



Thermoplastic Polyurethanes

Footprints of the future



Huntsman TPU

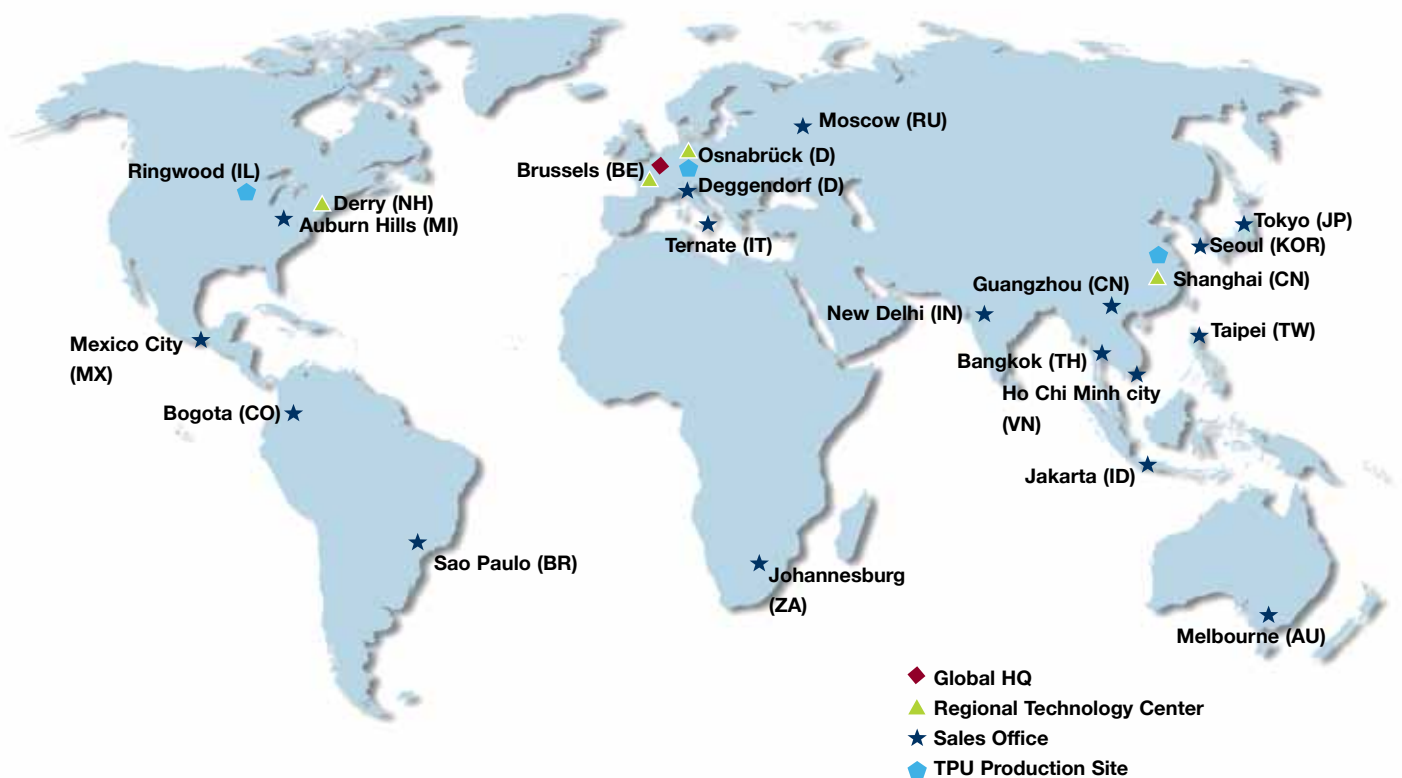
Whether producing hard wearing, chemical resistant boots for the work place or soft, supportive shoes to encourage a child's first steps, footwear manufacturers around the world generally want the same thing: innovative, cost-effective materials from a supplier that understands the market and can help them stay one step ahead of the competition.

Pioneering new footwear developments

At Huntsman we pride ourselves on making the procurement of footwear materials a painless process. Our dedicated footwear specialists were among the first to introduce polyurethanes to the footwear industry and today we continue to make enormous strides in product development – pioneering new technologies that leave a lasting impression on the sector.

Global support

We are a major global supplier to the footwear industry. Our international supply chain and research and development capabilities are world-class. With a specialist technical center in Belgium, and a team of experts located in all major regions, we serve customers in more than 70 countries – including famous footwear brands that apply our materials, advice and input to overcome complex design and manufacturing challenges.



AVALON® TPU: The advantages

Our dedicated range of thermoplastic polyurethane (TPU) materials for footwear is marketed under the trade name AVALON®. Suitable for use in top pieces for ladies fashion shoes, molded soles for casual footwear and specialist sports, hiking and safety shoe applications, AVALON® TPU is a premium material that can be used to create a variety of footwear components and is fully recyclable.

Known for its high quality, durability and aesthetics, AVALON® TPU is manufactured at production facilities around the world and is available at different hardness levels ranging from below 60 Shore A for unit soles, up to 65 Shore D for top pieces and sport shoe stabilizers.

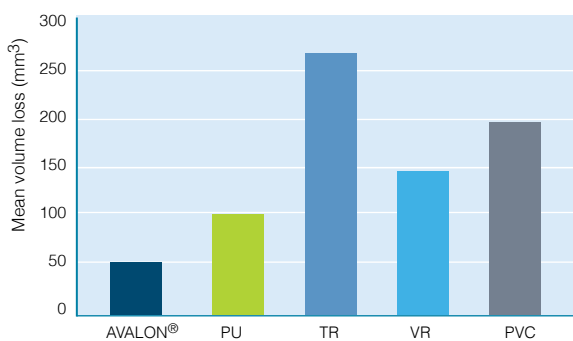
The design benefits associated with using AVALON® TPU are numerous and include: excellent surface definition, matt or glossy effects, good colorability, transparent grades available, rubber-like look and feel and reliable bonding.

Key properties

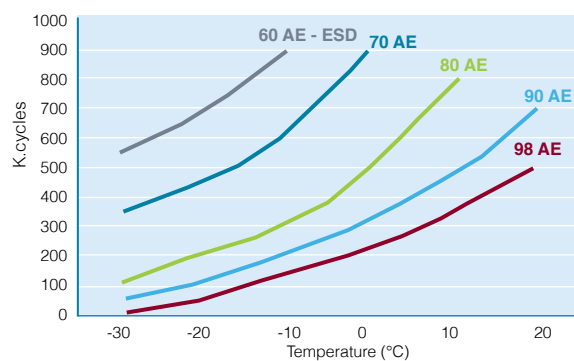
Abrasion resistance: For withstanding scuffs and scrapes, AVALON® TPU can be at least three times better than the best PVC and rubber soling materials.

Cold flex performance: At normal temperatures AVALON® TPU offers superior flex performance when compared to other soling materials. Below freezing it also functions where other competing materials start to fail.

Outstanding abrasion resistance



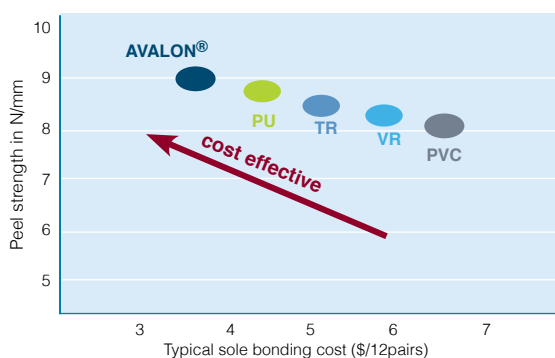
Flex performance at low temperature



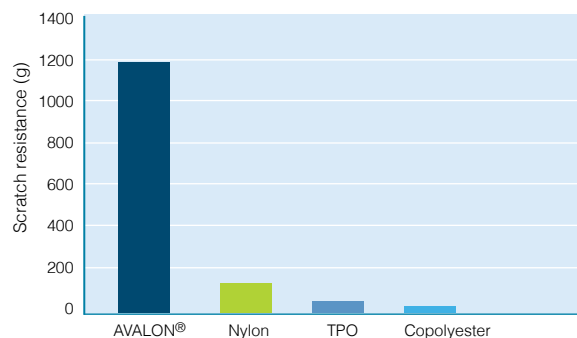
Bonding: AVALON® TPU is easy to bond with minimal surface preparation.

Scratch resistance: AVALON® TPU can withstand harsh environments and helps to keep its original look for longer.

Cost effective bonding



Scratch resistance



UV resistance: Incorporating a specifically designed UV resistance package, AVALON® TPU can be stabilized against premature yellowing and discoloration.



Safety shoes

To protect working feet on construction sites and in factories, international regulations for safety shoes are extremely precise.

TPUs can meet the high standards set for footwear in these specific environments, offering oil and solvent resistance as well as anti-slip properties and exceptional durability.

AVALON® TPU outsoles can be combined with the full range of Huntsman microcellular midsole systems in a direct-molded process.

This construction combines the outstanding wear and flex performance of a soft TPU for the outsole with the comfort and lightness of polyurethane for the midsole. Anti-static systems are also available to fulfil the requirements of the industrial boot sector.

Key benefits

- Outstanding flex performance
- Excellent slip resistance
- Perfect surface definition
- Transparency and translucency
- Oil resistance

Typical applications:

- **Outsole** 60 Shore A – 65 Shore A
- **Stabilizer** 95 Shore A – 65 Shore D



Sport shoes

Fitness enthusiasts and professional athletes require footwear that provide protection and stabilization while enhancing their performance.

Some of the world's best football boots demand the performance levels provided by AVALON® TPU. Improved abrasion grades for integral studs are also available to meet the most demanding environments. These are marketed under the AVALON® ABR range of TPUs.

Transparent grades from the AVALON® TPU range bridge the gap between style and function, enabling manufacturers to create exciting designs that won't impede performance.



Typical applications:

- | | |
|---------------------------|-------------------|
| • Studs and cleats | Shore 85 A – 65 D |
| • Sports plates | Shore 85 A – 98 A |
| • Eyelets | Shore 95 A – 60 D |
| • Stabilizers | Shore 80 A – 65 D |



Key benefits

- Fast cycle times
- Excellent multilayer bonding
- Flex performance, even at low temperatures
- Outstanding abrasion and scratch resistance
- Perfect color match with masterbatches
- Transparency effects

Casual shoes

AVALON® TPUs have been used in the creation of casual shoes since the 1970s. Providing superior durability and excellent surface definition, they are a reliable alternative to rubber and PVC, enabling manufacturers to create footwear soles that are soft, flexible and tactile.

Huntsman pioneered the development of plasticizer-free TPUs for the footwear industry – further increasing the breadth of design and color effects that are available to designers.

Innovative products include the AVALON® Light range of lightweight solutions. These expanded TPU grades are easy to process and suitable for direct molding.



Key benefits

- Perfect surface definition
- Transparency effects
- Matt finish
- Rubber-like look and feel
- Multiple color combinations
- Abrasion resistance
- Outstanding flex life
- Easy reliable bonding

Typical applications:

- **Outsoles** 60 Shore A – 75 Shore A
- **Unitsoles** 65 Shore A – 75 Shore A
- **Stabilizers** 95 Shore A – 65 Shore D
- **Direct molded** AVALON® Light



Fashion shoes

For some people shoes are a practical necessity. For others they are desirable objects that help them make a bold fashion statement. Whatever the motivation, one thing is clear: in an industry where trends regularly fluctuate, footwear designers and manufacturers need access to materials that allow their creativity to flow when it comes to form, function, color, style and design detail.

The production of fashion shoes requires the use of materials that look sharp and elegant but can also deliver the optimum balance between abrasion and slip resistance.

Delivering comfort and performance, a smooth or leather-like finish, with good paintability, AVALON® TPU grades can be used to create a wide range of components for the fashion shoe industry.



Typical applications:

- **Leather inserts** 65 Shore A – 85 Shore A
- **Top pieces** 90 Shore A – 65 Shore D
- **Thin soles** 75 Shore A – 85 Shore A
- **Unit soles** 65 Shore A – 75 Shore A

Key benefits

- Perfect mold definition
- Fast production cycle times
- Excellent bonding
- Transparency effects
- Outstanding abrasion and scratch resistance
- Perfect color match with masterbatches
- Slip resistance



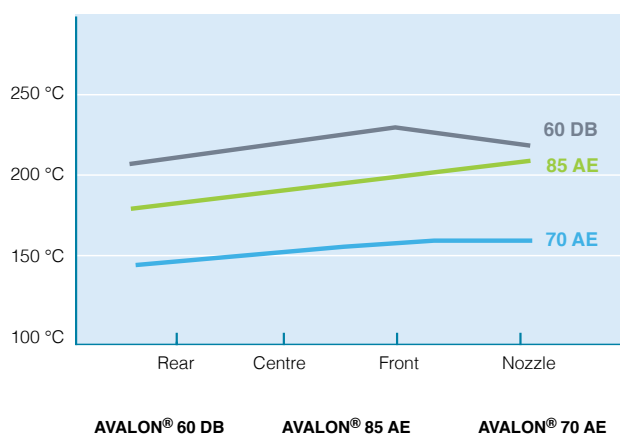
Processing recommendations

The following information describes the most ideal machine and screw configuration for a compact and expanded AVALON® TPU. It is not seen as a definitive guide as AVALON® grades can perform on a wide variety of shoe processing machines. We recommend that screw configurations of the polyamide type are not employed due to their inherent high shear characteristics. Long dwell times should be avoided.

AVALON® grade range	AVALON® soft grades	AVALON® hard grades	AVALON® Light
Material type	AVALON® 60 - 75	AVALON® > 80 Shore A	Expanded TPU
Machine type	Conventional IM and carousel machines	Conventional IM machines - vertical or horizontal	Conventional IM and carousel machines with shut-off and non-return valve
Screw configuration	Reciprocating screw Flexible PVC type	Reciprocating screw PE type (general purpose 3 stages)	Reciprocating screw PE type (general purpose 3 stages) and Flexible PVC type
Back pressure	0.3 - 3	0.3 - 3	0.3 - 50
Screw capacity cm ³	> 600	Part dependent	Part dependent
Screw speed rpm	20 - 80	20 - 100	20 - 100
Length: diameter ration (L/D)	15 - 25:1	15 - 25:1	14 - 18:1
Compression ratio	> 2:1	2.5 - 3.5:1	2.7 - 2.8:1
Injection pressure kg/cm ²	> 400	> 500	> 600
Clamping force kN	> 200	> 2000	> 1200
Heating	Electrical	Electrical	Electrical
Cooling	Water-jacketed feed zone	Water-jacketed feed zone	Water-jacketed feed zone
Process temperature °C	160 - 200	160 - 230	150 - 165
Tooling cooling	Water channels using chilled water	Water channels using chilled water	Water channels using chilled water
Tooling temperature °C	25 - 45	25 - 45	25 - 45
Injection speed (sec)	5 - 20*	5 - 20*	5 - 20*

* This parameter is dependent on the material hardness and the complexity of the tooling.

Temperature Ranges



It is recommended that waterways are included to facilitate improved cooling in continuous production.

Runners should be short in length and large in diameter; ideally full-round or trapezoidal and tapered where possible.

Hot runner systems are recommended for continuous production runs of high volume.

The **gates** should be generous to ensure the best flow conditions.

Sprues should be kept as short as possible and a minimum 5° taper should be allowed.

Molds should be tapered and vapor- or lightly, bead-blasted to avoid sticking. All common mould making materials are suitable for use with AVALON® TPU and short run or prototype moulds can be produced in aluminium or by metallized spray.

For detailed information of AVALON® TPU grades please request a datasheet from your nearest sales office.

Global offer 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. With locations around the world, our international network of footwear specialists combine global reach with local knowledge – a powerful offering that can help solve complex challenges and ensure the very best levels of customer service.

Development center

To keep pace with modern formulating and manufacturing techniques, we make regular investments at our global and regional technical centers – 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.



Regional technical centers

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Overview for the AVALON® TPU range:

Typical physical properties	Unit	Methods	DIN	60 AE-ESD	65 AB	65 AK	65 AK-ESD	70 AE	75 AE	80 AB	80 AHT DP	80 AE	85 AB	85 ABR	85 BR
Density	g/cm³	ISO 2781	DIN 53479	1,20	1,18	1,18	1,18	1,21	1,22	1,20	1,21	1,22	1,20	1,20	1,22
Hardness	A	ISO 868	DIN 53505	60	65	65	65	70	75	80	80	80	85	85	85
Hardness	D	ISO 868	DIN 53505							30	30	30	37	37	37
Tensile strength	MPa	ISO 37	DIN 53504	16	30	25	30	22	24	30	30	26	30	25	28
Elongation @ break	%	ISO 37	DIN 53504	1000	700	800	800	700	600	500	600	600	475	400	500
100 % tensile modulus	MPa	ISO 37	DIN 53504	2,4	2,5	2,5	2,5	3	4	5	5	5	6	6	6
300 % tensile modulus	MPa	ISO 37	DIN 53504	3,8	5	5	5	5	7	13	8	8	14	14	10
Tear strength	kN/m	ISO 34B	DIN 53515	40	40	45	40	65	70	95	70	80	105	80	90
Abrasion resistance	mm³	ISO 4649	DIN 53516	80	60	100	100	35	35	35	40	35	35	20	35
Ross flex @ -10°C	k.cycles	BS 5131			100		100	250	250	250	230	250	250	250	250
Flexural Modulus @23°C	MPa	ISO 178								25			30	30	
Electrical resistance	Mohm	Internal		100			< 100								
Appearance				amber	amber	transparent	transparent	amber	amber	semi transparent	highly transparent	amber	semi transparent	opaque	amber
End use applications															
Sport plates/studs										•	•		•	•	
Sport cleats										•	•		•	•	
Top-pieces															
Casual soles				•	•	•	•	•	•						
Safety Soes				•	•	•									
Thin soles				•								•			•
Inserts/stabilizers					•	•									
Outsoles				•	•	•	•	•	•		•				
Midsoles															

AVALON® 90 A BR

Hardness:

Shore A
Shore D

Chemistry:

B : improved
E : standard
K : transparent
BR: improved
HT: high trans

95 AE	90 AB	90 ABR	90 AE	90 AHT DP	92 AE	95 AB	95 ABR	95 AE	95 AHT DP	98 AB	98 AE	60 DB	60 DE	65 DB	65 DE	550 B*	650 B*
1,21	1,21	1,23	1,21	1,23	1,22	1,22	1,24	1,21	1,23	1,25	1,23	1,25	1,23	1,26	0,65	0,65	
90	90	90	90	92	95	95	95	95	98	98					48	54	
44	44	44	44	46	50	50	50	48	56	56	60	60	65	65			
32	28	30	28	32	35	30	33	30	40	34	43	42	45	43	5	5	
450	400	450	530	450	425	350	400	400	400	350	350	350	350	300	500	600	
8	8	7	7	9	13	13	11	15	17	16	19	17	22	24			
16	16	12	12	15	24	22	18	25	29	24	31	27	34	33			
115	80	105	95	110	146	90	130	118	165	165	180	188	220	224	10	17	
35	20	35	30	35	35	20	35	35	35	35	35	40	35	40	200	200	
250	250	250	250	250	250	250	250	250	250	250	250						
42	42				80	80			135		184		250			60	
semi transparent	opaque	slight amber	highly transparent	slight amber	semi transparent	opaque	slight amber	highly transparent	semi transparent	slight amber	semi transparent	slight amber	semi transparent	slight amber	opaque	opaque	
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* expanded TPU

performance in hydrolysis resistance
 grade
 nt
 performance in abrasion resistance
 parency in thick parts, UV resistance





AVALON® TPU for the footwear industry

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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About Huntsman

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 approximately 12,000 employees and operates from multiple locations worldwide. The Company had 2010 revenues of approximately \$9 billion. For more information about Huntsman, please visit the Company's website at www.huntsman.com.

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