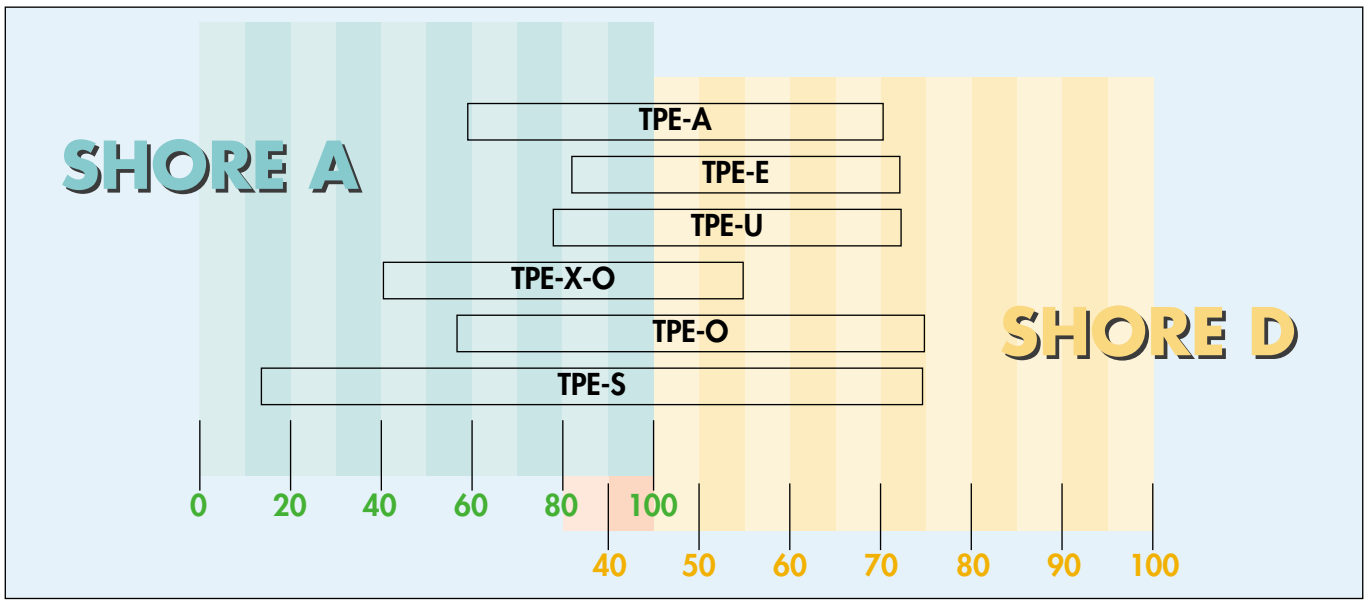
Resistive properties of elastomers

TPE/ RUBBER	V S	TEMPERATURE-RESISTANCE °C		HARDNESS FROM SH A - SH D		ABRASION	DVR RT	DVR 70°C	ELASTICITY	RESISTANCE TO: OIL	FUEL	HOT WATER	ACIDS	BASES	AGEING
TPE-O		-50	115	55	70	4	4	4	3	4	2	2	2	1	2
TPE-S		-60	115	5	50	2	2	3	2	4	4	2	1	1	1
TPE-V		-50	145	35	50	3	2	2	1	4	4	2	1	1	1
TPE-U		-60	110	65	80	1	3	3	1	1	2	4	3	4	1
TPE-E		-55	150	85	70	2	3	4	2	1	2	4	3	4	2
TPE-A		-40	160	60	70	2	3	3	1	1	3	3	2	2	2
NR	S	-50	80	30	50	1	2	3	1	4	4	2	3	2	3
IIR	S	-50	120	40	30	2	2	3	4	4	4	2	2	1	2
IIR	X	-50	180	40	30	2	2	2	4	4	4	1	1	1	1
EPDM	S	-55	120	30	55	2	2	2	2	4	4	2	2	1	1
	P	-55	160	30	55	2	2	1	2	4	4	1	1	1	1
NBR	S	-40	100	15	50	1	1	2	3	2	1**	2	2	3	2
	P	-40	120	15	50	1	1	1	3	2	1**	2	2	2	2
H-NBR	P	-40	140	15	40	2	1	1	3	2	1*	2	2	2	1
CR	B	-45	120	45	55	2	2	3	2	2	2	2	2	2	2
ECO	B	-40	140	40	40	2	1	1	1	1	1	3	2	2	1
ACM	P	-35	150	50	40	3	3	3	3	1	1	4	4	4	2
BR	S	-60	100	30	40	1	1	1	1	4	4	2	2	2	2
FPM	X	-40	200	50	45	3	2	1	3	1	1	2	1	3	1
VMQ	P	-80	200	30	30	3	2-3	2	1	1	4	4	4	4	1
SBR	S	-30	70	30	40	1-2	2-3	3	3	4	3	2	3	3	2

VS = cross-linking system S = sulphur, P = peroxide, B = bases, x = other systems
*1 = outstanding, 2 = good, 3 = adequate, 4 = poor * swelling **strong swelling*
NBR and IIR are particularly gastight
The figures quoted in this table are approximate. Depending on the Shore hardness and the composition, considerable differences in the resistive properties arise. An unrestricted comparability of the TPEs and the rubbers is not given.

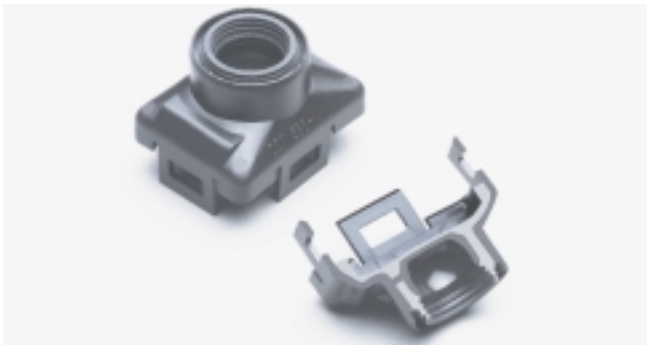
Shore hardnesses of the individual TPE groups



Ticona
Performance Driven Solutions™

Hard-Soft Combinations with Hostaform®, Celanex® and Fortron®

The importance of combining hard plastics with soft materials in two-component injection moulding is rapidly increasing. The driving force behind this dynamic development is primarily the reduction in production costs through the disappearance of assembly work, multi-functional components and new design possibilities. Ticona offer plastics for the hard components in two-component injection moulding (2-C injection moulding): Hostaform (POM), Celanex (PBT) and Fortron (PPS).



▲ *Sensor housing in the under-floor area of an automobile*

▲ *Locating clamp for an automobile CD player*

2-C Injection Moulding

The Hostaform, Celanex and Fortron materials can be used in hard-soft combinations wherever seals, damping elements, non-slip or shock-absorbent surfaces are required (see table: Application Areas for Combination with Soft Components). The usual procedure is for these hard plastics to be processed in a mould with a soft material so that both components enter into an adhesive bond. Usually the hard component is injected first, followed by the soft component, and they then are formed into one moulded part in the injection moulding process. Factors such as the delay time (between the two injections), melt temperatures, mould wall temperature, injection speed, and the residence time of the first component (part temperature) play a critical part.

Summary of the Characteristics of the Engineering Thermoplastics Used in 2-C Injection Moulding

Amongst the characteristics of Hostaform acetal copolymer (POM) are high toughness, hardness and stiffness, good chemical resistance and easy processing properties. Celanex polybutylene terephthalate (PBT) exhibits high hardness, stiffness and strength, good long-term stability and good electrical properties.

Fortron polyphenylene sulphide (PPS) is suitable for application at high temperatures (up to 240 °C), has inherent flame resistance, high hardness and stiffness. The combination of properties exhibited by these three engineering thermoplastics from Ticona gives rise to a wide spectrum of applications.

Thermoplastic elastomers (TPE)

Thermoplastic elastomers (TPE) are the most appropriate material for the soft combination material for 2-C injection moulding. They can be divided into five principal groups:

1. TPE-O:	based on polyoelfins (e.g. PP/EPDM and PP/NBR)
2. TPE-E:	based on polyesters (polyetherester, polyesterester)
3. TPE-U:	based on polyurethanes (polyetherurethane, polyesterurethane)
4. TPE-A:	based on polyamides (polyether block amide)
5. TPE-S:	based on styrene (e.g. SBS and SEBS)

The details of the properties and hardnesses of the TPEs differ (see figure: Shore Hardnesses of the Individual TPE Groups on the reverse).

Rubbers

Rubbers are plastic compositions that can be cross-linked under the influence of heat. The cross-linking, or vulcanisation, is a chemical process in the course of which the rubber molecules bond with one another. The classic rubbers are also known as "true elastomers". Their visco-elastic properties are retained over a wide temperature range. They are characterised by good elongation and elastic memory properties. They are superior to most thermoplastic elastomers in terms of temperature resistance, permanent set and resilience. Some of them, however, have disadvantages such as resistance to fuels or to acids and bases. Classic rubbers are divided into the non-polar rubbers (inc. BR, IR, SBR, EPM/EPDM) and polar rubbers (inc. NBR, CR, ACM, EAM, FPM, SR/LSR).

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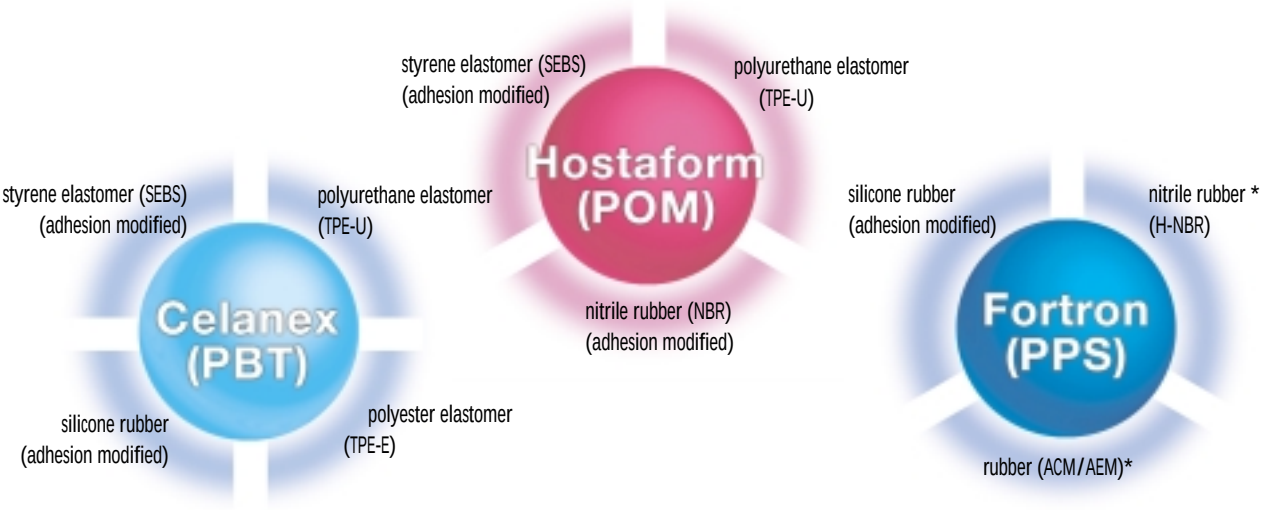
The Following Materials are Suitable for Hard-Soft Combinations:



Hostaform + SEBS

Thermoplastic elastomers particularly suited for hard-soft combinations include the SEBS types (TPE-S based on styrene). They are characterised by a very favourable combination of properties (including high elasticity, good flexibility at low temperatures, exceptional resistance to water, acids and alcohols). They offer, what is more, a widely varied range of Shore hardnesses. Kraiburg, Germany, have developed special adhesion-modified SEBS types that can very effectively be combined with Hostaform. The combination, which is the subject of a joint patent application, enables the user to work with soft components that already have a Shore A hardness of 45. The first mass produced components were avail-able after only a few weeks. The ease of processing and the good adhesion should be emphasised.

▲ *2-C clips with damping and sealing elements*

Hostaform + NBR-Rubber

After a positive result from preliminary tests performed by Ticona, a diploma research project was carried out at the FH Würzburg-Schweinfurt-Aschaffenburg. The result of this was a rubber mixture that could be vulcanised to Hostaform at low vulcanisation temperatures, in a short time, and without the need for a bonding agent. The bonding combination of NBR rubber and Hostaform makes it possible to manufacture POM parts with directly moulded-on sealing and damping elements. Schneegans in Emmerich, Germany, are already manufacturing series parts (housing elements with integrated seals and stop damping). Further experiments are being made jointly with Krallmann and with Krauss-Maffei, Germany.

▼ *Experimental part made from Hostaform with applied NBR rubber seal*

Celanex + SEBS

The hard/soft combination of Celanex / SEBS is suited to a wide range of applications. The glass-fibre reinforced Celanex types are used for housings in the automobile and electrical industries. Internal electronic components must be sealed into the housing in such a way that no moisture can penetrate. The seals for the housing parts, which are getting steadily more complex, are often difficult to fit using conventional procedures. The 2-C procedure, in combination with SEBS, provides a significant simplification to assembly in this area, and thus also a clear potential for savings.

The excellent electrical properties exhibited by Celanex are the reason why non-reinforced types are used for connectors. Connectors also sometimes have seals, and 2-C injection moulding can be used to optimise the process here, particularly because of the small component dimensions.

▼ *Even conveyor chain links with anti-slipping devices (MCC) are manufactured from Celanex and SEBS using the 2-C procedure.*

Fortron + Rubber

Fortron (PPS) is suitable for combination with vulcanised rubber because of the temperature requirements. The large number of developments using PPS in engine compartments, sometimes in combination with AEM rubber, make this area of work particularly interesting. Ticona are developing system solutions, which are expected to make combination possible even without pre-treatment. A further interesting possibility is the combination of Fortron with adhesion-modified silicone rubber, because of its suitability for long-term high temperature application. Parts already exist for commercial vehicle air-brakes, in which sulphur-vulcanised rubbers such as H-NBR are vulcanized on Fortron after appropriate pre-treatment.

▼ *Parts for commercial vehicle air-brakes (Helvoet).*

Areas of Application for Combination with Soft Components

Automobile	
Connectors with seals	PBT/POM
Housings with seals:	
Window winders	PBT
Door locks	POM/PBT
Central electrics	PBT
Valve covers	PPS
Oil pumps/water pumps	PPS
Sensors/sensor housings	POM/PBT/PPS
Operating elements:	
Steering columns	PBT/POM
Heating/air conditioning	POM/PPS
Audio	POM/PBT
Ventilation	POM/PPS
Valves/pistons	POM/PPS
Clip with vibration damper/seals	POM

General Industries	
Fluid handling/sanitation:	
Sprinkler heads	PBT/POM
Filter heads	POM
Valves	POM/PPS
Chain links	POM/PBT
Audio/video/office:	
Paper transport rollers	POM
Operating elements/knobs	POM
Levers/latches	POM
Drive seals	POM
Valves/pistons/ heating/pneumatics	POM/PPS
Medical engineering/insulin pen	POM
Small devices	POM/PBT
Large devices	POM/PBT

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Performance Driven Solutions™

World-Class Engineering Polymers

- Celanex® thermoplastic polyester (PBT)
- Celcon® and Hostaform® acetal copolymer (POM)
- Celstran® and Compel® long fiber reinforced thermoplastics (LFRT)
- Fortron® polyphenylene sulfide (PPS)
- GUR® ultra-high molecular weight polyethylene (UHMW-PE)
- Impet® thermoplastic polyester (PET)
- Riteflex® thermoplastic polyester elastomer (TPC-ET)
- Vandar® thermoplastic polyester alloy (PBT)
- Vectra® liquid crystal polymer (LCP)

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