Thermoplastic Polyurethanes
About Huntsman Corporation

Huntsman is a global manufacturer and marketer of differentiated chemicals. Our operating companies manufacture products for a variety of global industries, including chemicals, plastics, automotive, aviation, textiles, footwear, paints and coatings, construction, technology, agriculture, health care, detergent, personal care, furniture, appliances and packaging. Originally known for pioneering innovations in packaging and, later, for rapid and integrated growth in petrochemicals, Huntsman has approximately 2,000 employees and operates from multiple locations worldwide. The Company had 2011 revenues of over $11 billion.

With sales and operations sites located around the globe, Huntsman is able to deliver a quality service to customers worldwide.

Global TPU presence

[Map showing locations with icons for Global HQ, Regional Technology Center, Sales Office, and TPU Production Site]
Huntsman: A strong partner for the thermoplastics industry

Huntsman TPU: Shaping your world
Thermoplastic polyurethanes (TPUs) offer infinite possibilities to meet the manufacturing challenges of a fast-changing world. Tough, reliable and extremely versatile, our TPUs can meet injection molding, extrusion, adhesive, coating and film requirements to improve the production and performance of everything from shoes, technical parts, cables and films to conveyor belts and seals.

Commitment to customers
Combining a deep understanding of TPU chemistry with over 50 years practical industry experience, we help our customers grow their market share and respond to new opportunities.

Worldwide our customers trust us to deliver:
• Innovative TPU solutions that can be customized to individual needs
• Compatibility with key processing technologies
• First-class technical research, development and testing facilities
• Excellent support backed by a global supply network.

Commitment to quality
Customers can be confident that our TPU solutions are underpinned by:
• Continuous investment in research and development
• Quality assurance and quality control accreditations
• State-of-the-art manufacturing methods and process controls
• World-scale production capacity and just-in-time delivery
• Rigorous environmental, health and safety (EH&S) protection.

Take your ideas from concept to commercialization with Huntsman TPU
Huntsman TPU brands

**IRO GRAN**
An exceptional TPU favored for extrusion and high performance injection molding applications including cable & wire, hoses & tubes, film & sheet, seals and other technical parts.

**IRO STIC**
Adhesive grade TPU's designed for high-performance bonding projects in footwear, automotive and many other industrial fields.

**IRODUR**
A family of crosslinkers for TPU solutions that enhance heat resistance, adhesion, hydrolysis and chemical resistance. Mainly used for solvent-based TPU adhesive solutions, IRODUR® can also be used as a primer or a crosslinker for rubber materials.

**CRYSTAL FLEX**
A long-standing brand of optical aliphatic (OA) TPU films, which helps set the standard for interlayer laminating films within the glass industry.

**CRYSTAL GRAN**
Aliphatic-based resins that offer outstanding benefits for optical and non-optical applications such as display screens, traffic signs and protective films.

**AVALON**
A range of TPU products for injection molding, in particular footwear soling, enabling casual, sports and industrial manufacturers to develop tough yet comfortable shoes in a variety of designs and colors.

**smartLite®** is a novel high quality micro-cellular range of thermoplastic soling materials offering a unique combination of lightness, performance and aesthetics.
Nomenclature Key

**IROGRAN®**

<table>
<thead>
<tr>
<th>A</th>
<th>D</th>
<th>90</th>
<th>H</th>
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<th>P</th>
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**IROGRAN®**

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**AVALON®**

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<tr>
<td>Shore A</td>
<td>Shore D</td>
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**Product family chemistry and processing:**

- **B**: improved performance in hydrolysis resistance
- **E**: standard grade
- **K**: transparent
- **HT**: high transparency in thick parts, UV resistance

**Other characteristics:**

- **BR**: improved performance in abrasion resistance

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**Specialized series:**

**IROGRAN® H Series**
- Based on polyester
- Designed for extrusion and Injection Molding

**IROGRAN® PS Series**
- Based on Polyester
- Designed for Film and Sheet

**IROGRAN® E Series**
- Based on Polyester
- Designed for Extrusion and Injection Molding
- Some special products for Calendering

**IROGRAN® C Series**
- Based on Polyester
- Designed for Injection Molding

**IROGRAN® P Series**
- Based on Polyester
- Mainly designed for Cable and Wire
- Some special products for Injection Molding and Calendering

**IROGRAN® D Series**
- Based on Polyester
- Designed for Extrusion and Injection Molding

**IROGRAN® K Series**
- Based on Polycaprolactone
- Injection Molding only
- High performance - low compression set
Applications and markets

Huntsman’s thermoplastic polyurethane (TPU) is characterized by high quality, flexibility and performance and offers innovations and solutions for a wide range of application areas.

Adhesives
Design engineers pushing new boundaries need adhesives that can create long-lasting, durable bonds between dissimilar substrates. TPU adhesives do just this fusing ceramic, metal, rubber, plastic and wooden materials together.

Agriculture
As new technologies revolutionize traditional farming practices, ground-breaking materials are helping to cultivate a new generation of agricultural machines and accessories.

Automotive
Demand for greener vehicles that offer increased comfort, weight and reduction, better features and improved safety has made TPU an essential material in the automotive industry.

Belts
Manufacturers producing belts and profiles for timing, transmission and conveyor belt systems require cost effective raw materials with superb mechanical properties, including extreme abrasion, fatigue and hydrolysis resistance.

Wire and cable
Wires and cables used in automotive, telecommunication, automation and offshore projects need to be encased in highly flexible materials that meet the highest mechanical standards.

Film and sheet
The properties of Huntsman’s special TPU grades for the film and sheet industry offer significant technical advantages over many typical thermoplastics used in this market.
Plastic hoses and tubes are used across numerous different applications from pneumatic automation, food transportation, hydraulic systems, suction and irrigation.

Seals used in modern engines, appliances and machines must be totally impervious to chemicals they come into contact with. They need to withstand big changes in pressure, friction and temperature and retain their original shape to ensure systems remain leak-free.

In professional sports the difference between winning and losing can be just a fraction of a second. To achieve the best performance, athletes need to use technical equipment and clothing that will maximize results.

For the most demanding applications TPU has the versatility to make it the material of choice. From microscopic mechanical parts to larger, bulkier goods, it can be scaled as far as creativity and ambitions allow.
A wide variety of TPU products for technical extrusion, injection molding and films.

### Polyester Injection Molding

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<th>Property</th>
<th>AVALON® 65 AK</th>
<th>IROGRAN® A 70 H 4673 M</th>
<th>AVALON® 85 AB</th>
<th>IROGRAN® A 87 H 4651</th>
<th>IROGRAN® A 92 E 4246</th>
<th>AVALON® 95 AK</th>
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<th>IROGRAN® A 96 H 4681</th>
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* Compression Set 1: 70hrs @ 23°C
** Compression Set 2: 24hrs @ 70°C ^ 24hrs @ 100°C / 70hrs @ 100°C
A wide variety of TPU products for technical extrusion, injection molding and films

<table>
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<td>Applications</td>
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</table>

Applications:
- Profiles, Profiles, Toothed Spiral Technical Pneumatic Textile Melt Solution Blown
- Bushes, Spiral Cords, hoses, Parts, Matric, Calendering, Films
- Soft hoses, casual cords, tubes, Tubes, Tubing, Deringer, Calendering, Touch, shoes, Belts, Deringer
- Cables, Cables, Toothed, Calendering
- Watch Straps, Animal Tags
- Seals, O-rings, rollers, Coupling
- Seals, O-rings, rollers, Seals, O-rings, rollers, Seals, O-rings, rollers

Shore A: 56 86 78 85 92 96 98 56 86 78 88
Shore D: 25 26 36 35 41 50 51 15 36 - -
Tensile Strength (MPa): 30 45 45 45 55 50 55 11 35 42 48
Elongation (%): 650 650 600 500 550 450 480 850 600 700 650
100% Modulus (MPa): 3.3 4.0 5.0 5.0 8.2 13.0 14.0 1.4 5.9 2.0 5.6
300% Modulus (MPa): 5.8 8.0 14.0 15.0 19.7 26.0 26.0 2.4 11.2 1.5 5.4
Compression Set 1 (%): 35 25 25 - 23 30 29 40 30 40 30
Compression Set 2 (%): 58 40 40 - 40 46 48 80 42 90 80
Elongation (%): 90 35 30 35 25 35 35 43 25 50 30
Density (g/cm³): 1.15 1.20 1.20 1.20 1.21 1.22 1.22 1.15 1.21 1.19 1.21
Abrasion (mm²): 1.22 1.22 1.15 1.21 1.19 1.21 1.16 1.15 1.14 1.20 1.14 1.16 1.18 1.19 1.18 1.13 1.20

Applications:
- Profiles, Profiles, Toothed Spiral Technical Pneumatic Textile Melt Solution Blown
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- Soft hoses, casual cords, tubes, Tubes, Tubing, Deringer, Calendering, Touch, shoes, Belts, Deringer
- Cables, Cables, Toothed, Calendering
- Watch Straps, Animal Tags
- Seals, O-rings, rollers, Coupling
- Seals, O-rings, rollers, Seals, O-rings, rollers, Seals, O-rings, rollers

Shore A: 56 86 78 85 92 96 98 56 86 78 88
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Compression Set 2 (%): 58 40 40 - 40 46 48 80 42 90 80
Elongation (%): 90 35 30 35 25 35 35 43 25 50 30
Density (g/cm³): 1.15 1.20 1.20 1.20 1.21 1.22 1.22 1.15 1.21 1.19 1.21
Abrasion (mm²): 1.22 1.22 1.15 1.21 1.19 1.21 1.16 1.15 1.14 1.20 1.14 1.16 1.18 1.19 1.18 1.13 1.20

Applications:
- Profiles, Profiles, Toothed Spiral Technical Pneumatic Textile Melt Solution Blown
- Bushes, Spiral Cords, hoses, Parts, Matric, Calendering, Films
- Soft hoses, casual cords, tubes, Tubes, Tubing, Deringer, Calendering, Touch, shoes, Belts, Deringer
- Cables, Cables, Toothed, Calendering
- Watch Straps, Animal Tags
- Seals, O-rings, rollers, Coupling
- Seals, O-rings, rollers, Seals, O-rings, rollers, Seals, O-rings, rollers
Processes

Our range of thermoplastic polyurethanes (TPUs) can be processed in a number of different ways spanning the whole manufacturing spectrum.

**Injection molding**

IROGRAN® and AVALON® are the trade names for the Huntsman Polyurethanes range of injection molding products. Products in this portfolio can be processed easily on standard machines and are compatible with a range of color master batches.

**Extrusion**

Capable of outperforming traditional TPU elastomers, IROGRAN® extrusion grade TPUs can be used to create products that have good low temperature flexibility and can withstand the highest mechanical demands. They can be processed using conventional extrusion techniques.

**Laminations**

Our KRYSTALFLEX® optical aliphatic (OA) TPU product portfolio has been improved and expanded over the last twenty years for specification across the laminated glass industry. The films we produce are engineered for performance, fully compatible with polycarbonate and suitable for use in either industrial autoclaves or smaller laminating ovens.

**Adhesives**

IROSTIC® is Huntsman’s trade name for a polyurethane-based raw material used to manufacture TPU adhesives. Available as a one- or two-component system the range serves four core markets; solvent based footwear adhesives; industrial specialty adhesives; non-reactive and reactive hot melt adhesives.
Global offering with local support

Technical support

At Huntsman we build partnerships with our customers based on knowledge, trust and experience. This commitment means that comprehensive levels of technical support are always assured. As standard we offer:

- Access to a network of international specialists at locations around the world
- Global reach combined with local knowledge
- Innovative solutions to help solve complex challenges
- The highest levels of customer service.

Development center

To keep pace with modern formulating and manufacturing techniques, we make regular investments at our global technical center – purchasing the very latest processing equipment. This approach ensures our work remains current and relevant. Using industry standard machines to test new products and create prototypes or customer samples, we can respond rapidly to emerging trends with practical solutions that are ready to go straight into production – a major benefit for customers.

Alongside our customers we work closely with industry associations, universities and research centers around the world to keep ahead of the latest innovations and market developments.

Your Local Contact:

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Huntsman International (India) Private Limited
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TTC, MIDC Industrial Area,
Turbhe, District - Thane,
Navi Mumbai - 400705. Maharashtra

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e-mail: gaurav_deshpande@huntsman.com
Huntsman Polyurethanes is committed to working closely with its customers and can offer a fast and flexible response to your needs. We offer direct links to our laboratories with full technical backup. Commercial support and dedicated customer service is available throughout Europe, the Middle East, Asia-Pacific and the Americas.

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Tel.: +49 541 9141-0
Fax: +49 541 9141-395
e-mail: TPU_EAME@huntsman.com
www.huntsman.com/TPU

**About Huntsman:**
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