

High-performance plastics used in semi-conductor production and electronics



Utilisation of plastics in the production of semi-conductors



Many of the process stages involved in semi-conductor production call for handling components made of highly qualified materials. Their specific properties, including material purity, resistance to chemicals and good dimensional stability even at high temperatures make high-performance plastics from ENSINGER ideally suited for the manufacture and processing of wafers.

According to customer specifications we develop plastics with special properties and produce high quality semi-finished products and finished parts for challenging applications.

The outstanding properties of ENSINGER high-performance plastics:

- | High thermo-mechanical strength
- | Minimal thermal expansion
- | Good wear resistance
- | Good chemical resistance to acids, alkalis, greases and solvents, hydrogen peroxide, demineralised water, hot steam
- | Good plasma resistance
- | Minimal outgassing under vacuum
- | Minimal extraneous ion content
- | Good electrical insulating properties/ defined static conductivity

Approvals

Before plastics can be approved for clean room applications, they must comply with stringent requirements within the framework of exhaustive testing to ensure their suitability. To address the specific demands of semi-conductor production, ENSINGER processes special high-performance plastics capable of complying with strict clean room production standards. ENSINGER is certified according to ISO 9001 : 2000.

Plastics for every process stage.

ENSINGER high-performance plastics demonstrate the utmost precision and maximum reliability throughout every stage involved in the complex manufacture and processing of wafers. For example during coating and etching of silicon wafers - a field in which handling components made of ENSINGER plastics have proved highly successful over many years.

Cutting and polishing

During these processing stages, which include for instance chemical mechanical planarisation (CMP), plastics with good chemical resistance and hardness properties such as TECAPET, TECATRON and TECAPEEK are beneficial.

Coating and etching processes

Ultra high purity silicon is used as a substrate for the semi-conductor structure, which calls for dimensional accuracy in the nanometer range. Highly caustic acids and alkalis as well as detergents and solvents are involved in generating these nanostructures. Plastics belonging to the fluoropolymer group as well as TECAPEEK, TECATRON and TECAFINE have proved highly successful for this type of application. Also in the case of new technologies such as dry etching using plasma technology, plastics such as VESPEL®, SINTIMID and TECAPEEK from ENSINGER are commonly used.

Sheathing, encapsulating and contacting

The storage and transportation of silicon wafers during the manufacturing process entails a certain degree of physical contact. To preclude any damage to the finished chip, pure, outgassing free and dimensional stable materials are used, which may not contain foreign ions. VESPEL®, SINTIMID, TECATOR and TECAPEEK comply with this. Furthermore these antistatic dissipative materials offer a high degree of stability under thermal mechanical load.

Gauging, testing and packaging

ENSINGER offers a whole range of benefits: VESPEL®, SINTIMID PAI, TECATRON, TECAPEEK CMF and TECASON are characterised by outstanding dimensional stability. Materials such as SINTIMID PAI ESD, TECAPEEK ESD 7, TECANAT ESD 7, TECAFORM AH ELS and TECAFORM AH SD suppress the build up of static charges. And for sliding friction applications, friction modified materials from ENSINGER have proved highly successful for a wide range of performance categories.

ENSINGER Plastics for semiconductor production

I **VESPEL® (PI)**

Material with continuous service temperature over 300 °C. Dimensionally stable, creep resistant. Good electrical insulating properties, good plasma resistance. Vacuum resistant, minimal extraneous ion content.

I **SINTIMID HP (PI)**

Continuous service temperature 300 °C. High deflection temperature for brief periods up to 365 °C. Dimensionally stable, creep resistant, good hardness level. Excellent plasma resistance, vacuum resistance. High degree of material purity.

I **SINTIMID PAI (PAI)**

High-strength PAI with high deflection temperature for brief periods up to 328 °C. Outstanding dimensional stability, good wear resistance. Very good electrical conductivity, solvent resistant.

I **SINTIMID PAI ESD (PAI)**

High-strength, statically conductive PAI. High deflection temperature for brief periods up to 328 °C. Dimensionally stable, good wear resistance. Solvent resistant.

I **TECATOR 5013 (PAI)**

High thermal resilience for cryogenic and high temperature ranges up to 270 °C. High thermal stability long term. Electrically insulating. Very tough and rigid.

I **TECAPEEK ELS nano**

Statically conductive, high strength, minimal thermal expansion. Good chemical resistance, abrasion resistance, good heat conduction properties. Low extraneous ion content, low outgassing.

I **TECAPEEK GF 30 (PEEK GF 30)**

High strength, good dimensional stability. Good electrical insulating properties, abrasion resistant.

I **TECAPEEK CMF (PEEK)**

Low water absorption. High dimensional stability. Good machinability. Good thermal resistance.

I **TECAPEEK (PEEK)**

Minimal extraneous ion content. Very good chemical resistance, abrasion resistant.

I **TECATRON PPS (PPS)**

Very good chemical resistance. Electrically insulating and abrasion resistant. Minimal extraneous ion content.

I **TECAPEI (PEI)**

High-grade electrically insulating material, low dielectric loss factor.

I **TECAPEI ESD 7 (PEI)**

Statically conductive, high strength and rigidity, creep resistant, good dimensional stability. Heat deflection temperature up to 215 °C, abrasion resistant.

I **TECANAT ESD 7 (PC)**

Statically conductive PC with nanotubes.

I **TECAFLON PTFE TFM (PTFE)**

Very high chemical resistance, low absorption rates. Extremely low dielectric loss factor, weldable. High material purity.

I **TECAFLON PVDF (PVDF)**

Good chemical resistance, thermal application up to 150 °C. More mechanically stable than TECAFLON TFM.

I **TECAPET PET (PET)**

Very good solvent resistance, dimensionally stable, low water absorption.

I **TECAFORM AH SD (POM-C)**

Statically conductive, carbon black-free, inherently active continuous non-contaminating anti-static agent.

I **TECAFORM AH ELS (POM-C)**

Electrically conductive POM with special conductive carbon black for general applications.

ENSINGER plastics: Impressive performance profiles.



Contamination

Because of the danger of metal ion contamination, when manufacturing components for the semi-conductor industry, any contact with metal materials must be excluded. ENSINGER high-performance plastics reliably comply with this requirement.

	VESPEL® SP1	SINTIMID HP	TECAPEEK
Aluminium	<1	<2	<1
Calcium	<1	<4	<1
Iron	<1	<2	<1
Copper		<1	<1
Magnesium	<3	<5	<1
Zinc	0	<1	<1

Test in accordance with ICP-MS Concentration levels stated in ppm

Outgassing behaviour

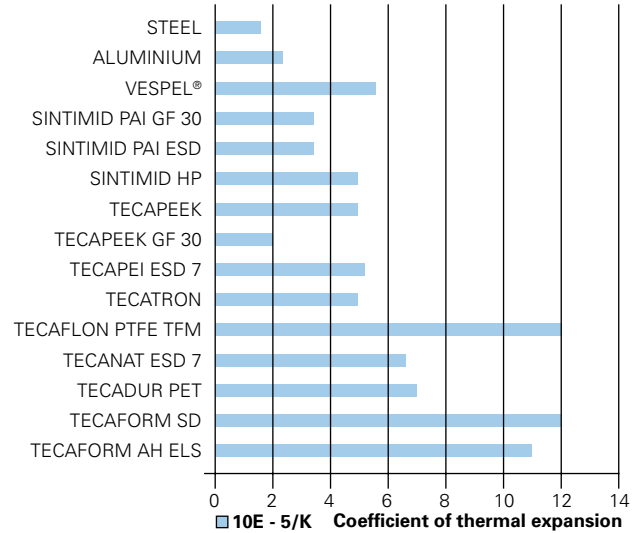
To comply with requirements in high vacuum environments, the materials used must be low-outgassing. High-performance plastics from ENSINGER fulfil these stringent requirements, offering maximum material purity and ensuring the minimal water absorption necessary for stability when working at high vacuum. Reject rates can be reduced as a result of the minimal risk of contamination.

	Outgassing characteristic	VESPEL® SP1 (PI)	SINTIMID PUR HT (PI)	TECAPEEK GF 30 (PEEK)	TECAPEEK (PEEK)
Total weight loss	TML %	1,3	1,5	0,2	0,26
Collected evaporated condensable material	CVCM %	0	0	0	0
Reabsorbed water vapour	WVR %	0,7	0,8	0,08	0,12

Test according to ESA PSS-01-702

Thermal expansion

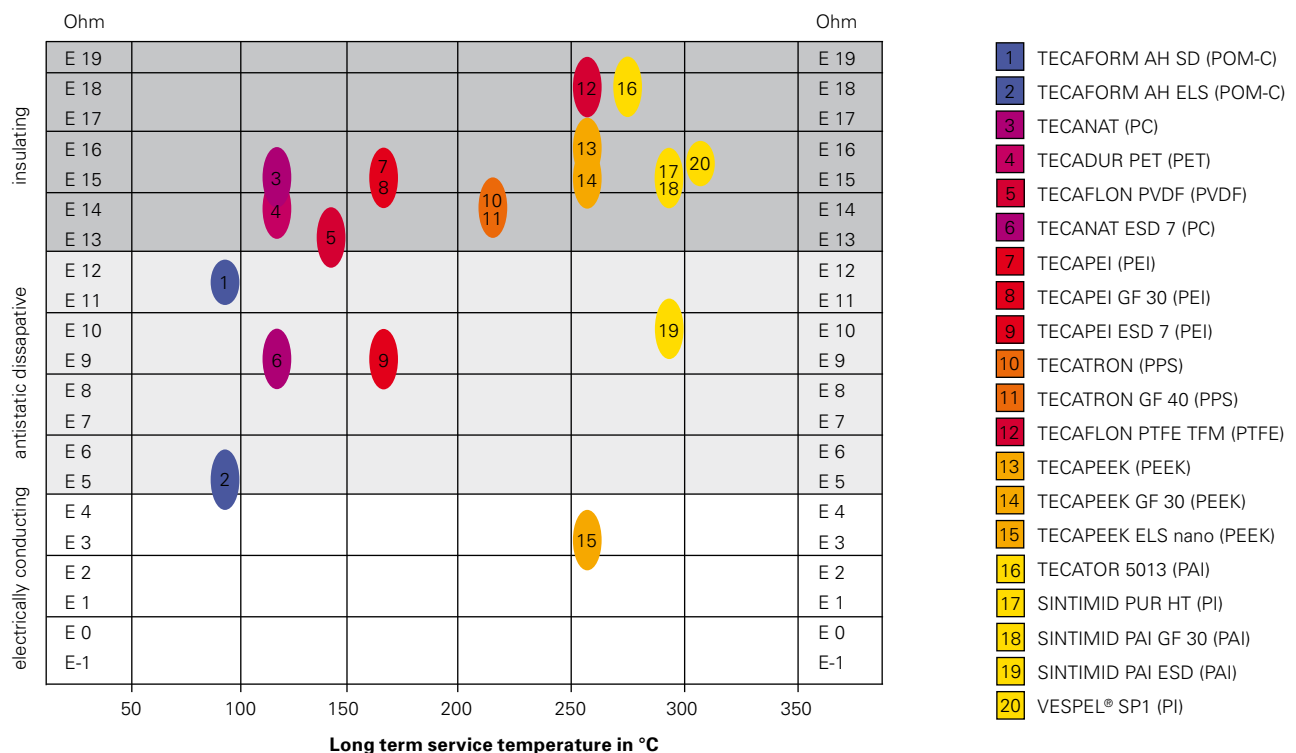
The plastics developed by ENSINGER for use in etching and cleaning applications provide the minimal coefficient of thermal expansion essential for precise handling, fixing and contact over a wide range of temperatures. Fibre reinforced plastics are capable of achieving values comparable to steel and aluminium.



Surface resistance

The insulating effect or static conductivity capability of ENSINGER high performance plastics is achieved by the selective addition of electrically active substances. These include special conductive carbon black, carbon fibres, conductive microfibrils with nanostructure or inherently conductive materials. Due to the risk of contamination is conductive carbon black,

mainly used for applications where the actual semi-conductor structures are closed and sealed. Carbon fibres, nanotubes and inherently conductive substances demonstrate higher abrasion resistance and therefore have a lower tendency to contamination. Here, electrical characteristic values can be kept within more easily definable limits.



Comprehensive engineering expertise enables innovative production techniques.



The comprehensive engineering expertise of ENSINGER industry specialists provides technically challenging and customised solutions. The result of intense development together with our customers is special customised materials. Customer-specific compounding of special modifications is possible even for minimal batch sizes.

Extrusion

The very latest process technologies and highly specialised expertise are essential to the manufacture of application-specific semi-finished products. ENSINGER is equipped to extrude all commonly used thermoplastic polymers to any required customer geometry. Our many years of experience in extrusion technology guarantee the very highest quality standard of the required material characteristics.

Compression Moulding

Alongside extrusion, ENSINGER also makes use of compression moulding as a production method for semi-finished products. This method is particularly suitable for high-temperature plastics with difficult processing properties such as PI, PEEK and PPS. High-grade semi-finished products and custom cast parts are manufactured using a special pressing technique. These are then used to produce ultra high precision parts.

From product development and material selection, tooling construction to shipment, our materials undergo a continuous process of quality assurance. A global network of production and sales facilities ensures that our products will reach you anywhere and on time.

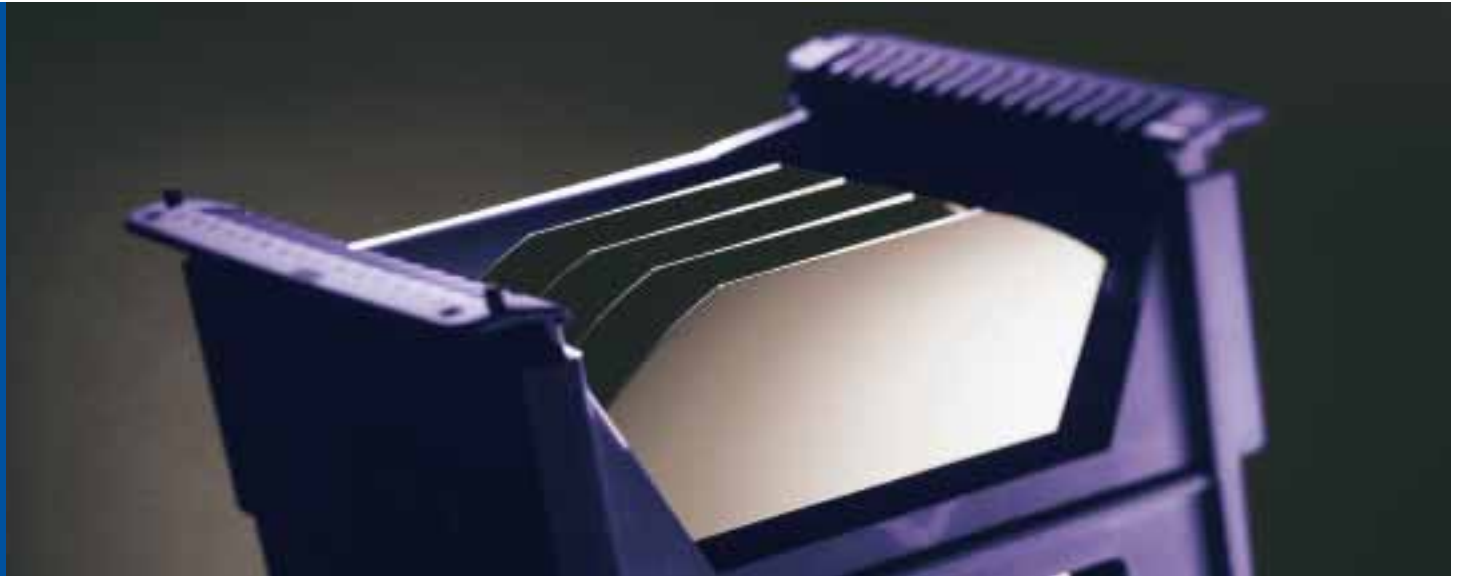
Injection moulding

ENSINGER injection moulded components conform to the stringent quality requirements prevailing in the semi-conductor production industry. The use of injection moulding techniques produces the ultra precise, complex geometries required for retaining fixtures or conveying applications. Our customers benefit here from our own internal toolmaking shop and our range of state-of-the-art high-performance equipment.

Machining

ENSINGER produces milled components to an outstanding standard of precision on the very latest CNC controlled machining centres. State-of-the-art machines are also available for machining turned components. In order to guarantee low-stress finished parts even when producing complex geometries involving the highest of tolerances, we carry out a heat treatment process to reduce material stress.

Typical applications.



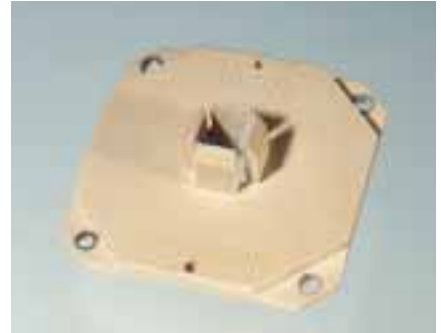
		High purity water systems	Chemical cleaning systems	Wafer-handling systems	Retainer systems	Wafer rings	Wafer wands	Wafer trays	Wafer carrier	Focus rings (plasma etching)	Clamp rings (plasma etching)	Water-etching (chemical)	Water-etching (plasma)	Wafer etching (chemical)	Wafer etching (plasma)	Heat exchangers	Vacuum tweezers	Chip-test-equipment	Test sockets for chips	Chip carriers	Burn-in-sockets	Insert for spring contacts	Contact sockets	Insulators	Contact plugs	
VESPEL® SP 1	PI							•	•	•	•	•					•					•	•	•		
SINTIMID HP	PI							•	•	•	•	•					•						•	•	•	
SINTIMID PAI GF	PAI GF								•												•	•	•			
SINTIMID PAI ESD	PAI ESD				•															•	•	•	•			
TECATOR 5013	PAI																	•			•		•			
TECAPEEK ELS nano	PEEK ELS	•	•				•	•								•	•	•						•	•	
TECAPEEK CMF	PEEK																			•				•	•	•
TECAPEEK	PEEK	•	•	•	•			•	•							•	•	•	•		•					
TECAPEI GF	PEI GF				•															•						
TECAPEI ESD 7	PEI ESD				•															•		•				
TECATRON	PPS			•	•	•										•				•						
TECAMAX SRP	PPP					•																				
TECAFLON PTFE TFM	TFM PTFE	•	•	•				•								•	•									
TECAFLON PVDF	PVDF	•	•	•												•	•									
TECANAT ESD 7	PC ESD				•				•											•						
TECADUR PET / TECAPET	PET				•															•				•	•	
TECAFORM AH SD	POM-C ESD				•															•						



Rollers.
VESPEL® SP 21.
 Suitable for clean room production, low outgassing.



Insulating sleeves.
VESPEL® SP1.
 High thermal resilience under high temperatures, electrically insulating.



Contact plate.
TECAPEEK.
 Very rigid and tough. Dimensionally stable.



Wafer handling wand.
TECAPEEK ELS nano.
 Electrically dissipative. High dimensional stability.



Centering insert in the wafer gripper.
VESPEL®.
 High thermal resilience.



Support comb.
TECAPEEK.
 High toughness, dimensionally stable, high chemical resistance.



Guide profile.
TECATRON GF 40.
 Very good tribological properties. Low thermal expansion.

ENSINGER High temperature plastics. Material standard values.

Mechanical properties

Trade name	DIN-abbreviation	Additives and/or colour	Service temperature °C long term	ρ g/cm ³	σ _S MPa	σ _R MPa	ε _R %	E _Z MPa	E _B MPa	H _k MPa	a _n kJ/m ²	σ _{B/1000} MPa	σ _{1/1000} MPa	μ -	V μ/km	Trade name	Mechanical properties									
																	Density (ASTM D 792, DIN EN ISO 1183)	Tensile strength at yield (ASTM D 638, DIN EN ISO 527)	Tensile strength at break (ASTM D 638, DIN EN ISO 527)	Elongation at break (ASTM D 638, DIN EN ISO 527)	Modulus of elasticity (ASTM D 638, DIN EN ISO 527)	Modulus of elasticity after tensile test (ASTM D 638, DIN EN ISO 527)	Hardness (all temperatures ISO 2009/1, DIN EN ISO 105, ISO 2009/2, 1)	Impact resistance (ISO 2009/1, DIN EN ISO 178)	Creep resistance with static load (see footnote 4)	Time to yield limit for 1% elongation
VESPEL® SP1	PI	brown	300	1,43		86 (a)	7,5 (a)	3275	3100					0,35		VESPEL® SP1										
SINTIMID PUR HT	PI	black	300	1,35		116	9	4000	4000		75 (c)		12	0,8		SINTIMID PUR HT										
SINTIMID PAI ESD	PAI	black	300	1,54	85		4	4500		93 (d)	21 (ai)					SINTIMID PAI ESD										
SINTIMID PAI GF 30	PAI GF 30	30% glass fibre	300	1,57		94	4	5800	6675		16					SINTIMID PAI GF 30										
TECATOR 5013	PAI	yellow-brown	260	1,42	147	137	21	3800	3750	E 86	142 (ai)					TECATOR 5013										
TECAPEEK	PEEK	natural, also black ⁽¹⁾	260	1,30	95		25	3000	4100	M99	o. Br. (c)			0,30-0,38		TECAPEEK										
TECAPEEK GF 30	PEEK GF 30	30% glass fibre	260	1,51		180	2,5	9500	10000	M103	60 (c)	36		0,38-0,46		TECAPEEK GF 30										
TECAPEEK ELS nano	PEEK CF	CNT, black	260	1,34		100	15	4100		M105	50 (c)					TECAPEEK ELS nano										
TECAPEEK CMF	PEEK		260	1,60		86	7	4500	4500	263 ⁽¹⁾	50					TECAPEEK CMF										
TECAPEEK PVX	PEEK CF CS TF	10% carbon fibre, graphite, PTFE, black	260	1,48		130	1,5	9500	8100	208 ⁽²⁾	30 (c)			0,11		TECAPEET PVX										
TECATRON	PPS	natural	230	1,35	75		4	3700	3600	190	50 (c)					TECATRON										
TECATRON GF 40	PPS GF 40	40% glass fibre, natural	230	1,64		185	1,9	14000	13000	320	45 (c)					TECATRON GF 40										
TECATRON PVX	PPS CF CS TF	10% carbon fibre, graphite, PTFE, black	230	1,47		115	1,5	10000		203 ⁽²⁾	20 (c)			0,21	0,69	TECATRON PVX										
TECASON S	PSU	translucent	160	1,24	80	6	> 50	2600		147	o. Br. (c)	42	22	0,4		TECASON S										
TECASON E	PES	translucent	180	1,37	90	6	40	2700		148	o. Br. (c)		20			TECASON E										
TECASON P	PPSU	coloured	170	1,29	70		> 50	2350	2600							TECASON P										
TECAPEI	PEI	translucent	170	1,27	105		> 50	3200	3300	140	4 (c)					TECAPEI										
TECAPEI ESD 7	PEI ESD 7	black	170	1,26		65	4	2760	2920	123 (r)	7,5 (ai)					TECAPEI ESD 7										
TECAPEI GF 30	PEI GF 30	30% glass fibre	170	1,51		165	2	9500	9000	165	40 (c)					TECAPEI GF 30										
TECAFLON PTFE TFM	PTFE		260	2,18	25		> 50		700	30	n. b. (c)	5	1,58	0,08-0,1	21	TECAFLON PTFE TFM										
TECAFLON ETFE	E/TFE		150	1,73	45		40	800		60 (d)	n. b. (c)			0,4		TECAFLON ETFE										
TECAFLON PVDF	PVDF		150	1,78	50		> 30	2000	2000	80	n. b. (c)	34	3	0,3		TECAFLON PVDF										
TECAFLON PVDF CF 8	PVDF CF 8	8% carbon fibre, black ⁽¹⁾	150	1,78		93	1	6000	6000					0,23		TECAFLON PVDF CF 8										
TECAFLON PVDF AS	PVDF	conductive carbon, black ⁽¹⁾	150	1,83	55	43	25	4200	4500	82 (d)	60 (ai)			0,23		TECAFLON PVDF AS										
TECAFLON PCTFE	PCTFE	natural	150	2,09		35	> 50	1400		70	n. b. (c)			0,35		TECAFLON PCTFE										
TECAMID 66 CF 20	PA 66 CF 20	20% carbon fibre, black	110	1,23		190/150*	2,5/6*	13500/11000*		187/200*	45 (c)			0,16-0,2	0,7	TECAMID 66 CF 20										
TECANAT	PC	transparent	120	1,20	60		130	2300		100	n. b. (c)	48	18	0,52-0,58	22	TECANAT										
TECANAT ESD 7	PC		120	1,22		62	8	2290	2340		6,4 (ai)					TECANAT ESD 7										
TECAPET	PET	natural, also in black ⁽¹⁾	110	1,37	88			3200		95	36 (c)		13	0,25	0,35	TECAPET										
TECAFORM AH	POM-C	natural	100	1,41	62		30	2700		145	n. b. (c)	40	13	0,32	8,9	TECAFORM AH										
TECAFORM AH ELS	POM-C	conductive carbon, black ⁽¹⁾	100	1,45	50		15	2000		M97(r)	>1000 (di)					TECAFORM AH ELS										
TECAFORM AH SD	POM-C	beige	100	1,33	45		> 25	1400	1450		100 (ai)			0,18		TECAFORM AH SD										
TECAFINE PP ELS	PP	conductive carbon, black	100	0,98	26	18	27	1200		71	30 (c)					TECAFINE PP ELS										

The information corresponds with current knowledge, and indicates our products and possible applications. We cannot give you a legally binding guarantee of the physical properties or the suitability for a specific application. Existing commercial patents are to be taken into account. A definite quality guarantee is given in our general conditions of sale.

Tests are carried out in a standard atmosphere of 23° C 50 RH according to DIN 50 014.

We reserve the right to make technical alterations.

These values represents the average of a number of individual measurements. Unless otherwise stated the test results apply to injection moulded samples.

Trade name	Thermal properties											Electrical properties						Miscellaneous data		
	T _m °C	T _g °C	HDT/A °C	HDT/B °C	°C	λ W/(K·m)	c J/(g·K)	α 10 ⁻⁵ /K	ε _r	tan δ	ρ _D Ω·cm	R ₀ Ω	E _d kV/mm	Stufe	W(H ₂ O) %	W _s %	-	-	-	Trade name
	Melting point (DIN 53765)	Glass transition temperature (DIN 53765)	Heat distortion temperature DIN EN ISO 75 method A	Heat distortion temperature DIN EN ISO 75 method B	Service temperature short term	Thermal conductivity (23°C)	Specific heat (23°C)	Coefficient of linear thermal expansion (23°C, ASTM D 696, DIN ISO 789, ASTM E 831)	Dielectric constant (106 Hz, ASTM D 150, DIN 53 483, IEC 250)	Dielectric loss factor (106 Hz, ASTM D 150, DIN 53 483, IEC 250)	Specific volume resistance (ASTM D 257, IEC 93, DIN IEC 60093)	Surface resistance (ASTM D 257, IEC 93, DIN IEC 60093)	Dielectric strength (ASTM D 149, DIN EN 60093)	Resistance to tracking (DIN EN 60112, VDE 0302 part 1)	Moisture absorption to equilibrium (DIN EN ISO 62)	Water absorption at saturation washing soda	Resistance to hot water	Flammability acc. to UL-Standard 94	Resistance to weathering ⁽⁸⁾	
VESPEL® SP1			360	360	360	0,35	1,13	5,4	3,55	0,0034	10 ¹⁴ -10 ¹⁵	10 ¹⁵ -10 ¹⁶	22		1,3			VO	-	VESPEL® SP1
SINTIMID PUR HT		360-375	368		350	0,22	1,04	4,9	3,1	0,003	10 ¹⁷	10 ¹⁶	20		2,6	3,6	(+)	VO	(+)	SINTIMID PUR HT
SINTIMID PAI ESD		340			320			3,3			10 ⁹ -10 ¹¹	10 ⁹ -10 ¹¹			2,1		(+)	VO	(+)	SINTIMID PAI ESD
SINTIMID PAI GF 30		330	320		320			3,3			10 ⁹ -10 ¹¹	10 ⁹ -10 ¹¹					(+)	VO	(+)	SINTIMID PAI GF 30
TECATOR 5013		275	278		270	0,26	0,24	3,1	3,9	0,031	> 10 ¹⁸	> 10 ¹⁸	23,6		2,5	4,5	+	VO	-	TECATOR 5013
TECAPEEK	343	143	140	182	300	0,25	0,32	5	3,2-3,3	0,001-0,004	10 ¹⁶	10 ¹⁵	20		0,1	0,5	+	VO	-	TECAPEEK
TECAPEEK GF 30	343	143	315		300	0,43		2		0,004	10 ¹⁵	10 ¹⁵	24,5		0,1	0,1	+	VO	-	TECAPEEK GF 30
TECAPEEK ELS nano	343	143			300	0,9		1,5			10 ² -10 ⁴	10 ¹ -10 ³			0,1	0,2	+	VO	+	TECAPEEK ELS nano
TECAPEEK CMF			219	260	300	0,43	1,04	4,4	4,1	<0,0050	>10 ¹⁴ (2)	>10 ¹⁴ (2)	15,2		0,0002			VO (1,5 mm)		TECAPEEK CMF
TECAPEEK PVX	343	143	277		300	0,24		2,2			3x10 ⁵	5x10 ⁶			0,1	0,1	+	VO	+	TECAPEEK PVX
TECATRON	280	90	110		260	0,25		5			10 ¹³	10 ¹⁵			0,01		+	VO	-	TECATRON
TECATRON GF 40	280	90	260		260	0,25	1,18	ca. 3	4	0,004	10 ¹⁴	10 ¹⁵	20	KC 175	0,02	1	+	VO	-	TECATRON GF 40
TECATRON PVX	280	90			260			3-4(2)			4x10 ⁵ (2)	1x10 ⁶ (2)			0,02		+	VO	+	TECATRON PVX
TECASON S		180	169	181	180	0,25	1	5,5	3,1	0,005	10 ¹⁶	10 ¹⁴	42	KA 1 KB 175	0,2	0,8	+	VO	-	TECASON S
TECASON E		225	204	214	220	0,18	1,12	5,5	3,5	0,005	10 ¹⁶	10 ¹⁴	40		0,7	2,1	+	VO	-	TECASON E
TECASON P		220	207	214	190	0,35		5,6	3,45		10 ¹⁵	10 ¹³	15		0,37	1,1	+	VO	+	TECASON P
TECAPEI		217	180	200	200	0,22		5	3,15	0,001	10 ¹⁵	10 ¹⁵	33		0,7	1,25	+	VO	-	TECAPEI
TECAPEI ESD 7					200			5,2			10 ⁶ -10 ⁸	10 ⁸ -10 ¹⁰				0,25		VO	+	TECAPEI ESD 7
TECAPEI GF 30		217	210	215	200	0,23		2	3,7	0,007	10 ¹⁵	10 ¹⁵	30		0,5	0,9	+	VO	-	TECAPEI GF 30
TECAFLON PTFE TFM	327	-20	55	121	260	0,25		12	2,1	0,0002	10 ¹⁸		48				+	VO	+	TECAFLON PTFE TFM
TECAFLON ETFE	267	-100	71	105	150	0,24	0,9	13	2,6	0,001	>10 ¹⁶	> 10 ¹⁶	40		<0,05	0,03	+	VO	+	TECAFLON ETFE
TECAFLON PVDF	172	-18	95	140	150	0,11	1,2	13	8	0,06	10 ¹⁴	10 ¹³		KA 1	<0,05	<0,05	+	VO	+	TECAFLON PVDF
TECAFLON PVDF CF 8	172	-18			150			3,6			10 ³ -10 ⁵	10 ⁵ -10 ⁷			0,04		+	VO	+	TECAFLON PVDF CF 8
TECAFLON PVDF AS	174	-30			150			1,2-1,4			10 ² -10 ⁴	10 ² -10 ⁴			0,07		+	VO	+	TECAFLON PVDF AS
TECAFLON PCTFE	216	52		126	180	0,24	0,9	6,5	2,5	0,02	10 ¹⁶	10 ¹⁶	55-81	KA 3c KB>600	<0,05		+	VO	+	TECAFLON PCTFE
TECAMID 66 CF 20	260	72/5*	245	250	170	0,43	1,8	5,5(2)			10 ² -10 ⁴ (2)	10 ² -10 ⁴ (2)			2,2	6,5	(+)	HB	+	TECAMID 66 CF 20
TECANAT		148	135	140	140	0,19	1,2	7	3	0,006	10 ¹³	10 ¹⁵	27	KA 1	0,15	0,36	-	HB	-	TECANAT
TECANAT ESD 7								6,7			10 ⁷ -10 ⁹	10 ⁸ -10 ¹⁰			0,1	0,3	-	V2	+	TECANAT ESD 7
TECAPET	255	70	95	170	170	0,24	1,1	7	3,2	0,0021	10 ¹³	10 ¹⁵	60	KC 350	0,25	0,5		HB		TECAPET
TECAFORM AH	165	-60	110	160	140	0,31	1,5	10	3,5	0,003	10 ¹⁴	10 ¹⁴	>50	KA 3c	<0,3	0,5	(+)	HB	-	TECAFORM AH
TECAFORM AH ELS	165	-60	89		140			11			10 ² -10 ⁴	10 ² -10 ⁴			<0,3	0,5	(+)	HB	+	TECAFORM AH ELS
TECAFORM AH SD	165	-60	88		140	0,3		6,5			10 ⁹ -10 ¹¹	10 ⁹ -10 ¹¹			0,25	~0,8	(+)	HB	-	TECAFORM AH SD
TECAFINE PP ELS	165	-18	150	90	120	0,2					<10 ³	<10 ⁴			<0,1	<0,1	(+)	HB	-	TECAFINE PP ELS

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NB: For polyamides the values strongly depend on the humidity contents.
 * humid, after storage in standard atmosphere 23°C 50 RH (DIN 50 014) until saturation.
 + = Resistant
 (+) = Limited resistance
 - = Not resistant
 (depending on concentration, time and temperature)

(1) When plastics are listed under „additives and colour“ as available „also in black“, the electrical properties are not valid for the black variant.
 (2) Testing on semi-finished products.
 (3) Expected values.
 (4) Impact resistance is measured with different methods.
 The values in the following tables are marked with the following letters:
 (c) Charpy: DIN EN ISO 179: a_n kJ/m²
 (ai) Izod: ASTM D 256: a_n J/m
 (di) Izod: DIN EN ISO 180, a_n kJ/m²
 (k) Notch impact strength: DIN EN ISO 179: a_n kJ/m²

Ensinger Germany

Headquarters and European Stock

ENSINGER GmbH
Rudolf-Diesel-Straße 8
71154 Nufringen
Telephone +49 (0) 70 32 / 8 19-0
Fax +49 (0) 70 32 / 8 19-100
www.ensinger-online.com
info@ensinger-online.com

Germany

ENSINGER GmbH
Thierlsteiner Straße 14
93413 Cham
Telephone +49 (0) 99 71 / 3 96-0
Fax +49 (0) 99 71 / 3 96-5 20
info@ensinger-online.com

ENSINGER GmbH

Borsigstraße 7
59609 Anröchte
Telephone +49 (0) 29 47 / 97 22-0
Fax +49 (0) 29 47 / 97 22-77
info@ensinger-online.com

ENSINGER GmbH

Mooswiesen 13
88214 Ravensburg
Telephone +49 (0) 7 51 / 3 54 52-0
Fax +49 (0) 7 51 / 3 54 52-22
Internet: www.thermix.de
info@thermix.de

Ensinger Great Britain

Great Britain

ENSINGER Limited
Wilfried Way
Tonyrefail
Mid Glam CF39 8JQ
Telephone +44 (0) 14 43 / 67 84 00
Fax +44 (0) 14 43 / 67 57 77
http://www.ensinger.ltd.uk
sales@ensinger.ltd.uk
Further Factories in GB:
Waterlooville, Hampshire
PO7 7XX
Irlam, Manchester
M44 6GD
Bridgwater, Somerset
TA6 6TS
Bishop's Stortford, Herts
CM23 5PE
East Kilbride, Glasgow
G74 4QZ
Birmingham, West Midlands
B7 4SN

Ensinger worldwide

Austria

ENSINGER Sintimid GmbH
Werkstraße 3
4860 Lenzing
Telephone +43 (0) 76 72 / 7 01 28 00
Fax +43 (0) 76 72 / 9 68 65
office@ensinger-sintimid.at

ENSINGER TECARIM GmbH

Floetzerweg 184
4030 Linz
Telephone +43 (0) 7 32 / 38 63 84-0
Fax +43 (0) 7 32 / 38 63 84-10
office@ensinger.at

Brazil

ENSINGER Ltda.
Av. São Borja 3185
93.032-000 São Leopoldo-RS
Telephone +55 (0) 3 51 / 35 79 88 00
Fax +55 (0) 3 51 / 35 88 28 04
ensinger@ensinger.com.br

Canada

ENSINGER Plastifab
8115 Lafrenai Street
Montréal, Québec H1P 2B1
Telephone +1 (5 14) 3 25-98 40
Fax +1 (5 14) 3 25-52 22
e-mail: infoprod@plastifab.ca

China

ENSINGER International GmbH
Rm 2301.23/F
Nanzheng building No. 580
Nanjing Road (W)
Shanghai 200041
Telephone +86-21-52 28 51 11
Fax +86-21-52 28 52 22
info@ensinger-china.com

Czech Republic

ENSINGER s.r.o.
Průmyslová 991
P.O. Box 15
33 441 Dobřany
Telephone +420 (0) 37 / 7 97 20 56
Fax +420 (0) 37 / 7 97 20 59
ensinger@ensinger.cz

France

ENSINGER France SARL
ZAC les Batterses
ZI Nord
01700 Beynost
Telephone +33 (0) 4 78 55 36 35
Fax +33 (0) 4 78 55 68 41
contact@ensinger.fr

Italy

ENSINGER Italia S.R.L.
Via Franco Tosi 1/3
20020 Olcella di Busto Garolfo
Telephone +39-03 31 / 56 83 48
Fax +39-03 31 / 56 78 22
home@ensinger.it

Japan

ENSINGER Japan Co., Ltd.
Shibakoen Denki Bldg. 7F
1-1-12, Shibakoen, Minato-ku
Tokyo 105-0011
Telephone +81 (0) 3-54 02-44 91
Fax +81 (0) 3-54 02-44 92
y.okada@ensinger.jp

Poland

ENSINGER Polska Sp. z o.o.
ul. Spółdzielcza 2a
64-100 Leszno
Telephone +48 (0) 65 / 5 29 58 10
Fax +48 (0) 65 / 5 29 58 11
info@ensinger.pl

Singapore

ENSINGER International GmbH
(Singapore Branch)
63 Hillview Avenue # 04-07
Lam Soon Industrial Building
Singapore 669569
Telephone +65-65 52 41 77
Fax +65-65 52 51 77
info@ensinger.com.sg

Spain

ENSINGER S.A.
Girona, 21-27
08120 La Llagosta
Barcelona
Telephone +34 9 02 10 19 16
Fax +34 9 35 74 27 30
info@ensinger-plastics.com

Sweden

ENSINGER Sweden AB
Box 185
Kvartsgatan 2C
74523 Enköping
Telephone +46 (0) 1 71 47 70 50
Fax +46 (0) 1 71 44 04 18
info@ensinger.se

USA

ENSINGER Inc.
365 Meadowlands Boulevard
Washington, PA 15301
Telephone +1 (7 24) 7 46-60 50
Fax +1 (7 24) 7 46-92 09
ensinger@ensinger-ind.com

Your specialist dealer: