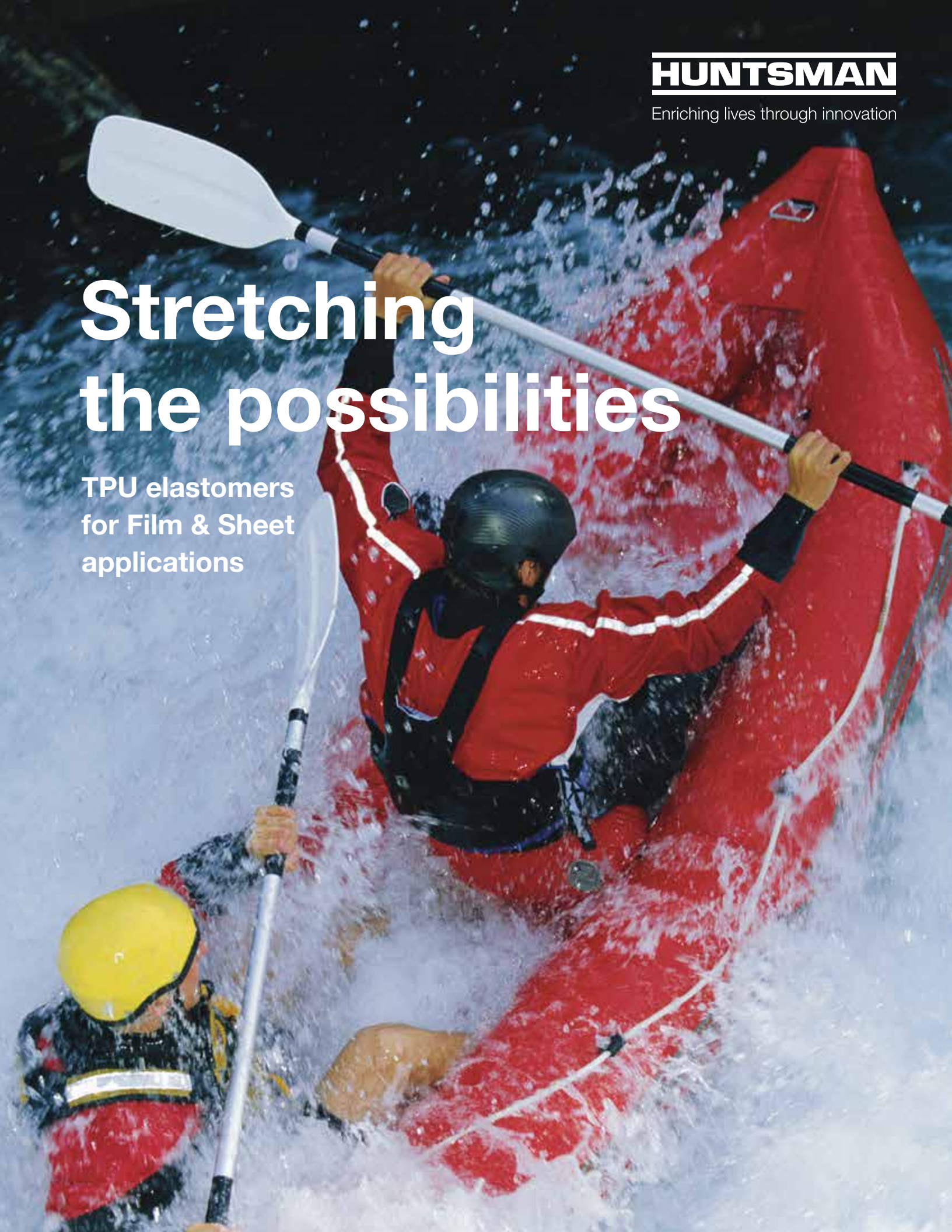


HUNTSMAN

Enriching lives through innovation

Stretching the possibilities

TPU elastomers for Film & Sheet applications

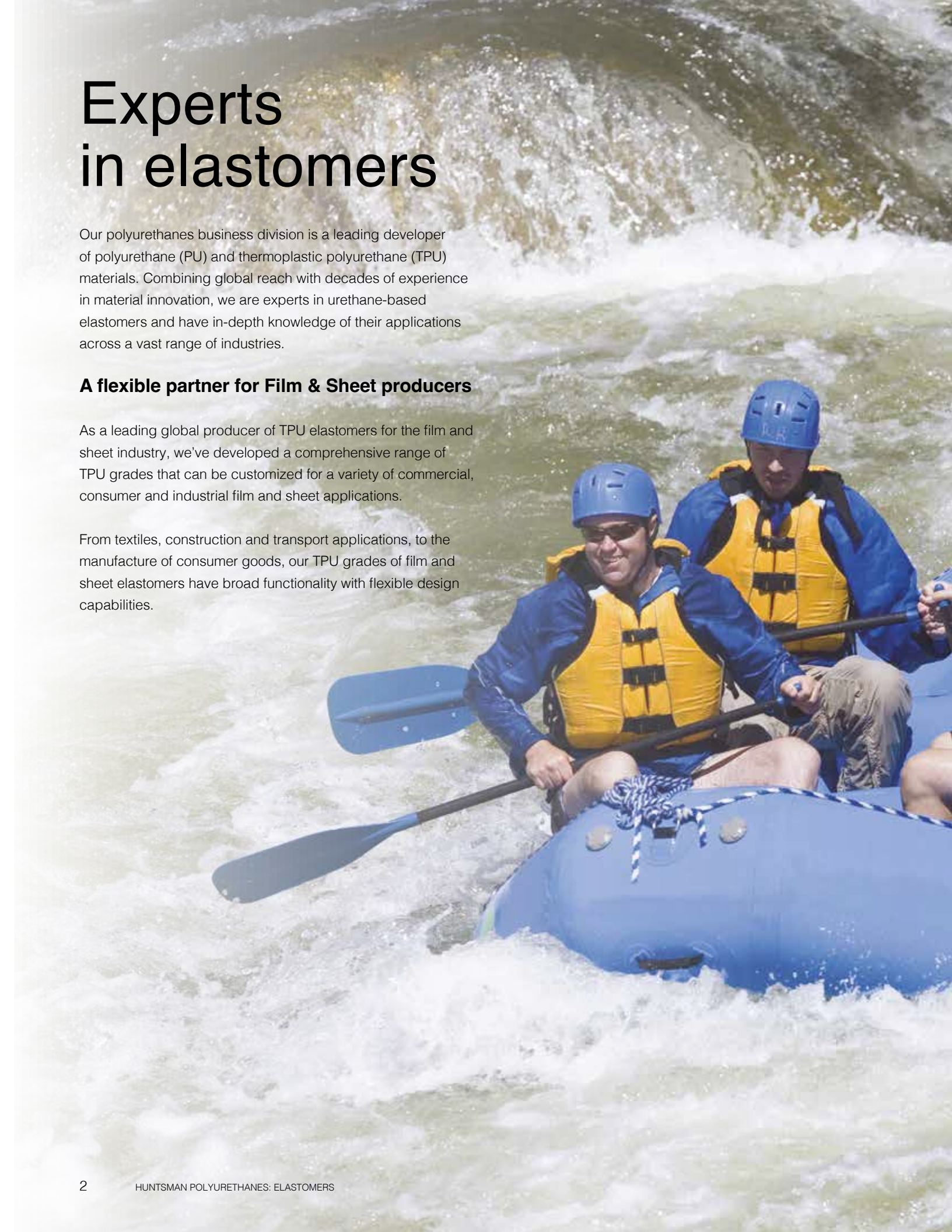
Experts in elastomers

Our polyurethanes business division is a leading developer of polyurethane (PU) and thermoplastic polyurethane (TPU) materials. Combining global reach with decades of experience in material innovation, we are experts in urethane-based elastomers and have in-depth knowledge of their applications across a vast range of industries.

A flexible partner for Film & Sheet producers

As a leading global producer of TPU elastomers for the film and sheet industry, we've developed a comprehensive range of TPU grades that can be customized for a variety of commercial, consumer and industrial film and sheet applications.

From textiles, construction and transport applications, to the manufacture of consumer goods, our TPU grades of film and sheet elastomers have broad functionality with flexible design capabilities.



Trusted brands to inspire innovation

We offer a portfolio of TPU elastomers for the film and sheet industry, which includes a variety of aromatic and aliphatic backbones, combined with polyester, polyether and polycaprolactone polyols.

Aromatic TPU

- Used in applications that require flexibility, strength and toughness
- Good processability.

Aliphatic TPU

- Intrinsically resistant to UV light
- No yellowing even in outdoor conditions
- Excellent optical clarity.

IROGRAN®

KRYSTALGRAN®

Ester-based TPUs

- Good resistance to oils and chemicals
- Excellent abrasion and wear resistance
- High mechanical properties including high tear resistance
- High thermal resistance
- Compatible with PVC and other polar polymers.

Ether-based TPUs

- Excellent hydrolysis resistance, particularly at elevated temperatures
- Excellent low temperature properties
- High dynamic flexibility
- Resistance to microbial attack
- Specific gravity slightly lower than polyester grades.

Benefits:

- Durability
- High abrasion resistance
- High elasticity across the entire hardness range
- Good flexibility over a wide temperature range
- Excellent impact strength at low temperatures
- Resistance to oils, grease and numerous chemicals
- Pleasant haptics
- Easy to color
- Intrinsically recyclable.

Barrier films

Our IROGRAN® E and PS (ester-based) and IROGRAN® P (ether-based) TPU grades are frequently used in barrier type structures for containment applications. An excellent choice for barrier and wear layer films or sheets, these TPU elastomers can offer high durability, and puncture, abrasion and tear resistance, alongside soft, elastic properties.

Typical applications:

- Breathable roofing membranes
- Breathable performance textiles
- Lumbar support for automotive seating
- Inflatables
- Cure-in-place pipe (CIPP) liners
- Coated textiles
- Protective clothing and life vests
- Waterproof apparel
- Containment liners and water tanks
- Bladders for sports and automotive applications
- Air mattresses and mattress covers.

Benefits:

- Tunable breathability
- Weathering, oil and chemical resistance
- Antimicrobial.

Adhesive films

Our IROGRAN® CA, E and PS, and IROSTIC® M ester-based TPUs for adhesive film applications provide a solvent-free, environmentally friendly, permanent thermo-bonding solution that enables new design and performance possibilities.

Typical applications:

- Adhesive applications in footwear
- Seam sealing tapes for waterproofing apparel
- Stitch-free and seamless lingerie
- Emblems and labels
- Laminated fabrics
- Composite wood panel to plastics lamination for furniture.

Benefits:

- A broad range of melting points to suit each application
- Fast crystallization rate
- Good resistance to washing agents
- Excellent adhesion to different substrates
- High elastic recovery combined with a soft touch.

IROGRAN®

Surface protection

Our aliphatic KRYSTALGRAN® TPU film and sheet grades are a reliable and robust surface protection solution for applications where excellent durability, abrasion and scratch resistance, and strict outdoor UV protection is required.

Suitable for use in a wide range of sectors, our KRYSTALGRAN® TPUs are commonly used in OEM and after-market automotive and aerospace paint protection projects.

Typical applications:

- Paint protection films for susceptible vehicle components such as wheel arches
- Laminated flooring topcoat
- Leading edge protection for helicopter and wind turbine blades
- Graphic films, signs and labels
- Textile coatings
- Electronic screen protection
- Synthetic leather.

Benefits:

- Transparency
- Intrinsic outdoor UV resistance
- Weathering and chemical resistance
- Abrasion and scratch resistance.

Specialty TPUs

Within our diverse portfolio of TPU products, we offer specialty elastomer grades for established and emerging applications that are tunable to achieve specific performance traits for your film and sheet application.

Our range of available TPU grades can be produced under good manufacturing practice (GMP) conditions to meet FDA / FCM requirements for food contact applications and NSF / KTW certification standards for potable water applications.

For the textile industry, we have a team of experts that can help choose OEKO-TEX® or blue sign® compatible grades, which can be used for direct skin contact applications.

We also provide products that offer:

- Flame retardancy (e.g., UL 94 V0)
- Antistatic properties
- A matt finish.

IROGRAN® TPUs:
Key products for barrier films

Physical properties			A 70 P 6027UV	A 80 P 5039	A 80 P 4699	A 85 P 5115UV	A 85 P 4394	A 85 P 4441	A 92 P 4637	A 92 P 4851	A 95 P 5044	A 75 E 5040	A 78 E 4506	PS370-204	PS49-204	PS440-200	A 92 E 4694	A 92 E 4860	PS443-201
	Norm	Unit	IROGRAN® ether-based									IROGRAN® ester-based							
GENERAL																			
Hardness	ASTM D 2240	Shore A	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
Hardness	ASTM D 2240	Shore D	-	33	31	41	40	39	45	45	48	25	30	30	31	42	50	42	58
Density	ASTM D 792	g/cm³	1.07	1.10	1.10	1.12	1.12	1.11	1.14	1.12	1.14	1.15	1.17	1.20	1.16	1.22	1.21	1.19	1.22
MECHANICAL																			
Tensile strength	ASTM D 412	psi	4630	5660	4600	6960	6850	6960	7100	6440	8290	2200	5200	9320	5320	8110	7770	7500	7850
Elongation @ break	ASTM D 412	%	730	620	660	550	560	580	500	500	480	650	450	520	590	520	500	530	430
Tensile stress @ 100% elongation	ASTM D 412	psi	475	680	610	930	930	980	1300	1290	1630	570	700	600	560	940	1260	1020	1800
Tensile stress @ 300% elongation	ASTM D 412	psi	770	1140	930	1800	1730	1560	2860	2520	4050	950	1230	1340	1050	2550	2430	2430	5120
Tear strength	ASTM D 624	pli	320	380	420	510	470	480	550	580	620	300	480	370	340	530	620	650	750
Abrasion	ISO 4649	mm^3	50	34	40	30	31	48	33	54	31	90	25	36	53	34	33	46	36
THERMAL																			
TMA low melt range	Huntsman	°C	156	141	125	160	157	155	167	165	175	150	175	130	136	159	179	187	169
TMA high melt range	Huntsman	°C	170	156	155	172	170	169	181	179	187	190	185	166	151	173	192	203	181
OTHER FEATURES																			
Transparency			x	x		x	x		x		x			x	x	x	x		x
High crystallinity													x					x	
Matt finish					x			x		x									
Available as food contact grade			x	x		x	x	x	x							x			
Processable by blown-film extrusion				x	x	x	x	x	x				x			x		x	

IROGRAN® TPUs:
Key products for adhesive films

Physical properties			A 60 E 4902N	A 60 E 6038	A 70 E 6059UV	A 70 E 5096HUV	PS455-203	PS455-218	PS456-202	CA117-200	CA116-201
	Norm	Unit	IROGRAN® ester-based								
GENERAL											
Hardness	ASTM D 2240	Shore A	55	60	70	70	78	78	85	93	95
Hardness	ASTM D 2240	Shore D	15	-	-	-	30	30	36	50	49
Density	ASTM D 792	g/cm³	1.13	1.14	1.19	1.18	1.19	1.18	1.19	1.15	1.16
MECHANICAL											
Tensile strength	ASTM D 412	psi	2100	4400	2936	4290	3170	5740	2840	2900	4490
Elongation @ break	ASTM D 412	%	610	655	692	620	570	650	690	640	680
Tensile stress @ 100% elongation	ASTM D 412	psi	250	416	418	410	260	549	360	980	1040
Tensile stress @ 300% elongation	ASTM D 412	psi	400	700	731	935	930	1090	690	1070	1130
Tear strength	ASTM D 624	pli	220	308	264	-	350	410	310	520	570
Abrasion	ISO 4649	mm^3	75	-	-	-	130	73	-	-	-
THERMAL											
TMA low melt range	Huntsman	°C	105	105	85	89	119	126	73	71	95
TMA high melt range	Huntsman	°C	135	135	115	112	139	145	89	93	124
OTHER FEATURES											
Excellent multi-layer bonding			x	x	x	x	x	x	x	x	x
Transparency			x	x	x	x	x	x	x		
High crystallinity										x	x
Available as food contact grade											
Processable by blown-film extrusion											

KRYSTALGRAN® TPUs:
Key products for surface protection films (aliphatic)

Physical properties			PE102-201	PN3429-227	PN25-200	PN27-204	PN30-200	PN60-200
	Norm	Unit	Ether-based	Ester-based	Caprolactone-based			
GENERAL								
Hardness	ASTM D 2240	Shore A	79	83	90	92	90	97
Hardness	ASTM D 2240	Shore D	34	35	43	44	43	56
Density	ASTM D 792	g/cm³	1.07	1.17	1.14	1.14	1.14	1.14
MECHANICAL								
Tensile strength	ASTM D 412	psi	3000	8800	7730	6950	7800	8430
Elongation @ break	ASTM D 412	%	550	450	430	480	420	370
Tensile stress @ 100% elongation	ASTM D 412	psi	890	920	1480	1000	1350	2160
Tensile stress @ 300% elongation	ASTM D 412	psi	1600	3020	3900	3400	4400	6200
Tear strength	ASTM D 624	pli	360	410	550	470	500	650
Abrasion	ISO 4649	mm^3	40	48	-	-	-	-
THERMAL								
TMA low melt range	Huntsman	°C	110	110	108	108	108	95
TMA high melt range	Huntsman	°C	119	132	127	130	126	120
OTHER FEATURES								
Transparency			x	x	x	x	x	x
UV protected			x	x	x	x	x	x

Further technical data about individual products plus best practice advice for handling and processing our elastomers is available by contacting your local sales representative or by visiting our online product finder tool:
http://www.huntsman-tpu.com/

Handling recommendations

Storage

- Our TPU grades should be stored in cool and dry conditions, if possible at room temperature.
- TPUs are hydroscopic, meaning that dry pellets can absorb up to 1.5 wt. % of moisture relatively quickly if packaging is left open. After use, seal any packaging promptly to protect any remaining material.
- Keep material dry during processing by covering the feed hopper whenever possible.

Drying

- To ensure optimal processing performance, materials must be dried before processing. Water content of the granulate should not exceed 0.02 wt. %.
- Desiccant air dryers, circulating air dryers and vacuum drying ovens can be used to reduce the moisture content of the granulates before processing.
- Drying recommendations depend on the hardness of the resin, chemical structure and drying process. For TPUs with a Shore A above 90, a higher drying temperature is typically required. For drying conditions for specific TPU grades, please refer to the respective technical datasheet.

Coloring & additives

- Our TPU elastomers can be opaque or transparent, depending on their processing route and microstructure. They can be colored using a masterbatch with typical amounts ranging from 1 to 4 wt. %, depending on the thickness of the final product and the pigment concentration in the masterbatch.
- Using an incompatible masterbatch may cause poor pigment dispersion as well as a poor surface finish with surface defects.
- Different types of additives (UV stabilizers, anti-blocking agents, release aids, etc.) can be added to our TPU grades to enhance material properties.
- It is important to ensure that color or additive masterbatches do not contain any moisture. For that reason, masterbatches used during the processing of our TPU grades should be pre-dried appropriately.

Processing advice

We have developed TPU film and sheet materials for special processes including:

- Flat-die or T-die extrusion
- Cast-film extrusion
- Blown-film extrusion
- Laminating and embossing.

Our TPU grades can be extruded either by flat-die extrusion or blown-film extrusion (annular die). Although blown film extrusion is more suitable for the production of very thin films (<20µm), and flat-die extrusion is more suited to sheets (>250µm), both processes can be used to achieve a very broad range of film or sheet thicknesses. With blown films, the addition of anti-blocking agents as well as the use of a carrier (i.e., supporting foil) makes the entire process easier.

Flat-die extrusion line (Courtesy of Breyer)

Blown-film extrusion line

Global elastomers experts

Committed to customers: We build partnerships with our customers and work across an international network of R&D and manufacturing locations to help solve complex challenges and deliver the highest levels of technical support and customer care.

Committed to quality: Wherever we are, whatever we are doing, we prioritize environmental, health and safety protection, and we are always rigorous about quality control and assurance.

Committed to innovation: We keep pace with the most innovative trends in plastics processing by using the latest equipment and making regular investments in our formulation, manufacturing and R&D capabilities.

Committed to sustainability: We create solutions that contribute to a more sustainable society by helping to conserve energy, preserve natural resources and reduce our overall carbon footprint.

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About Huntsman:
Huntsman Corporation is a publicly traded corporation headquartered in The Woodlands, Texas, in the United States of America. Huntsman is a global downstream, differentiated, and specialty chemicals company. For more than 50 years, we have been using science and ingenuity to innovate and create products that enable more sustainable and comfortable lives for millions of people around the world. In 2023, Huntsman had more than 6,000 associates working in nearly 60 manufacturing, research and development (R&D), and operations facilities in 25 countries. Through our three divisions, we produce approximately 6,250 products to serve a broad and diverse range of consumer and industrial end markets including aerospace, transportation, building and construction, consumer goods, energy and fuels, and food preservation.