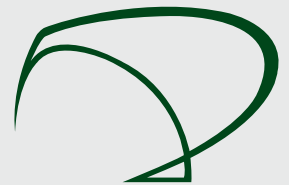


**High-performance Plastics for Aviation and Aerospace.**



# **SUPPLY SERVICES LTD**



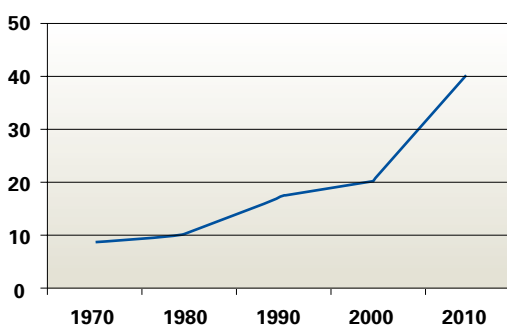
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## Plastics in aviation and aerospace applications.



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.

### | VESPEL®/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.

### | TECAMAX SRP

Amorphous plastic with extremely high strength and hardness without the use of fillers. Continuous service temperature of 140 °C. Very good chemical resistance and outstanding cryogenic properties. Very good scratch resistance. Inherently flame retardant, extremely low smoke gas emission and density.



Sensor plate  
**TECAPEEK GF 30.**



Attenuation tube  
**TECAFORM AH**



Twin Pulley  
**TECAPEI GF 30**



Output Pulley  
**TECAPEI GF 30**



S-frequency aerial for satellites  
**TECAPEEK and VESPEL® SP1**

## 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.

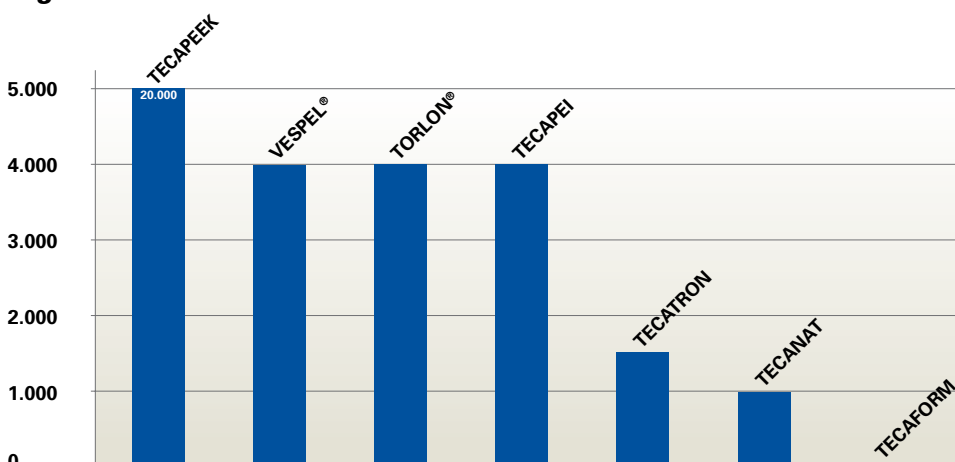
### Injection moulding

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
<b>VESPEL®</b>	PI	+	0	++	++
<b>SINTIMID</b>	PI	+	0	++	++
<b>TORLON®</b>	PAI	+	+	++	++
<b>TECAPEEK</b>	PEEK	+	++	++	++
<b>TECATRON VF</b>	PPS	+	++	++	++
<b>TECASON P VF</b>	PPSU	+	+	0	0
<b>TECAPEI</b>	PEI	0	+	+	0
<b>TECAMAX SRP</b>	PPP	++	++	+	+

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
<b>VESPEL®</b>	VESPEL®	PI	DuPont	V-0	No data	No data	No data	
<b>SINTIMID</b>	SINTIMID	PI	Degussa	V-0	No data	No data	No data	
<b>TORLON®</b>	Torlon®	PAI	Solvay	V-0	No data	No data	No data	only injection moulding
<b>TECAPEEK</b>	VICTREX® PEEK™	PEEK	Victrex	V-0	Yes	Yes	Yes	
<b>TECATRON VF</b>	Fortron®	PPS	Ticona	V-0	No data	No data	No data	
<b>TECASON P VF</b>	Radel R®	PPSU	Solvay	V-0	Yes	No data	Yes	R7700 series
<b>TECAPEI</b>	Ultem®	PEI	GE Plastic	V-0	Yes	Yes	No data	
<b>TECAMAX SRP</b>	Primospire™SRP	PPP	Solvay	V-0	No data	Yes	No data	



Thermal Values										Electrical Values <sup>(1)</sup>										Misc. Data			
T <sub>03</sub> °C	T <sub>02</sub> °C	HDT/A °C	HDT/B °C	α <sub>c</sub> °C	λ W/(K·m)	c J/(g·K)	α 10 <sup>-2</sup> /K	ε <sub>r</sub>	tan δ	ρ <sub>D</sub> Ω·cm	R <sub>0</sub> Ω	E <sub>d</sub> kV/mm	grade	W(H <sub>2</sub> O) %	W <sub>s</sub> %	-	-	-	-	-	-	Trade name	
Melting Point (DIN 53 755, DIN EN ISO 3146)	Glass transition temperature (DIN 53 755, DIN EN ISO 3146)	Heat deflection temperature (DIN EN ISO 75 procedure A)	Heat deflection temperature (DIN EN ISO 75 procedure B)	Service temperature short term	Thermal conductivity (23°C)	Specific heat (23°C)	Coefficient of linear thermal expansion (23°C, ASTM D 990, DIN ISO 1997, ASTM E 831)	Dielectric constant (106 Hz, ASTM D 150, DIN 53 483, IEC 2500)	Dielectric loss factor (106 Hz, ASTM D 150, DIN 53 483, IEC 2500)	Specific Volume resistance (ASTM D 257, EC 93, DIN IEC 60093)	Surface resistance (ASTM D 257, EC 93, DIN IEC 60093)	Dielectric strength (DIN EN 60112, VDE 0303 Part 1)	Resistance to tracking (DIN EN 60112, VDE 0303 Part 1)	Moisture absorption to equilibrium (23°C/50% rel. air humidity (DIN EN ISO 62))	Moisture absorption at saturation (23°C/100% rel. air humidity)	Flammability (DIN EN ISO 82)	Resistance to hot water, washin soda	Flammability acc. to UL standard 94	Resistance to weathering <sup>(5)</sup>	Outgassing TML (%)	Total Mass Loss	Outgassing CYM Collectable volatile condensable material	
		360	360	360	0,35	1,13	5,4	3,55	0,0034	10 <sup>14</sup> - 10 <sup>15</sup>	10 <sup>15</sup> - 10 <sup>16</sup>	22		1,3			V0		1,29 <sup>(1)</sup>	0,00 <sup>(1)</sup>		VESPEL® SP1	
		360	360	360	0,87		4,9	13,4	0,01	10 <sup>12</sup> - 10 <sup>13</sup>		9,84		1,1			V0		0,52 <sup>(1)</sup>	0,01		VESPEL® SP21	
	360-375	368		350	0,22	1,04	4,9	3,1	0,003	10 <sup>17</sup>	10 <sup>16</sup>	20		2,6	3,6	(+)	V0	(+)	1,79 <sup>(3)</sup>	0,01 <sup>(3)</sup>		SINTIMID PUR HT	
	275	278		270	0,26	1	3,1	3,9	0,031	2x10 <sup>15</sup>	8x10 <sup>18</sup>	23,6		2,5	5,5	(+)	V0	+				TORLON® (5) 4203	
	275	279		270	0,54	1	2,5	5,4	0,042	8x10 <sup>13</sup>	8x10 <sup>17</sup>			1,9	4,5	(+)	V0	+				TORLON® (5) 4301	
	275	282		270	0,37	0,95	1,6	4,2	0,05	2x10 <sup>15</sup>	10 <sup>18</sup>	32,6		1,8	4,0	(+)	V0	+				TORLON® (5) 5030	
343	143	140	182	300	0,25	0,32	5	3,2-3,3	0,001-0,004	10 <sup>16</sup>	10 <sup>15</sup>	20		0,1	0,5	+	V0	-	0,24 <sup>(2)</sup>	0,00 <sup>(2)</sup>		TECAPEEK	
343	143	315		300	0,43		2		0,004	10 <sup>15</sup>	10 <sup>15</sup>	24,5		0,1	0,1	+	V0	-	0,14 <sup>(2)</sup>	0,00 <sup>(2)</sup>		TECAPEEK GF 30	
343	143	315		300	0,92		1,5 <sup>(2)</sup>			10 <sup>5</sup> - 10 <sup>7(2)</sup>	10 <sup>5</sup> - 10 <sup>7(2)</sup>			0,1	0,1	+	V0	+	0,18 <sup>(2)</sup>	0,00 <sup>(2)</sup>		TECAPEEK CF 30	
343	143	277		300	0,24		2,2			3x10 <sup>5</sup>	5x10 <sup>6</sup>			0,1	0,1	+	V0	+	0,16 <sup>(2)</sup>	0,00 <sup>(2)</sup>		TECAPEEK PVX	
280	90	110		260	0,25		5			10 <sup>13</sup>	10 <sup>15</sup>			0,01		+	V0	-				TECATRON	
280	90	260		260	0,25	1,18	ca. 3	4	0,004	10 <sup>13</sup>	10 <sup>15</sup>	20	KC 175	0,02	1	+	V0	-	0,05 <sup>(1)</sup>	0,00 <sup>(1)</sup>		TECATRON GF 40	
280	90	220	115								10 <sup>15</sup>			0,02			V0					TECATRON GF 15 VF	
280	90	255									10 <sup>15</sup>	10 <sup>15</sup>		0,02			V0					TECATRON GF 30 VF	
280	90	260		260	0,25	1,18	ca. 3	4	0,004	10 <sup>13</sup>	10 <sup>15</sup>	20	KC 175	0,02			V0					TECATRON GF 40 VF	
	220	207	214	190	0,35		5,6	3,45		10 <sup>15</sup>	10 <sup>13</sup>	15		0,37			V0					TECASON P VF	
	217	180	200	200	0,22		5	3,15	0,001	10 <sup>15</sup>	10 <sup>15</sup>	33		0,7	1,25	+	V0	-	0,40 <sup>(1)</sup>	0,00 <sup>(1)</sup>		TECAPEI	
	217	210	215	200	0,23		2	3,7	0,007	10 <sup>15</sup>	10 <sup>15</sup>	30		0,5	0,9	+	V0	-	0,43 <sup>(1)</sup>	0,01 <sup>(1)</sup>		TECAPEI GF 30	
	155	152		150 <sup>(3)</sup>			3-4	3,1		6x10 <sup>15</sup>	2x10 <sup>16</sup>	6,44	CTI 150	0,5	0,5		V0					TECAMAX SRP	
260	72/5*	100	>200	170	0,23	1,7	8	3,6-5	0,026-0,200	10 <sup>12</sup>	10 <sup>10</sup>	28*/30	CTI 600	2,8	8,5	(+)	HB	-				TECAMID 66	
	148	135	140	140	0,19	1,2	7	3	0,006	10 <sup>13</sup>	10 <sup>15</sup>	27	KA 1	0,15	0,36	-	HB	-	0,11 <sup>(1)</sup>	0,00 <sup>(1)</sup>		TECANAT	
	165	-60	110	160	0,31	1,5	10	3,5	0,003	10 <sup>14</sup>	10 <sup>14</sup>	>50	KA 3c	<0,3	0,5	(+)	HB	-				TECAFORM AH	

Vespele® is a registered trade mark of DuPont de Nemours and Company.

Remarks: With polyamides, values are strongly dependent upon moisture content.  
\* wet, after storage in standard climate 23/50 (DIN 50 014) to saturation.

+ = resistant  
(+) = limited resistance  
- = not resistant (dependent upon concentration, time and temperature)(1)

(1) For plastics, which under "Additives or Colour" are also quoted alternatively in black, the electrical values do not apply for the black version.

(2) Tested on semi-finished goods.

(3) Estimated values.

(4) Impact strength is measured according to various methods. The values in the following table are marked with letters according to the method used

(c) Charpy: DIN EN ISO 179: a<sub>n</sub> kJ/m<sup>2</sup>

(ai) Izod: ASTM D 256: a<sub>n</sub> J/m

(di) Izod: DIN EN ISO 180: a<sub>n</sub> kJ/m<sup>2</sup>

(k) Notch impact strength DIN EN ISO 179: a<sub>n</sub> kJ/m<sup>2</sup>

(5) Only injection moulding

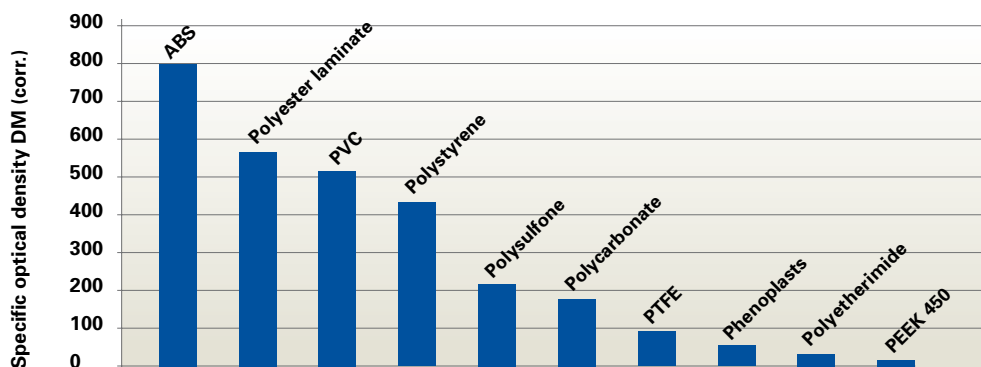
Source

1) NASA, ASTM E-595-90

2) ESA, ESA PSS-01-702

3) ESA, ECSS-Q-70-02A

## Smoke gas density of plastics



Test conditions:  
Smoke chamber of the American National Bureau of Standards  
Sample thickness 3.2 mm flamed

(Source: Victrex® plc.)



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