HUNTSMAN

Enriching lives through innovation

IROGRAN®

Thermoplastic Polyurethanes (TPU)

Shaping your world

Huntsman: A strong TPU partner

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 more than fourty 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

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TPUs for specialist injection molding applications

In the world of technical parts production, our injection molding TPUs are renowned for their extreme adaptability. Scaled as far as creativity and ambitions allow they can be used to create microscopic mechanical parts or – at the opposite end of the manufacturing spectrum – large, bulky components.

IROGRAN® is the trade name for our premium range of injection molding polyurethane products. Particularly well suited to demanding applications these high performance engineering materials are trusted worldwide to add value and deliver specific, functional characteristics, wherever they are used.

IROGRAN® TPUs: The benefits

- Better demolding
- Potential for improved cycle times
- Polymer morphology designed for high performance products
- Properties matched to end-use applications
- Specially selected raw materials for optimal performance
- Tailor-made environmental protection.

Technical parts: applications

Our IROGRAN® TPU products range from 65 Shore A to 60 Shore D hardness. With such a comprehensive span of resistance options available, we're confident that we have a grade of IROGRAN® TPU to suit every manufacturing requirement. From general products to niche applications, premium IROGRAN® TPUs can be adapted to achieve different degrees of mechanical strength, temperature stability, wear characteristics or production rates as appropriate.

Key performance features

Using our IROGRAN® TPU range, manufacturers of technical parts can achieve the highest levels of:

- Wear and tear strength
- Dimensional stability
- Oil resistance
- Low compression set
- Dynamic load performance
- Elasticity and flexibility
- Temperature performance
- Processing consistency.

Potential applications

The IROGRAN® high performance injection molding portfolio is mainly foreseen for:

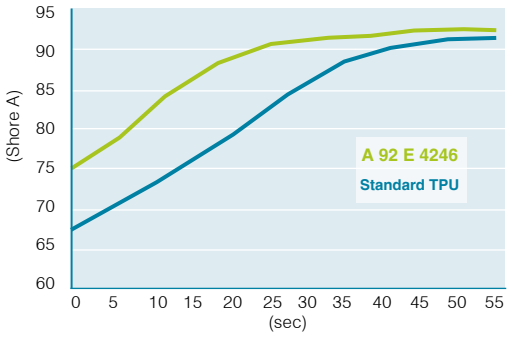
- **Automotive**
  Bumpers and buffers, stone protection parts, shearing belts / bushings, armrests, dashboards, cupholders, instrument panels, door handles
- **Agricultural**
  General purpose parts for agricultural applications, such as potato sorter, ear tags and sowing disc
- **Consumer**
  Recreational and professional sporting equipment
- **Furniture**
  Chair rollers, arm rests, table edging
- **Engineering**
  Wheels, rollers, seals, gasket, handles of professional and DIY power tools, supermarket trolley tyres.

Efficient injection molding

IROGRAN® TPUs can also deliver significant production efficiencies:

- Cycle times up to 30% faster for thick parts
- Less flashing
- Good over molding properties
- Excellent bonding strength to other plastics
- Easy coloring.

Hardness build up after demolding IROGRAN® grades (6 mm test plates)



IROGRAN® product range highlights

IROGRAN® A 70 E 4675 – Exceptional performance in overmolding applications

IROGRAN® A 70 E 4675 is a soft, plasticizer-free, polyester TPU for injection molding applications. With high bond strength to a wide range of substrates, this versatile product is particularly suitable for design and manufacturing projects where over-molding is required. Easily processed and with an exceptionally short cycle time, IROGRAN® A 70 E 4675 is used extensively across a wide range of industries in the production of specialized automotive, sports and consumer goods.

Product	Shore A	Shore D	Tensile strength (N/mm^2)	Ultimate elongation %	Tear strength (N/mm)	MVR 190°C/21,6kg (cm^3/10 min)	Special characteristic
IROGRAN® **A 70 E 4675**	75	25	30	650	35	30	Plasticiser-free

IROGRAN® A 70 H 4673 M – Soft polyester based TPU grade for IM applications

Within the HUNTSMAN injection molding product range the IROGRAN® A 70 H 4673M represents a soft standard polyester based thermoplastic polyurethane. This grade is processable at low temperatures and offers a specially designed, flexible material suitable for moldings.

Product	Shore A	Shore D	Tensile strength (N/mm^2)	Ultimate elongation %	Tear strength (N/mm)	MVR 190°C/5kg (cm^3/10 min)	Properties
IROGRAN® **A 70 H 4673 M**	71	21	35	880	45	50	Soft touch & easy demolding

IROGRAN® A 92 E 4246 – High crystalline polyester based TPU grade for IM applications

Within the HUNTSMAN injection molding product range the IROGRAN® A 92 E 4246 represents one of the high performance polyester based thermoplastic polyurethanes. Due to the increased degree of crystallinity this grade is particularly suitable for thick walled parts where short cycle times and fast demolding are needed.

Product	Shore A	Shore D	Tensile strength (N/mm^2)	Ultimate elongation %	Tear strength (N/mm)	MVR 210°C/21,6kg (cm^3/10 min)	Properties
IROGRAN® **A 92 E 4246**	92	44	50	610	90	48	Short cycle times, high crystallinity

IROGRAN® A 92 H 4656 – Polyester based TPU grade for IM applications

Within the HUNTSMAN injection molding product range the IROGRAN® A 92 H 4656 represents a standard polyester based thermoplastic polyurethane. This grade offers a high melt flow and easy demolding for wheels & rollers or other engineered parts

Product	Shore A	Shore D	Tensile strength (N/mm^2)	Ultimate elongation %	Tear strength (N/mm)	MVR 210°C/10kg (cm^3/10 min)	Properties
IROGRAN® **A 92 H 4656**	93	40	45	550	100	75	Easy demolding, Good melt flow

IROGRAN® D 60 E 4024 – Hard polyester based TPU grade for IM applications

Within the HUNTSMAN injection molding product range the IROGRAN® D 60 E 4024 represents a hard high performance polyester based thermoplastic polyurethane. Due to the increased degree of crystallinity this grade is particularly suitable for thick walled parts where short cycle times and fast demolding is required.

Product	Shore A	Shore D	Tensile strength (N/mm^2)	Ultimate elongation %	Tear strength (N/mm)	MVR 220°C/21,6kg (cm^3/10 min)	Properties
IROGRAN® **D 60 E 4024**		59	54	500	180	50	Short cycle times

IROGRAN® TPUs
Product overview for technical parts

IROGRAN® high performance IM polyester grades

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Physical properties Physikalische Eigenschaften	Unit/ Maßeinheit	Norm/ Norm	A 60 E 4612 N	A 70 E 4675	A 78 E 4588	A 92 E 4246	A 95 E 4813	A 98 E 4066	D 60 E 4024	A 70 H 4673 M	A 80 H 4698	A 87
Shore hardness A		ASTM D-2240	65	75	80	92	95	97		71	81	85
Shore Härte A		ISO 7619	65	75	80	92	95	97		71	81	85
Shore hardness D		ASTM D-2240	18	25	30	44	44	49	60	21	31	35
Shore Härte D		ISO 7619	18	25	30	44	44	49	60	21	31	35
Tensile strength	psi	ASTM D-412	3700	2200	6090	7100	5400	6530	5800	4450	5080	5300
Zugfestigkeit	MPa	DIN 53504	31	30	50	50	41	50	54	35	47	45
Ultimate elongation	%	ASTM D-412	900	650	730	630	410	570	610	790	690	720
Reißdehnung	%	DIN 53504	900	650	650	610	550	530	500	880	650	640
100% Tensile modulus	psi	ASTM D-412	510	570	740	1330	1600	2010	2940	600	1020	860
Spannungswert 100%	MPa	DIN 53504	2,7	3,3	4,3	7,2	10,0	14,0	20,4	3,5	4,6	5,6
300% Tensile modulus	psi	ASTM D-412	800	950	1270	2600	3500	2970	3670	1220	2330	1680
Spannungswert 300%	MPa	DIN 53504	5,0	5,8	8,1	15,0	17,5	25,0	32,6	7,0	12,7	11,1
Tear strength	pli	ASTM D-624	360	300	500	630	750	910	1250	460	590	600
Weiterreißfestigkeit	N/mm	ISO 34-1	35	35	50	90	105	135	180	45	85	80
Abrasion resistance	in^3	ASTM D-5963	0,0034	0,0055	0,0015	0,0015	0,0018	0,0018	0,0018	0,0021	0,0018	0,0015
Abriebverlust	mm^3	ISO 4649	55	90	25	25	30	30	30	35	30	25
Compression set/70h @ 23 °C	%	ASTM D-395	43	35	30	25	25	30	44	34	19	25
Druckverformungsrest 70 h @ 23 °C	%	ISO 815	43	35	30	25	25	30	44	34	19	25
Compression set/24 h @ 70 °C	%	ASTM D-395	54	58	40	50	45	45	56	48	40	43
Druckverformungsrest 24 h @ 70 °C	%	ISO 815	54	58	40	50	45	45	56	48	40	43
Mould shrinkage	in/in	ASTM D-955	0,03	0,016	0,016	0,009	0,008	0,007	0,011	0,009	0,006	0,011
Schwindung ***	%	ISO 955	3	1,6	1,6	0,9	0,8	0,7	1,1	0,9	0,6	1,1
Density	kg/m^3	ASTM D-792	1,17	1,15	1,20	1,21	1,21	1,22	1,24	1,15	1,19	1,20
Dichte	kg/m^3	ISO 1183-1	1,17	1,15	1,20	1,21	1,21	1,22	1,24	1,15	1,19	1,20
Thermal: Melt range	°F	Huntsman/TMA	290-340	300-375	320-345	350-370	340-390	370-390	400-415	295-340	310-330	275-365
Schmelzbereich	°C	Huntsman/TMA	140-170	150-190	160-175	175-190	170-200	185-200	205-215	145-170	155-165	135-185
Bayshore rebound	%	ASTM D-2632	54	25	48	32		30	34	50	42	40
Rückprallelastizität	%		54	25	48	32		30	34	50	42	40
Ether / Ether *												
Ester / Ester **			●	●	●	●	●	●	●			
Opaque / Opak			●			●	●	●	●	●	●	●
Antistatic / Antistatisch												
Matt surface / Matte Oberfläche												
Low compression set / Geringer Druckverformungsrest												
Transparency / Transparent				white/weiß	●					●	●	●
Others / Andere			Phthalate free	Plasticizer free								

* **Ether TPU**
- **Weather resistance / Gute Beständigkeit gegen Witterungseinflüsse**
- **Resistant against microbial attack Gute Mikrobenbeständigkeit**
- **Excellent hydrolysis resistance Gute Hydrolysefestigkeit**
- **Easy colouring Problemlose Einfärbung /**
- **High dynamic flexibility Hohe Dauerknickfestigkeit /**

*** **Mold shrinkage is dependent on wall thickness and processing parameters. Die Schwindung ist sowohl von der Wandstärke als auch von den Verarbeitungsparametern abhängig.**

OGRAN® IM polyester grades

IROGRAN® IM polyether grades

H 4615	A 92 H 4656	A 95 H 4678	A 98 H 4661	A 65 P 4324 N	A 75 P 4655 N	A 80 P 5039	A 85 P 4394	A 92 P 4207	A 92 P 4637	A 95 P 5044	A 98 P 4535	**Physical properties** **Physikalische Eigenschaften**
93	95	96	71	73	80	85	92	92	95	96		Shore hardness A
93	95	96	71	73	80	85	92	92	95	96		Shore Härte A
40	45	52	22	23	29	36	40	39	51	51		Shore hardness D
40	45	52	22	23	29	36	40	39	51	51		Shore Härte D
5560	5800	5670	3050	3480	3500	5075	5300	4870	8200	5740		Tensile strength
45	45	50	30	30	32	45	49	45	62	55		Zugfestigkeit
710	690	610	900	850	760	610	640	670	470	550		Ultimate elongation
550	540	520	800	820	720	640	570	600	450	510		Reißdehnung
1420	1720	2390	650	640	700	1015	1400	1300	1600	2260		100% Tensile modulus
8,9	11,1	16,0	3,9	3,6	4,6	7,0	9,5	9,1	12,0	15,4		Spannungswert 100%
2570	2810	2960	1000	1040	1300	1740	2280	2050	4000	3360		300% Tensile modulus
18,9	19,8	27,7	9,8	6,4	8,7	12,0	16,6	15,9	32,0	25,0		Spannungswert 300%
770	860	970	400	390	480	574	680	660	600	840		Tear strength
100	115	125	35	35	45	60	75	74	101	120		Weiterreißfestigkeit
0,0018	0,0018	0,0021	0,0037	0,0037	0,0018	0,0015	0,0015	0,0018	0,0018	0,0018		Abrasion resistance
30	30	35	60	60	30	25	25	30	30	30		Abriebverlust
25	24	25	25	20	23	20	28	25	30	32		Compression set/70h @ 23 °C
25	24	25	25	20	23	20	28	25	30	32		Druckverformungsrest 70 h @ 23 °C
43	43	46	48	48	43	40	44	41	82	50		Compression set/24 h @ 70 °C
43	43	46	48	48	43	40	44	41	82	50		Druckverformungsrest 24 h @ 70 °C
0,006	0,007	0,007	0,012	0,012	0,009	0,008	0,008	0,009	0,007	0,008		Mould shrinkage
0,6	0,7	0,7	1,2	1,2	0,9	0,8	0,8	0,9	0,7	0,8		Schwindung ***
1,21	1,23	1,23	1,12	1,12	1,10	1,12	1,14	1,13	1,14	1,16		Density
1,21	1,23	1,23	1,12	1,12	1,10	1,12	1,14	1,13	1,14	1,16		Dichte
340-365	360-380	370-390	230-327	265-310	295-310	300-340	330-370	320-338	347-369	365-390		Thermal: Melt range
170-185	180-190	190-200	110-164	130-155	145-155	150-170	165-188	160-170	175-187	185-200		Schmelzbereich
32	30	28	58	55	47	36	34	34	35	30		Bayshore rebound
32	30	28	58	55	47	36	34	34	35	30		Rückprallelastizität
			●	●	●	●	●	●	●	●		Ether / Ether *
												Ester / Ester **
●	●	●					●			●		Opaque / Opak
●	●	●										Antistatic / Antistatisch
												Matt surface / Matte Oberfläche
												Low compression set / Geringer Druckverformungsrest
			●	black/schwarz	●	●		●	●			Transparency / Transparent
UV stabilized			Phthalate free	Phthalate free								Others / Andere

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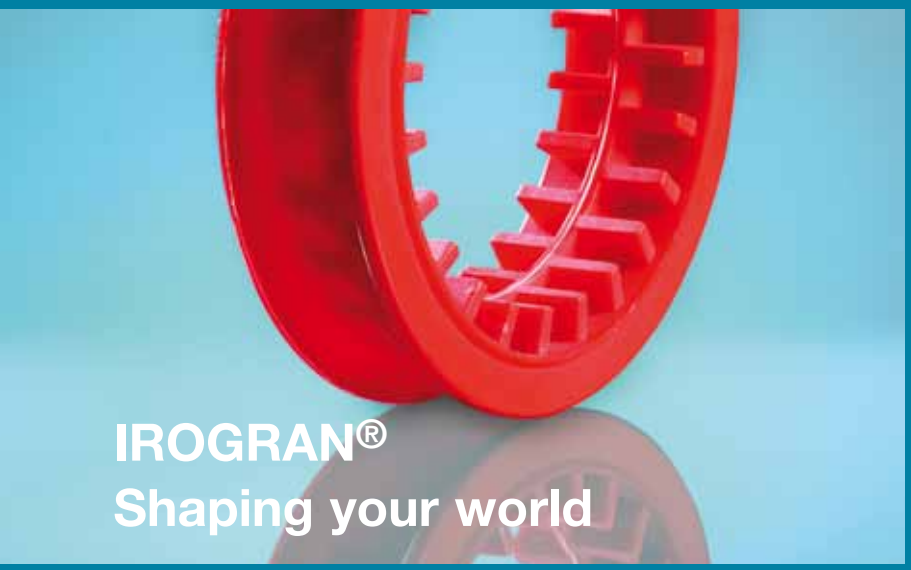

Technical support

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 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 emergingtrends with practical solutions that are ready to go straight into production – a major benefit for customers.

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 Corporation is a publicly traded global manufacturer and marketer of differentiated chemicals with 2014 revenues of approximately $13 billion including the acquisition of Rockwood's performance additives and TiO2 businesses. Our chemical products number in the thousands and are sold worldwide to manufacturers serving a broad and diverse range of consumer and industrial end markets. We operate more than 100 manufacturing and R&D facilities in more than 30 countries and employ approximately 16,000 associates within our 5 distinct business divisions. For more information about Huntsman, please visit the company's website at **www.huntsman.com.**

EUROPE 2016

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