

DuPont Engineering Polymers

FOR WIRE & CABLE

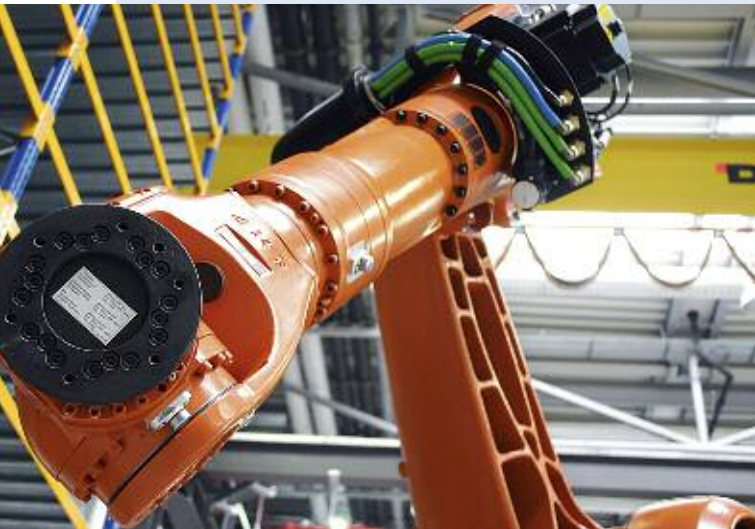


The miracles of science™

DuPont Engineering Polymers for Wire & Cable

Are you looking for better alternatives for your high-performance cables?

With the right selection, DuPont™ Engineering Polymers can provide superior performance at a lower cost versus competitive materials. For example, wire insulation or jacketing made with our polymers may require less material due to their thinner walls. As a consequence, the cables may become less expensive per length of wire, while delivering superior physical properties, such as improved flexibility at low temperatures, easier routing through tight spaces, improved flex fatigue performance, and good abrasion resistance. Moreover, our polymers are plasticizer-, lead-, and halogen-free, making them RoHS compliant.



Typical robotic application

Today you need more from your suppliers than just materials. You need a resource that is willing and able to join in at the earliest stages of the product development process. One that can carry a project from concept through design, processing support, material selection, quality control, and even commercialization assistance. You need a fully fledged partner.

DuPont can be that partner. We believe that true partnership is a dynamic process of teamwork and sharing. And we recognize that only through your continued success will our relationship thrive, to bring out the best in both of us.

Should you decide to work with us from the initial design concept, and on through every stage to full production, we can share our experience and help you choose the optimum engineering polymer for your needs. The result? A very competitive, new and successful product.

Front cover:
Left: Granules made of engineering polymers.

Top right: Slimmer profiled cable, insulated with DuPont™ Hytrel® (left), indicates longer flex life than rubber-insulated cable (right), which failed after only two years of service on a bridge over the Mississippi.

Bottom right: Jacketing of DuPont™ Hytrel® thermoplastic polyester elastomer for a high speed train application.

DuPont engineering polymers offer you the properties and benefits required to give your products that extra competitive edge: high-performance, lightweight cables and reduced processing costs for greater customer satisfaction. All these advantages add up to new opportunities in design, manufacture and finished cable cost.

DuPont has a unique history in engineering polymers. Nylon, which we invented back in the 1930s, led to the development of DuPont™ Zytel®, the first real engineering thermoplastic.

Our family of high performance polymers has since grown rapidly. We have added new materials suitable for injection molding; including Zytel® ST super tough nylon and, more recently, a complete range of PBT polyesters under the trademark of DuPont™ Crastin® PBT. Grades of each of these products are used in the wire and cable industry.

| THERMAL | Melting Point | Melt Viscosity shear rate (1000s-1) |
|---------------------------|---------------|--|
| Test Method – ISO | 11357-1/-3 | 11443 |
| Units | °C | Pa × S |
| Crastin® 6129 NC010 | 225 | 370 (@250°C) |
| Crastin® 6130 NC010 | 225 | 370 (@250°C) |
| Crastin® S600F10 NC010 | 225 | 290 (@250°C) |
| Crastin® ST820 NC010 | 225 | 500 (@250°C) |
| DuPont™ ETPV 80A01 NC010 | 205 | 220 (@225°C) |
| DuPont™ ETPV90A01 NC010 | 205 | 150 (@225°C) |
| DuPont™ ETPV95A02HS BK001 | 216 | 170 (@235°C) |
| Hytrel® 4056 | 150 | 320 (@190°C) |
| Hytrel® 5556 | 203 | 240 (@220°C) |
| Hytrel® 7246 | 218 | 250 (@240°C) |
| Hytrel® HTR8303FR | 220 | 900 (@245°C) |
| Zytel® 42 NC010 | 263 | 270 (@290°C) |
| Zytel® 103HSL NC010 | 262 | 110 (@290°C) |
| Zytel® 158 NC010 | 218 | 180 (@240°C) |
| Zytel® EFE4168 BK | 218 | 170 (@280°C) |

The properties published for the Zytel® materials are DAM

| ELECTRICAL | Dielectric Strength | Flamability | Volume Resistivity |
|-----------------------------------|---------------------------------------|------------------|-------------------------|
| Test Method | IEC 60243 ASTM D 149 ¹⁾ | UL 94 | ASTM D 257 IEC 60093 |
| Units | kV/mm | | ohm × cm |
| Testing temperature | 23°C | 23°C | 23°C |
| Crastin® 6129 NC010 | 26 | HB | >1E15 |
| Crastin® 6130 NC010 | 26 | HB | >1E15 |
| Crastin® S600F10 NC010 | 26 | HB | >1E15 |
| Crastin® ST820 NC010 | 27 | HB | >1E15 |
| DuPont™ ETPV 80A01 NC010 | 28 | HB | >1E13 |
| DuPont™ ETPV90A01 NC010 | 28 | HB | >3E13 |
| DuPont™ ETPV95A02HS BK001 | 28 | HB | >1E14 |
| Hytrel® 4056 | 24 | HB | 1E13 |
| Hytrel® 5556 | 24 | HB | 1E13 |
| Hytrel® 7246 | 27 | HB | 1E13 |
| Hytrel® HTR8303FR | 24 | V2 ³⁾ | 7.5 E14 |
| Zytel® 42 NC010 ²⁾ | 30 | HB | 1E15 |
| Zytel® 103HSL NC010 ²⁾ | 31 | V2 | 1E15 |
| Zytel® 158 NC010 ²⁾ | 31 | HB | 1E15 |
| Zytel® EFE4168 BK ²⁾ | 31 | HB | 1E15 |

1) All data refer to samples 1 mm thick

2) All Zytel® data refer to Dry as Molded condition

3) Internal DuPont Tests



Tough and thin layer of DuPont™ Hytrel® provides effective insulation and excellent flex life in a robotic cable application.

Complementary to this extensive line of plastics is DuPont™ [Hytrel®](#) thermoplastic polyester elastomer. Hytrel® TPC-ET combines many of the most desirable characteristics of high performance elastomers and flexible plastics, yet it can be extruded into quality cables by conventional thermoplastic processing techniques.

And, most recently, DuPont™ [ETPV](#) has been added as an elastomeric material, which in reality is a Thermoplastic Vulcanizate with outstanding high temperature performance.

In today's competitive markets, each new product launch seems to require more and more investment. So it pays, at the earliest stage, to take full advantage of the latest developments in engineering polymers by starting with DuPont and calling us in at the initial concept stage. More than just selling polymers, we share with you a world of practical experience and technological know-how that can help you build a real competitive advantage into everything you design and manufacture.

For more detailed data, contact your local DuPont representative.

| MECHANICAL | Tensile Modulus | Stress at Yield | Stress at Break | Strain at Yield | Strain at Break | Flexural Modulus | Notched Charpy Impact Strength | |
|---------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------------|--------------------------------|-------------------|
| Test Method – ISO | ISO 527 | ISO 527 | ISO 527 | ISO 527 | ISO 527 | ISO 178 | ISO 179/1eA | ISO 179/1eA |
| Units | MPa | MPa | MPa | % | % | MPa | KJ/m ² | KJ/m ² |
| Testing temperature | 23°C | 23°C | 23°C | 23°C | 23°C | 23°C | -30°C | 23°C |
| Crastin® 6129 NC010 | 2600 | 58 | – | 5 | 200 | 2350 | 4 | 5.5 |
| Crastin® 6130 NC010 | 2600 | 59 | – | 10 | 110 | 2350 | 4.5 | 5 |
| Crastin® S600F10 NC010 | 2700 | 57 | – | 8 | 200 | 2300 | 4 | 5 |
| Crastin® ST820 NC010 | 1700 | 38 | – | 7 | 150 | 1500 | 10 | 85 |
| DuPont™ ETPV 80A01 NC010 | 35 | – | 8 | – | 120 | 28 | 55 | NB |
| DuPont™ ETPV90A01 NC010 | 55 | – | 10 | – | 200 | 50 | – | NB |
| DuPont™ ETPV95A02HS BK001 | 180 | – | 15 | – | 206 | 170 | – | NB |
| Hytrel® 4056 | 53 | – | 30 | – | 420 | 62 | NB | NB |
| Hytrel® 5556 | 180 | – | 42 | – | 500 | 180 | 85 | NB |
| Hytrel® 7246 | 530 | – | 53 | – | 450 | 550 | – | 33 |
| Hytrel® HTR8303FR | 680 | – | 25 | – | 200 | 700 | 11 | 80 |
| Zytel® 42 NC010 | 3100 | 86 | – | 5 | 100 | 2800 | 5 | 6 |
| Zytel® 103HSL NC010 | 3100 | 85 | – | 4 | 30 | 2800 | 5.5 | 5 |
| Zytel® 158 NC010 | 2400 | 62 | – | 4.5 | 100 | 2050 | 5 | 4 |
| Zytel® EFE4168 BK | 1000 | 30 | – | 26 | 300 | – | 10 | 40 |

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DuPont Engineering Polymers for Wire & Cable

| PROCESSING PARAMETERS | Melt Temperature Range | Drying Time, Dehumidified Dryer | Drying Temperature | Processing Moisture Content |
|---------------------------|------------------------|---------------------------------|--------------------|-----------------------------|
| Units | °C | h | °C | % |
| Crastin® 6129 NC010 | 240–260 | 2 to 4 | 110–130 | < 0.04 |
| Crastin® 6130 NC010 | 240–260 | 2 to 4 | 110–130 | < 0.04 |
| Crastin® S600F10 NC010 | 240–260 | 2 to 4 | 110–130 | < 0.04 |
| Crastin® ST820 NC010 | 240–260 | 2 to 4 | 110–130 | < 0.04 |
| DuPont™ ETPV 80A01 NC010 | 215–230 | 2 to 3 | 80 | < 0.05 |
| DuPont™ ETPV90A01 NC010 | 215–230 | 2 to 3 | 80 | < 0.05 |
| DuPont™ ETPV95A02HS BK001 | 225–240 | 2 to 3 | 80 | < 0.05 |
| Hytrel® 4056 | 165–180 | 2 to 3 | 80 | < 0.08 |
| Hytrel® 5556 | 220–240 | 2 to 3 | 100 | < 0.08 |
| Hytrel® 7246 | 235–250 | 2 to 3 | 110 | < 0.08 |
| Hytrel® HTR8303FR | 235–250 | 2 to 3 | 110 | < 0.08 |
| Zytel® 42 NC010 | 280–300 | 2 to 4 | 80 | < 0.05 |
| Zytel® 103HSL NC010 | 280–300 | 2 to 4 | 80 | < 0.05 |
| Zytel® 158 NC010 | 230–250 | 2 to 4 | 80 | < 0.05 |
| Zytel® EFE4168 BK | 230–250 | 2 to 4 | 80 | < 0.05 |

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DuPont Engineering Polymers Offering for Wire & Cable

Current product offering

- DuPont™ Crastin®: 6129, 6130, S 600 F20, S660FR, ST830FR.
- DuPont™ Hytrel®: 4056, 5556, 7246, AC, HTR 8303 FR
- DuPont™ ETPV: 90, 95
- DuPont™ Zytel®: 42, 158, EFE 4168, FR 7026

Products under development:

- Halogen-free FR
- Anti Rodents & termites
- Improved Abrasion & UV performance
- Long-chain polyamides

A prime example of the benefits to be gained by adopting of Hytrel® TPC-ET as an insulating material for cables, can be found in the following robotic cable application:

- Because of its combination of high mechanical strength and dielectric strength, Hytrel® TPC-ET is used in thinner layers than many alternative materials.
- In multi-conductor cables, thinner insulation results in a substantial reduction in cable diameter, which means longer flex life at a given bend radius.
- Slimmer cables can also permit tighter bends while meeting a particular flex life target.
- Another advantage for Hytrel® TPC-ET is its productivity and stability during extrusion of thin insulation layers.

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Caution: Do not use in medical applications involving permanent implantation in the human body. For other medical applications, see "DuPont Medical Caution Statement".

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