DUPONT

# Vespel®

polyimide parts and shapes

## Introducing the New Generation in High-Temperature Components

Polyimide parts and shapes made of DuPont Vespel® 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® ST can often save costs while improving performance.

### Superior Toughness

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

### Higher Strength

Components made of Vespel® 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® 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® 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 1. Elongation vs. Temperature—SP-21 vs. ST-2010**

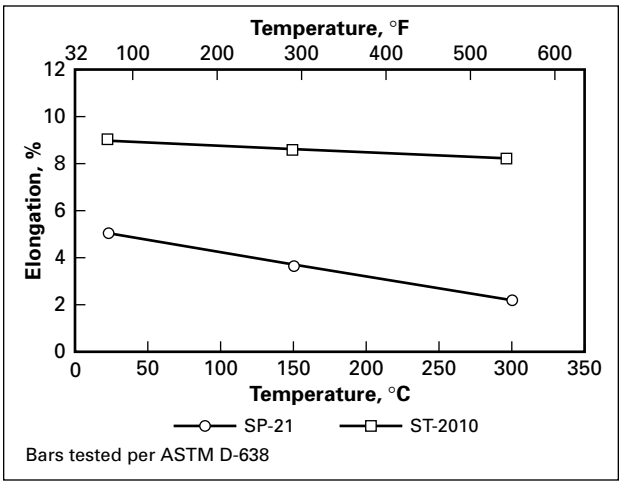



**Figure 2. Tensile Strength vs. Temperature—SP-21 vs. ST-2010**

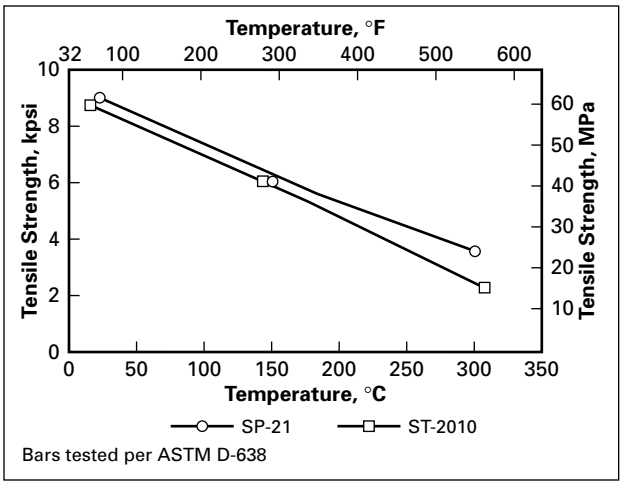


**Table 1**
**Typical Physical Properties of Direct-Formed Parts Made of Vespel® ST**

| Property/Unit | Temp., °C | ASTM Method | ST-2010 | SP-21 | ST-2030 | SP-22 |
|---|---|---|---|---|---|---|
| Tensile strength, psi | Room | D-638 | 8,750 | 9,000 | 8,300 | 6,500 |
| (MPa) | | | (61) | (62) | (57) | (45) |
| | 150 | | 6,340 | 6,300 | | |
| | | | (44) | (43) | | |
| | 260 | | 4,110 | 4,400 | | 3,800 |
| | | | (29) | (30) | | (26) |
| | 300 | | 3,310 | 3,600 | | |
| | | | (23) | (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 | Room | D-638 | 400 | 380 | | |
| (MPa) | | | (2,758) | (2,620) | | |
| Izod, notched, ft·lb/in | Room | D-256 | 1.0 | 0.7 | | 0.4 |
| (J/m) | | | (53) | (37) | | (21) |
| Thermal conductivity | Room | F-433 | 3.5 | 4.2 | 6.7 | 5.8 |
| Btu·in/h·ft²·°F | (23) | | (5.0) | (6.1) | (9.7) | (8.4) |
| ([W·cm/cm²·°C] × $10^{-3}$) | | | | | | |
| Water absorption | | | | | | |
| % change (weight), 24 h | Room | D-570 | 1.3 | 0.6 | 0.5 | |
| 48 h | 50 | | 3.1 | 1.5 | 1.3 | |
| Compressive strength | | | | | | |
| psi (MPa), 1% strain | Room | D-695 | 2,200 | 2,800 | | 3,200 |
| | | | (15) | (19) | | (22) |
| 10% strain | | | 11,900 | 13,900 | | 14,300 |
| | | | (82) | (96) | | (99) |
| Ultimate | | | 39,000 | 29,700 | | 19,300 |
| | | | (269) | (205) | | (133) |
| Compressive modulus | Room | D-695 | 265 | 313 | | 350 |
| kpsi (MPa) | | | (1,827) | (2,158) | | (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 |

## 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**

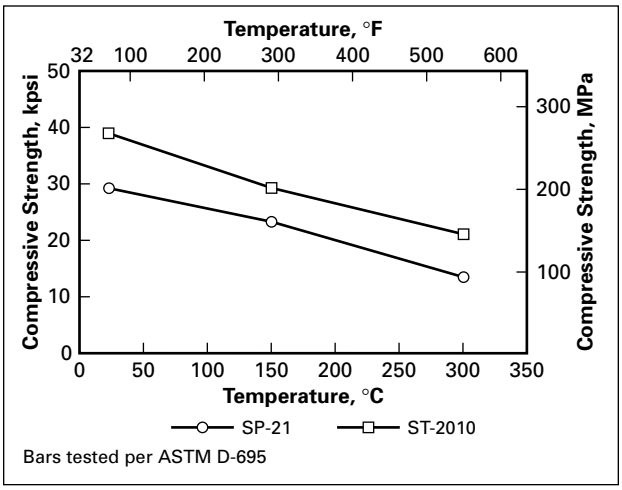



**Figure 4. Heat Aging 260°C (500°F) Effects on Elongation—SP-21 vs. ST-2010**

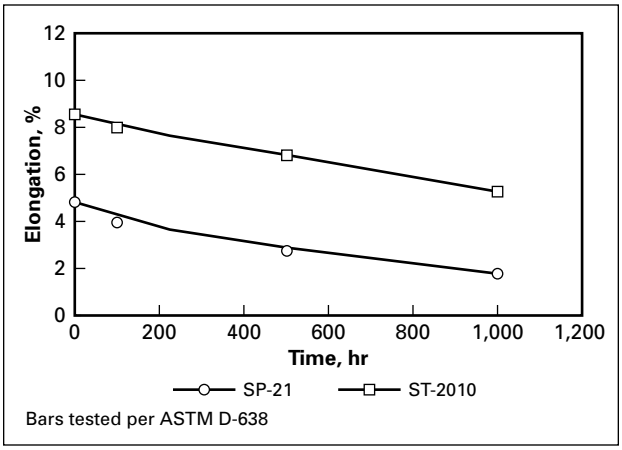
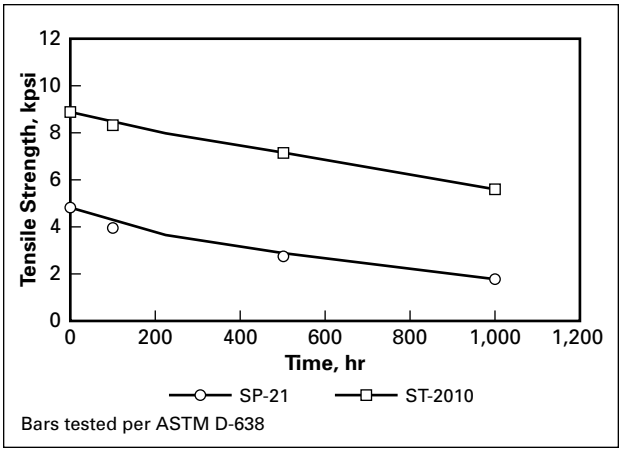



**Figure 5. Heat Aging 260°C (500°F) Effects on Tensile Strength—SP-21 vs. ST-2010**




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

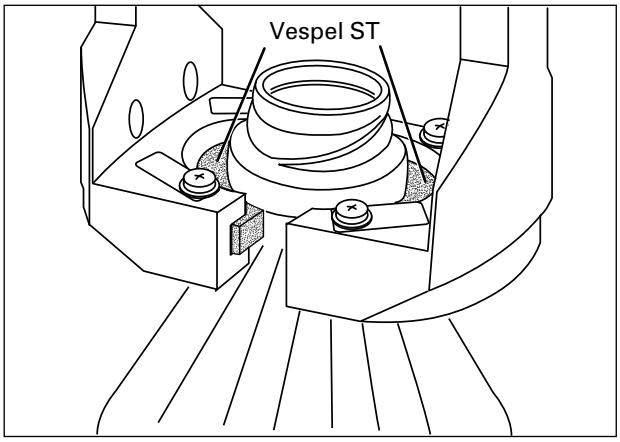
Experienced DuPont engineers can provide design assistance for parts made of Vespel® ST for maximum value.

## 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 Spinoystraat 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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