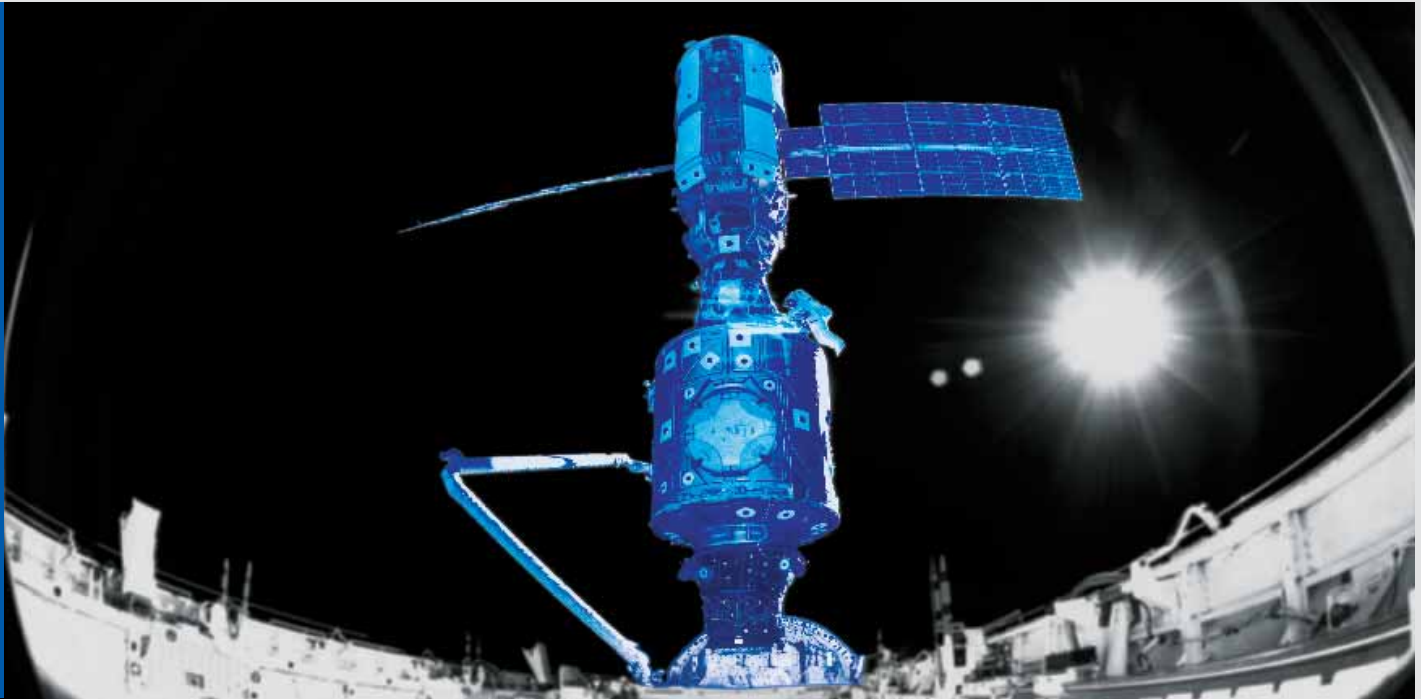


**High-performance Plastics for Aviation and Aerospace.**

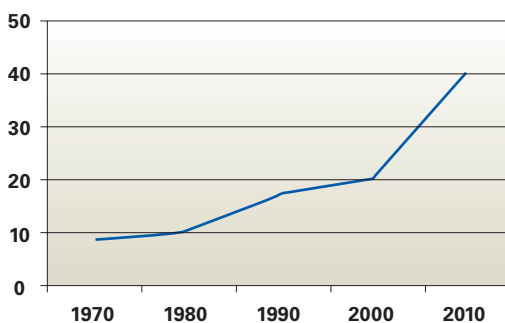


## Plastics in aviation and aerospace applications.



The dream of flying would quickly become a thing of the past without today's plastics. This is easily substantiated by a casual glance at the inside of a modern aeroplane. The use of plastics makes planes lighter, safer and more economical. This is by no means the case for just the interior, however, but also for sophisticated technical parts, structural elements and propulsion components, for example.

More recently, the significance of technical plastics and composites in aviation and aerospace applications has grown rapidly.



Development of the weight of technical plastics and composites [in %] used in commercial aeroplanes

### Areas of application for plastics in aviation and aerospace

Interior components, technical parts, structural elements as well as components for navigation, propulsion engineering and satellite technology.

### Advantages of plastics

- | Every extra kilogramme a plane weights costs energy to move it and thus money. The use of modern polymer materials and reinforcing fibres makes it possible to achieve lightweight constructions and hence fuel savings
- | Plastic components can normally be fabricated economically
- | Plastics are approx. 50% lighter than aluminium
- | Compared to metals, plastics do not corrode
- | Plastics provide a high degree of freedom in design
- | Plastics with modified sliding properties are best suited for use in dry operation under extreme conditions
- | Transparent plastics serve as lighter and more impact resistant alternatives to glass

### Properties of high-performance plastics

- | High thermal and mechanical stability
- | Inherently flame retardant
- | Low degree of thermal expansion
- | High chemical resistance even at raised temperatures
- | Low level of outgassing in vacuum
- | Good electrical insulation

### Approvals

Before plastics are approved for applications in aviation and aerospace, they normally have to undergo testing which is specific for the components.

ENSINGER processes special high-performance plastics to satisfy special needs, which meet the high standards and fulfill the requirements of QSF-B, AS 9100, OSU, ABD 0031 or FAR 25.853. TECAPEEK® products are qualified according to IPS 04-06-004-01 specifically for interior Airbus applications.

## ENSINGER Plastics for aviation and aerospace.

### | SINTIMID

Materials with a continuous service temperature of 300 °C. High strength, rigidity and creep strength. Good chemical resistance and excellent sliding properties for specific grades. Excellent electrical insulation properties and inherently flame retardant. May be used in cryogenic applications. High degree of purity and low out-gassing in vacuum.

### | TORLON®

High mechanical strength and toughness. Very good creep resistance, low thermal expansion and high thermal resistance. Good mechanical values up to temperatures of 260 °C. Good frictional characteristics for special types. May be used in cryogenic applications. Good chemical resistance and inherently flame retardant.

### | TECAPEEK

Semi-crystalline plastic with high strength, rigidity and hardness. Continuous service temperature up to 260 °C. Resistant to many different types of hydraulic fluid (Skydrol) and chemicals, also at high temperatures. Excellent dimensional stability and very good sliding properties for special types. Inherently flame retardant. Extremely low smoke gas emission and density, as well as extremely low toxicity of the smoke gases.

### | TECATRON/TECATRON VF

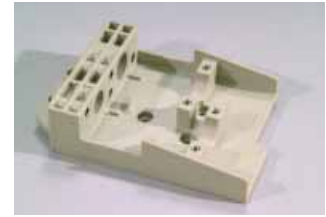
Plastic with very high strength, rigidity and hardness. Continuous service temperature of 230 °C. Excellent chemical resistance even at high temperatures. Excellent dimensional stability and low water absorption. Inherently flame retardant. Very good creep resistance.

### | TECASON P VF

Very good creep strength and extremely impact resistant. Outstanding resistance to fluids used in the aerospace industry. Highly resistant to radiation (gamma, X-rays, etc.). Extremely low smoke gas emission and density. Inherently flame retardant.

### | TECAPEI

Amorphous plastic with high strength and continuous service temperature of 170 °C. Good chemical resistance to many substances, such as fully halogenated hydrocarbons, alcohols and aqueous solutions. Excellent dimensional stability. Inherently flame retardant. Extremely low smoke gas emission and density, as well as extremely low toxicity of the smoke gases.



Sensor plate  
**TECAPEEK GF 30.**



Attenuation tube  
**TECAFORM AH**



Twin Pulley  
**TECAPEI GF 30**



Output Pulley  
**TECAPEI GF 30**

## Process engineering to match the highest demands.



Perfect products are the result of highly precise production processes and the most modern process technology. The comprehensive know-how of ENSINGER's industrial specialists in conjunction with engineering expertise makes technically demanding and customised solutions possible. All processes are subject to continuous quality assurance. Thanks to the global sales network, our products reach you anywhere and on time every time.

### Extrusion

ENSINGER extrudes semi-finished goods from more than 100 different thermoplastics as rods, sheets and tubes in the dimensions the customer requires and as stock items. Many years of experience and the most modern equipment ensure the highest quality of all products, as well as individually adaptable material properties.

### Machining

Small parts and large size components can be economically produced on the most modern CNC-controlled processing centres and cycle-controlled automatic turning lathes. Lot sizes are irrelevant. Complex geometries are possible with simultaneous four and five-axis processing.

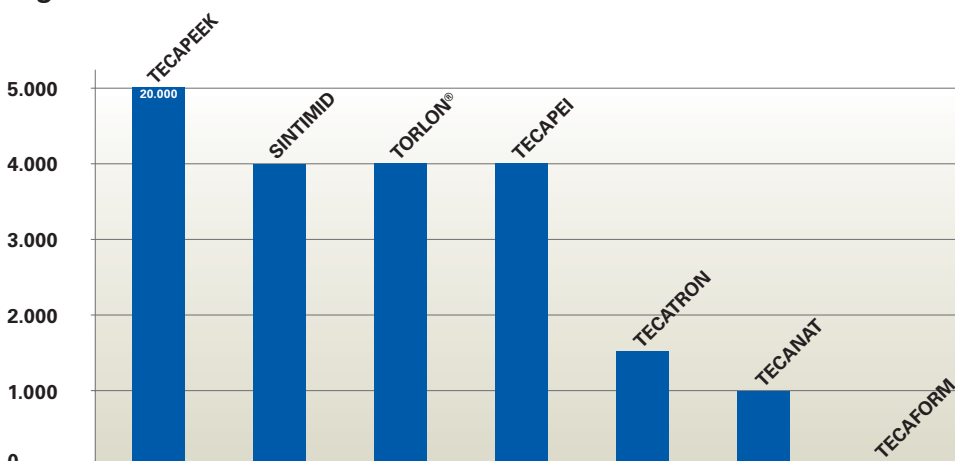
### Injection moulding

We produce high-precision and demanding geometries for large volume production using injection moulding. These are used, for example, in holding fixtures or material handling equipment.

### Industrial profiles

ENSINGER demonstrates its high level of expertise in the production of special profiles and special tubes. Solid profiles, hollow chamber profiles and particularly thin-walled profiles are manufactured for this purpose from specially adapted materials.

### Highest radiation resistance



Approximate values:  
Dosage in kGy, which reduce elongation by 25%.

## Outstanding properties and top performance for your safety.



### Outstanding resistance to chemicals

High-performance plastics have to show special properties in their resistance to chemicals, in order to be used in the aviation and aerospace industry. This depends on the state of the part, the geometry and the internal stress of the materials. Our plastics satisfy these requirements. It is recommended that a test for suitability is carried out for definite applications, taking into account the resistance at different temperatures, concentrations, residence times and mechanical loads.

		Resistance to acids	Resistance to alkalis	Resistance to solvents	Resistance to stress cracking
SINTIMID	PI	+	0	++	++
TORLON®	PAI	+	+	++	++
TECAPEEK	PEEK	+	++	++	++
TECATRON VF	PPS	+	++	++	++
TECASON P VF	PPSU	+	+	0	0
TECAPEI	PEI	0	+	+	0

Chemical resistance according to different temperatures, residence times, concentrations and the geometry of the parts (possibly internal stress)  
 ++ good resistance + resistant 0 limited resistance

### Safety through special fire protection properties

For certain plastic applications, high requirements are placed on flame retardant properties. ENSINGER plastics satisfy the current flammability ratings for aviation and aerospace purposes.

	Name of raw material		Manufacturer of raw material	UL 94	FAR 25.853	ABD 0031	ATS 1000.001	Remarks
SINTIMID	SINTIMID	PI	Degussa	V-0	No data	No data	No data	
TORLON®	Torlon®	PAI	Solvay	V-0	No data	No data	No data	only injection moulding
TECAPEEK	VICTREX® PEEK™	PEEK	Victrex	V-0	Yes	Yes	Yes	
TECATRON VF	Fortron®	PPS	Ticona	V-0	No data	No data	No data	
TECASON P VF	Radel R®	PPSU	Solvay	V-0	Yes	No data	Yes	R7700 series
TECAPEI	Ultem®	PEI	GE Plastic	V-0	Yes	Yes	No data	
TECAMAX SRP	Primospire™SRP	PPP	Solvay	V-0	No data	Yes	No data	

# ENSINGER High-temperature plastics. Material reference values.

## Mechanical Values

Trade name	DIN-abbreviation	Additives and/or colour	Service temperature °C long term	Mechanical Values												
				$\rho$ g/cm <sup>3</sup>	$\sigma_S$ MPa	$\sigma_R$ MPa	$\epsilon_R$ %	$E_z$ MPa	$E_B$ MPa	$H_k$ MPa	$a_n$ kJ/m <sup>2</sup>	$\sigma_{B/1000}$ MPa	$\sigma_{1/1000}$ MPa	$\mu$ -	$V$ µ/km	
SINTIMID PUR HT	PI	Black	300	1,35		116	9	4000	4000		75 (c)		12	0,8		
TORLON® (5) 4203	PAI	Brown	260	1,42		192	15	4900	5000	E86	142					
TORLON® (5) 4301	PAI CS TF	Black	260	1,46		164	7	6600	6900	E72	63					
TORLON® (5) 5030	PAI GF 30	30% glass fibre, black	260	1,61		205	7	1080	11700	E94	79					
TECAPEEK	PEEK	Natural, also black (1)	260	1,30	95		25	3000	4100	M99 (r)	o. Br. (c)			0,30-0,38		
TECAPEEK GF 30	PEEK GF 30	Natural, 30% glass fibre	260	1,51		180	2,5	9500	10000	M103 (r)	60 (c)	36		0,38-0,46		
TECAPEEK CF 30	PEEK CF 30	30% carbon fibre, black	260	1,40		215	1,5	18500	20000	256(2)	35 (c)					
TECAPEEK PVX	PEEK CF CS TF	Carbon fibre, graphite, PTFE, black	260	1,48		130	1,5	9500	8100	208(2)	30 (c)			0,11		
TECATRON	PPS	Natural	230	1,35	75		4	3700	3600	190	50 (c)					
TECATRON GF 40	PPS GF 40	40% glass fibre, natural	230	1,64		185	1,9	14000	13000	320	45 (c)					
TECATRON GF 15 VF	PPS GF 15	15% glass fibre, black	230	1,44		120	2	7700	7500		32 (c)					
TECATRON GF 30 VF	PPS GF 30	30% glass fibre, black	230	1,58		160	2	11000								
TECATRON GF 40 VF	PPS GF 40	40% glass fibre, black	230	1,65		185	1,9	14000	14000	320	45 (c)					
TECASON P VF	PPSU	Coloured	170	1,29	70		> 50	2350	2600							
TECAPEI	PEI	Translucent	170	1,27	105		> 50	3200	3300	140	4 (c)					
TECAPEI GF 30	PEI GF 30	30% glass fibre	170	1,51		165	2	9500	9000	165	40 (c)					
TECAMAX SRP	PPP	Black	140	1,21	207			8300	8300	80B (r)	41,9 (ai)					
TECAMID 66	PA 66		100	1,14	80/60*		40/150*	3100/2000*	2830	170/100*	o. Br. (c)	55	8	0,35-0,42	0,9	
TECANAT	PC	Transparent	120	1,20	60			2300		100	o. Br. (c)	48	18	0,52-0,58	22	
TECAFORM AH	POM-C	Natural, also in black (1)	100	1,41	62		30	2700		145	o. Br. (c)	40	13	0,32	8,9	

This data represents the current state of our knowledge and is meant to provide information about our products and their possible applications. It thus does not represent any legally binding guarantee of particular properties of the products or their suitability for a definite purpose.  
All existing industrial property rights are to be observed.

We ensure the perfect quality of our products within our General Terms and Conditions of Sale. Norm tests are carried out under standard climatic conditions 23/50 according to DIN 50 014. The right is reserved to make technical changes. Unless otherwise specified, the values are average values obtained from many different single measurements from tests on injection moulded specimens.

## Specifications

Victrex® PEEK™ Polymer Specifications and Approvals. Victrex® PEEK™ polymer and compounds are recognised or approved by the following bodies:

Aerospace/Military	
FAR25-25853B	Victrex® PEEK™ 381G & 450G meet the fire, smoke and toxicity standard FAR 25-25853 for aircraft cockpit use.
ATS 1000.001	Victrex® PEEK™ 381G & 450G meet the fire, smoke and toxicity standard ATS 1000.001 for optical density and toxicity of fumes from burning.
SP-R-0022A	Victrex® PEEK™ 450G meets the NASA standard SP-R-0022A for vacuum stability of polymeric materials in spacecraft applications.
BMS 8-317A	Victrex® PEEK™ unfilled glass and carbon filled polymers can be supplied to Boeing specification BMS 8-317A for use in aircraft applications.
MIL-P-46183	Victrex® PEEK™ polymer and compounds can be supplied to the military specification MIL-P-46183.
Staining Test	Victrex® PEEK™ 381G complies with the Boeing Aircraft staining test.
#DMSRR 1018	Victrex® PEEK™ CA30 complies with the Rolls Royce standard #DMSRR 1018.
75-T-2-3007-4-1	Victrex® PEEK™ CA30 meets the Deutsche Aerospace/Airbus standard 75-T-2-3007-4-1.
MS29.02.03	Victrex® PEEK™ 450GL30 complies with the Sundstran Aerospace materials specification MS29.02.03.
JAR 25.853	Victrex® PEEK™ 381G meets the fire, smoke and toxicity standard JAR 25.853 for flame resistance.
S26 4625	Victrex® PEEK™ 381G meets the fire, smoke and toxicity standard S26 4625 for non-flaming smoke generation.
VPRM85-10A	Victrex® PEEK™ 381G meets the fire, smoke and toxicity standard VPRM85-10A for peak and total heat release when heated.
299-947-362	All grades of Victrex® PEEK™ polymer meet Bell Helicopter specification 299-947-362.
P6240	All grades of Victrex® PEEK™ polymer meet General Dynamics specification P6240.
HS13534	Victrex® PEEK™ 450FC30 meets Hamilton Standard (United Technologies) specification HS13534.

## Flammability Rating

Underwriters Laboratories V-0 Victrex® PEEK™ 450G and compounds 450GL30 and 450CA30 have an Underwriters Laboratories V-0 rating at .057 in. (1.45mm) thickness



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