temperature Capabilities

Because parts made of Vespel<sup>®</sup> ST have such good initial mechanical properties, they retain functional levels of toughness and strength for longer periods at elevated temperatures than the earlier generation (**Figures 4 and 5**).

Operating temperatures for Vespel<sup>®</sup> ST can range up to 288°C (550°F)\* with excursions to more than 482°C (900°F). They do not melt at any temperature.

\*Depending on the application

**Figure 2. Tensile Strength vs. Temperature—SP-21 vs. ST-2010**



**Table 1**  
**Typical Physical Properties of Direct-Formed Parts Made of Vespel® ST**

Property/Unit	Temp., °C	ASTM Method	ST-2010	SP-21	ST-2030	SP-22	
Tensile strength, psi (MPa)	Room	D-638	8,750 (61)	9,000 (62)	8,300 (57)	6,500 (45)	
	150		6,340 (44)	6,300 (43)			
	260		4,110 (29)	4,400 (30)		3,800 (26)	
	300		3,310 (23)	3,600 (25)			
Elongation, %	Room	D-638	8.5	5.5	4.9	2.5	
	150		8.5	6.5			
	260		8.3	5.7		2.8	
	300		8.2	5.1			
Tensile modulus, kpsi (MPa)	Room	D-638	400 (2,758)	380 (2,620)			
Izod, notched, ft-lb/in (J/m)	Room	D-256	1.0 (53)	0.7 (37)		0.4 (21)	
Thermal conductivity Btu-in/h-ft <sup>2</sup> -°F ([W-cm/cm <sup>2</sup> -°C] × 10 <sup>-3</sup> )	Room (23)	F-433	3.5 (5.0)	4.2 (6.1)	6.7 (9.7)	5.8 (8.4)	
Water absorption % change (weight), 24 h 48 h	Room	D-570	1.3	0.6	0.5		
	50		3.1	1.5	1.3		
Compressive strength psi (MPa), 1% strain	Room	D-695	2,200 (15)	2,800 (19)		3,200 (22)	
			10% strain	11,900 (82)	13,900 (96)		14,300 (99)
			Ultimate	39,000 (269)	29,700 (205)		19,300 (133)
Compressive modulus kpsi (MPa)	Room	D-695	265 (1,827)	313 (2,158)		350 (2,413)	
Deformation under load, %	23	D-621	0.18	0.17		0.13	
	50		0.38	0.26			
Specific gravity	Room	D-792	1.32	1.42	1.44	1.56	
Coefficient of Linear Expansion (µm/m/°C)	Room	E-228	50	28	31	15	

### Improved Chemical Resistance

Parts made of Vespel® ST also exhibit improved chemical resistance (especially to acids and bases) and better hydrolytic stability while retaining the outstanding solvent resistance of SP parts.

### Low Friction and Wear

Vespel® ST shares the low friction and excellent wear properties typical of Vespel® SP polyimides. Thanks to their low friction and resistance to softening under the influence of frictional heat, bearings made of ST exhibit low wear over a broad pressure-velocity range:

- PVs up to 200,000 psi·fpm, unlubricated
- PVs to 1 million psi·fpm, lubricated

### Effective Insulators

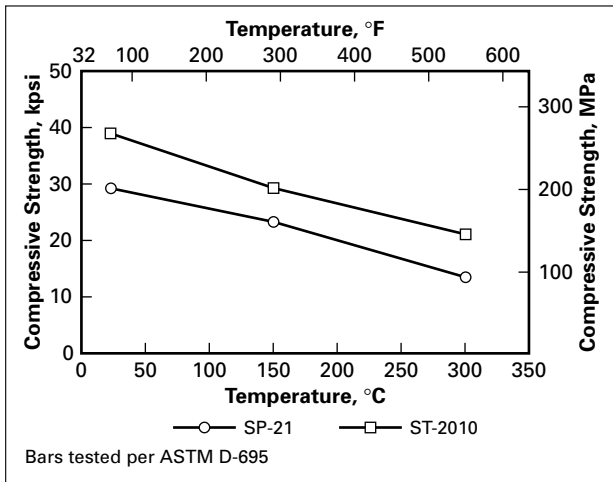
The combination of high-temperature performance and low conductivity makes parts made of Vespel® ST highly effective electrical (**Table 2**) and thermal insulators.

### Broad Applications

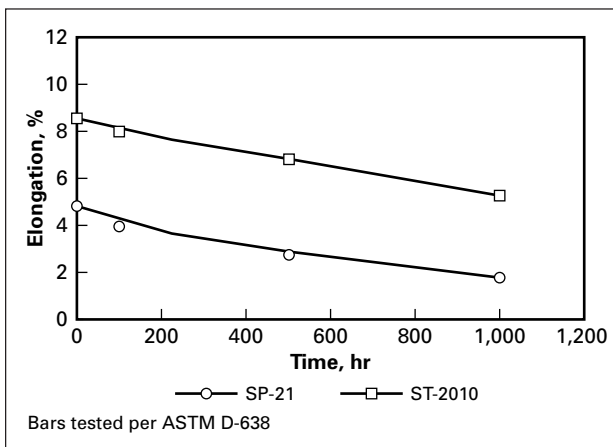
Parts made of Vespel® ST can be used in many demanding environments. These include:

- Jet engines
- Industrial machinery and equipment
- Business machines
- Cars, trucks, off-road vehicles
- Instruments

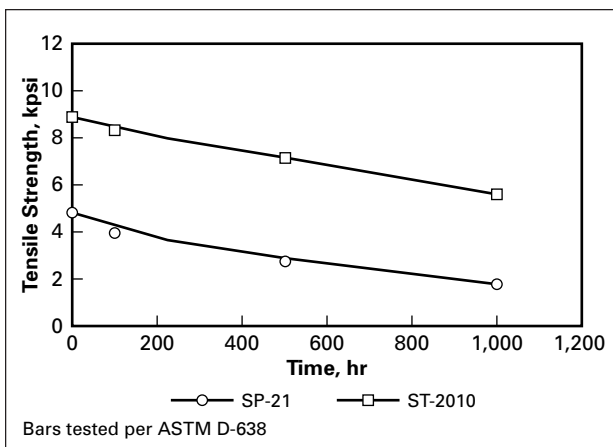
**Figure 3. Compressive Strength vs. Temperature—SP-21 vs. ST-2010**



**Figure 4. Heat Aging 260°C (500°F) Effects on Elongation—SP-21 vs. ST-2010**



**Figure 5. Heat Aging 260°C (500°F) Effects on Tensile Strength—SP-21 vs. ST-2010**



Parts made of Vespel® ST are supplied as direct-formed custom parts and shapes. Typical parts include:

- Bushings and other bearing parts
- Wear pads
- Seals, gaskets, valve seats
- Electrical and thermal insulators
- Multifunctional components

### Design and Technical Assistance

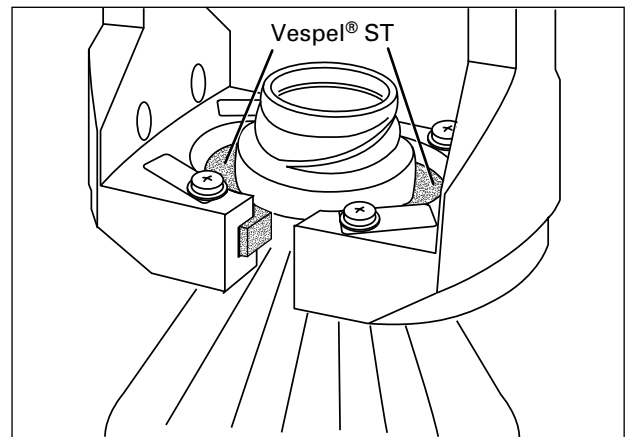
Experienced DuPont engineers can provide design assistance for parts made of Vespel® ST for maximum value.

### Materials Choices

Properties of current commercial formulations of Vespel® ST are shown in **Table 1**. A summary description follows:

**ST-2010.** Excellent wear and friction properties combined with good toughness, strength, and insulation properties. Contains 10% graphite.

**ST-2030.** Lower coefficient of thermal expansion, lower elongation than ST-2010. Contains 30% graphite.



Grippers for glass bottle manufacture underscore value of the low thermal conductivity of Vespel® ST. Grippers made of conductive materials cause nonuniform bottle cooling, resulting in many microcracking rejects.

Grippers made of Vespel® ST grab the 538 to 649°C (1000 to 1200°F) bottles as they emerge from the oven and lift them onto a conveyor.

**Table 2**  
**Typical Electrical Properties of Direct-Formed Parts Made of Vespel® ST**

Property/Unit	Temp., °C	ASTM Method	ST-2010	SP-21	ST-2030	SP-22
Dielectric strength V/mil (kV/mm)	Room	D-149	265 (10.4)	140 (5.5)		
Dielectric constant	Room	D-150				
100 Hz			4.80	6.55	300	12.6
10 kHz			4.78	6.51	110	18.7
1 MHz			4.70	6.41	40.6	18.6
Dissipation factor	Room	D-150				
100 Hz			0.0014	0.0019	6.9	
10 kHz			0.0023	0.0040	0.65	
1 MHz			0.0075	0.0070	0.30	
Volume resistivity ohm-cm	Room	D-257	$3.2 \times 10^{16}$	$2.2 \times 10^{16}$	$4.8 \times 10^7$	$2.3 \times 10^{10}$
Surface resistivity ohm/square	Room	D-257	$2.0 \times 10^{16}$	$4.7 \times 10^{12}$	$2.6 \times 10^8$	$1.4 \times 10^6$

**For more information on Vespel®:**

**(800) 972-7252**

**For Automotive Inquiries:**

**(800) 533-1313**

**United States**

DuPont Engineering Polymers  
Pencader Site  
Newark, DE 19714-6100  
(800) 972-7252  
(302) 733-8158

**Europe**

DuPont de Nemours  
(Belgium) N.V.  
DuPont Engineering Polymers  
Antoon Spinostraat 6  
B-2800 Mechelen, Belgium  
011-32 (015) 44 1494  
Fax: 011-32 (015) 44 1408

**Far East**

DuPont Kabushiki Kaisha  
Specialty Polymers  
Vespel® Marketing  
19-2, Kiyohara Kogyo Danchi  
Utsunomiya, Tochigi  
321-32, Japan  
011-81-286-67-6734  
Fax: 011-81-286-67-7299

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