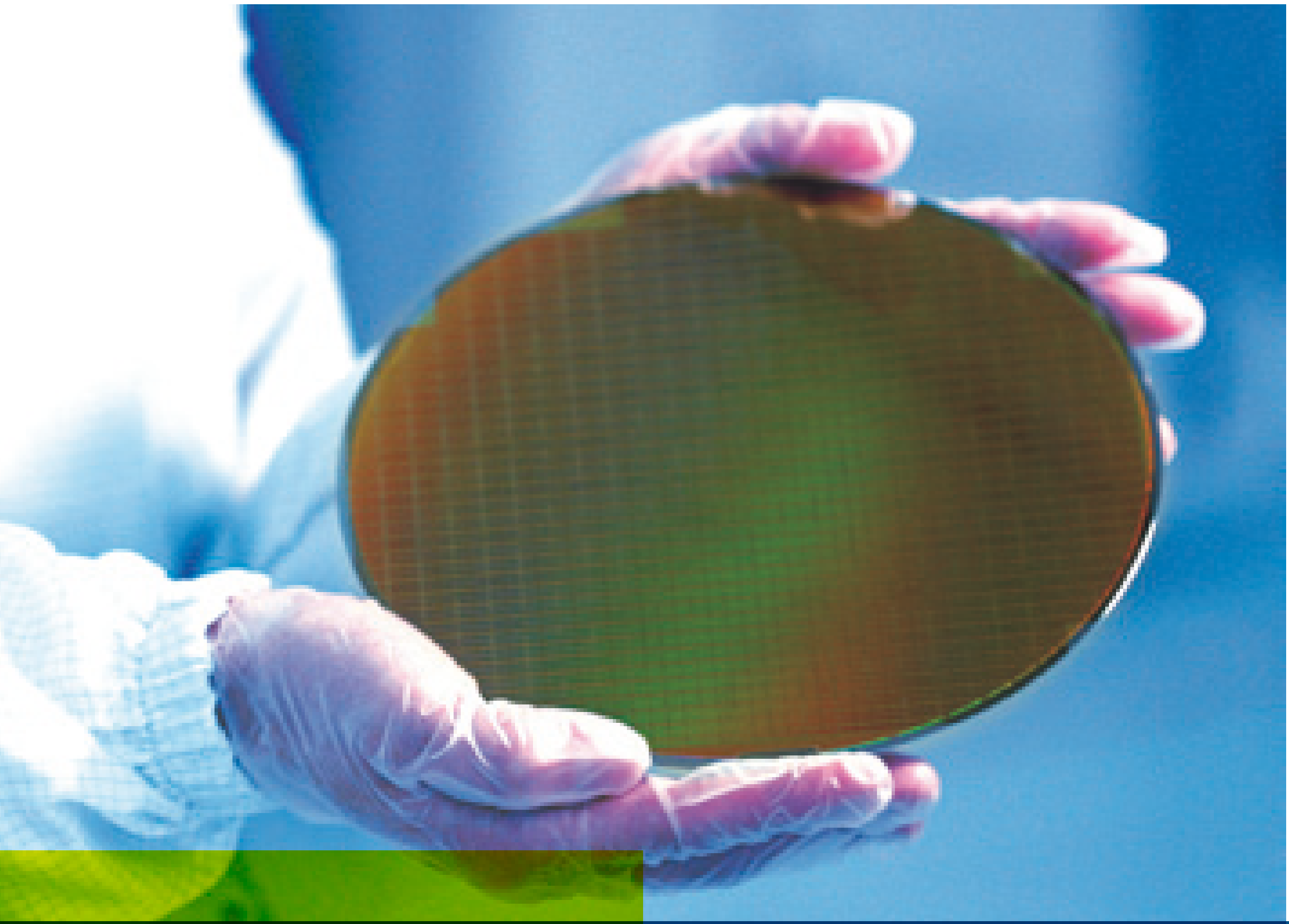
Ensinger



Stock shapes

Plastics used in semiconductor technology

Content

In many areas of industry technical plastics play a vital role in improving the efficiency and competitiveness of customer applications. Lightweight, versatile plastics have a proven track record stretching back over many years in the processing and testing of semiconductor products. Their success is based on a combination of material benefits which are brought to bear even under harsh chemical or different temperature level conditions. Moreover the trend to even smaller and more powerful integrated circuits (ICs) raises new challenges to the entire production chain, from cutting the raw wafer to the final testing stage, which can be met by the deployment of technical plastics.

In the process of semiconductor production, technical plastics can be used in a wide range of applications. The special demands imposed upon these materials are addressed by the outstanding properties of 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 out-gassing under vacuum

Ensinger quality in the world of semiconductor products

Ensinger offers a dedicated broad portfolio for semiconductor applications to meet the increasing demand for extremely high quality solutions. This is particularly important because failures in production or even a halt to the process can cause immense costs. Ensinger consequently feels an obligation to invest particular care and to conduct special testing when producing products for the semiconductor industry. This constitutes special raw material specifications, initial raw material testing and intermediate quality testing of products, but is not limited to machining tests, surface inspection or even customer specific tests.

In many cases, plastics provide convincing alternatives when it comes to the implementation of unusual technical applications. Ensinger offers a wide portfolio of products for applications in the semiconductor industry.

To make sure that we permanently meet all the relevant demands of the industry, we have set up a special range of semiconductor products with stock items or short-term availability. The dimensions and tolerances we offer for the tubes designed for production of retaining rings are adapted to meet the special demands of the semiconductor industry for closer finished ring sizes.

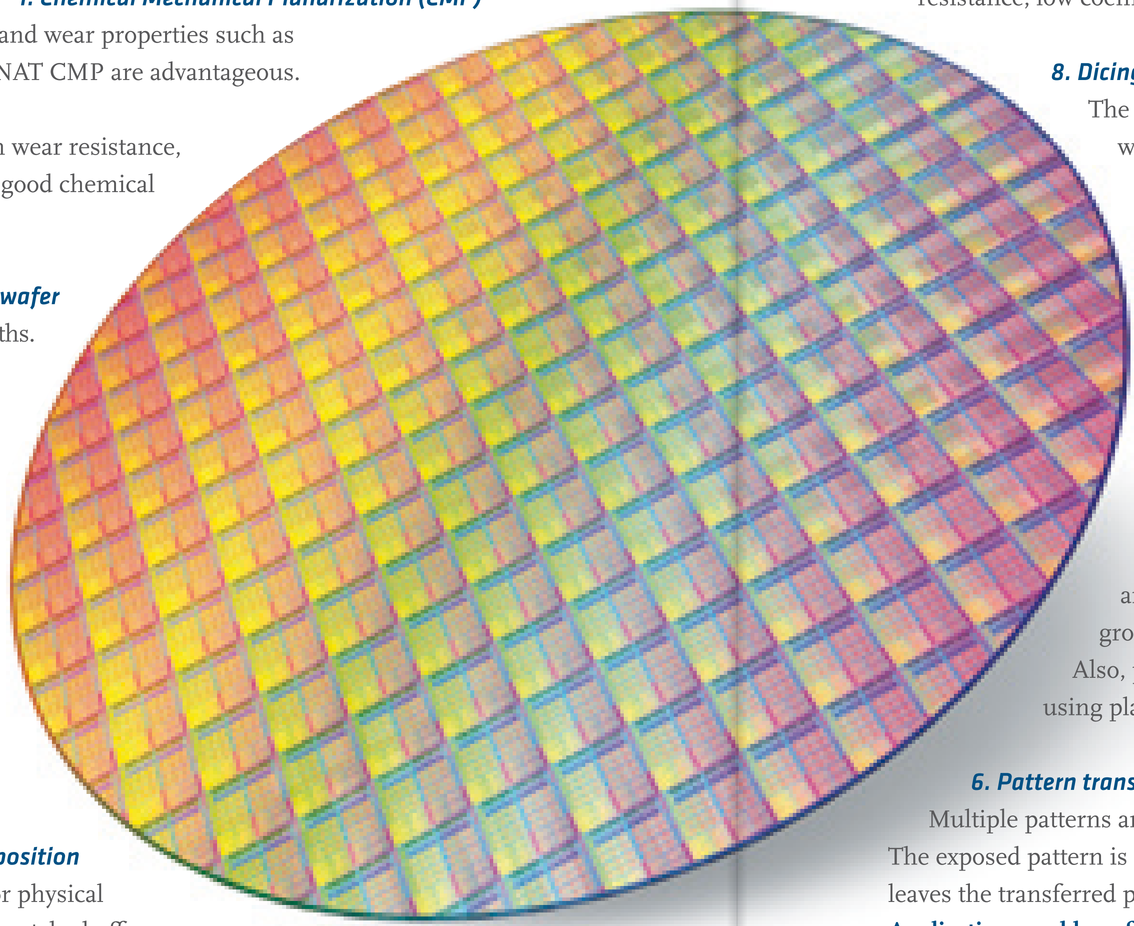
We develop plastics with special properties and produce high quality semi-finished products and finished parts for challenging customer applications.

Additionally, Ensinger can provide full documentation and traceability on all materials. This is done by process control which is well proven in other sensitive industries and across all manufacturing types such as compounding, stock shapes and component production through injection moulding and machining.

Ensinger is certified according to ISO 9001:2008 and has implemented a quality management system in line with international standards that is firmly rooted in our corporate procedures.

Plastics in application: wafer processing cycle

Many of the process stages involved in semiconductor production require 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.



1. Chemical Mechanical Planarization (CMP)

During these processing stages, plastics with good chemical resistance and wear properties such as TECATRON CMP, TECAPEEK CMP, TECADUR PET CMP and TECANAT CMP are advantageous.

Applications and benefits:

→ Retaining rings made of TECATRON CMP or TECAPEEK CMP; high wear resistance, low contamination, low defectivity rate, high temperature resistance, good chemical resistance

2. Cleaning of the wafer

The sliced and polished wafers are cleaned in a wide range of chemical baths.

Applications and benefits:

→ Cleaning tanks made of TECAPEEK, TECAFLON PVDF and other fluoropolymers: excellent chemical resistance

→ Vacuum grippers from TECATRON or TECAPEEK: low out-gassing in vacuum and high mechanical strength

→ Wafer containers and front opening unified pods (FOUP) made of TECATRON or TECAPEEK: high mechanical stability

3. Oxidation

Oxygen or water vapour reacts chemically with the silicon wafer surface at high temperatures to form thin uniform layers of silicone dioxide.

4. Deposition

Deposition may occur by chemical, vapour (CVD) or physical processes. A thin coat of metal is deposited and later etched off.

Applications and benefits:

→ Wafer clamp rings made of TECASINT for high temperature, high purity, high wear resistance

→ Wafer handling systems made of TECAPEEK ELS nano for high temperature stability, electrostatic dissipative behaviour

5. Photo resist coating

A photo sensitive material is spread evenly over the wafer surface. It will be used for transfer of layer patterns to the wafer.

Applications and benefits:

→ Wafer chuck from TECASINT or TECAPEEK: low out-gassing, dimensional stability, chemical resistance, wear resistance

9. Testing

Packaged chips are functionally tested for electrical performance.

Applications and benefits:

→ Test sockets made of e.g. TECASINT 5201 SD, 5051 and 4111, TECATOR 5013, TECAPEEK TS, TECAPEEK CMF, TECAPEEK ELS nano, TECAPEEK, TECATRON, TECAPEI GF30: high strength, wear resistance, high temperature resistance, low coefficient of thermal expansion

8. Dicing (cutting), die attach, wire bond, encapsulation

The wafer is diced into separate chips. Individual chips are mounted in a suitable package, fine wires connect each chip's bonding pads with leads in the package. The package is sealed for mechanical and environmental protection.

7. Etching

Reactive gases etch away the exposed area to create a dimensional pattern on the wafer surface. (repeated for each layer)

Applications and benefits:

→ Wafer retaining rings made of TECASINT or TECAPEEK: high temperature resistance, low out-gassing, dimensional stability, chemical resistance

Coating and etching processes

Ultra high purity silicone is used as a substrate for the semiconductor structure, which calls for dimensional accuracy in the nanometre range. Highly caustic acids and alkalines as well as detergents and solvents are involved in generating these nanostructures. Plastics belonging to the fluoropolymer group as well as TECAPEEK and TECATRON have proved highly successful for this type of application. Also, plastics such as TECASINT and TECAPEEK are commonly used for technologies such as dry etching using plasma technology.

6. Pattern transfer, pattern development and bake

Multiple patterns are transferred from the reticle to the coated wafer by a wafer stepper. The exposed pattern is developed in a chemical solution which removes the soluble portion and leaves the transferred pattern, which is then baked for increased adhesion.

Applications and benefits:

→ Wear and transfer oven components in high temperature applications made of TECASINT

Handling and cleaning (in different process steps)

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, out-gassing free and dimensionally stable materials are used, which are of the highest purity.

Applications and benefits:

→ Cleaning tanks, vacuum grippers, wafer container made of TECASINT 5201, TECAPEEK ELS nano and TECAFLON PVDF: electrostatic dissipative, excellent dimensional stability, high purity, chemical resistance, wear resistance.

Typical applications of technical plastics in the semiconductor industry

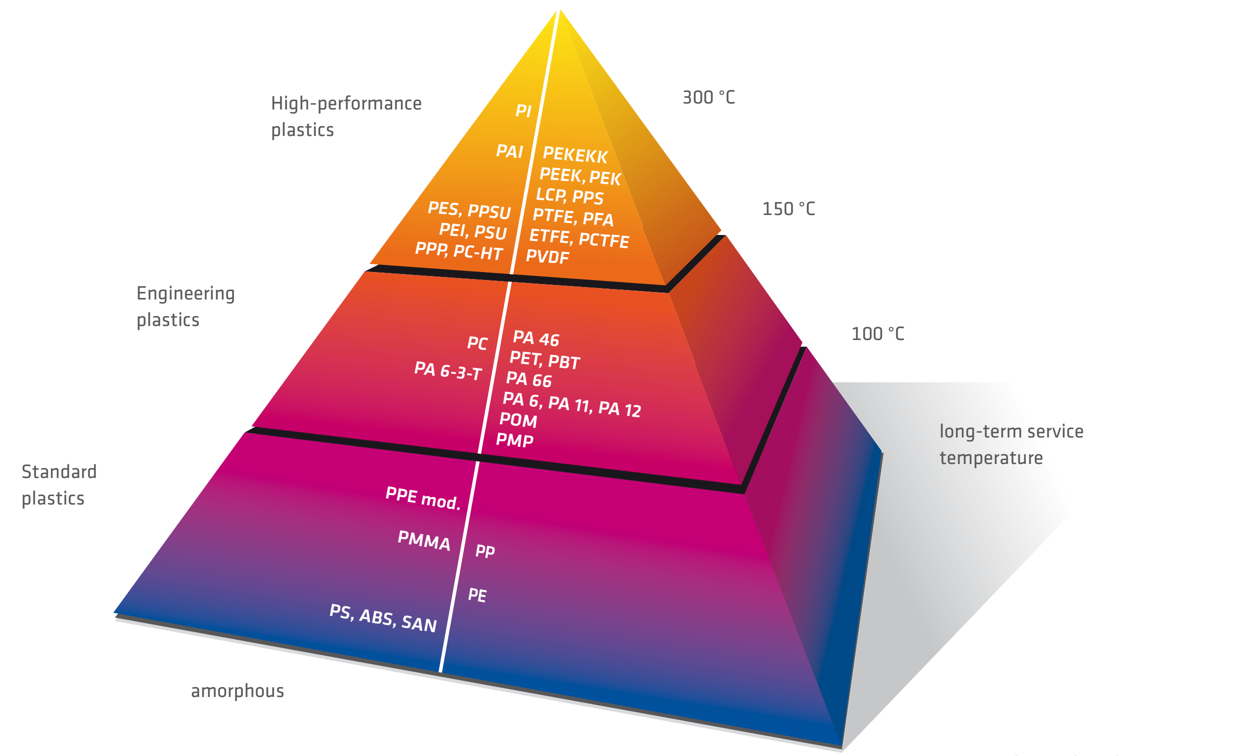
		CMP applications	Further semiconductor processes														Back-end applications			
		Retaining rings	High purity water systems	Chemical cleaning systems	Wafer handling systems	Wafer carrier	Wafer etching (chemical)	Wafer etching (plasma)	Clamp rings (plasma etching)	Focus rings (plasma etching)	Heat exchangers	Vacuum tweezers	Chip carriers	Insulators	Contact sockets	Contact plugs	Chip test equipment	Test sockets for chips	Burn in sockets	Insert for spring contacts
TECASINT 5201 SD	PAI				●											●	●	●	●	
TECASINT 5051	PI																●	●	●	
TECASINT 4111	PI																●	●	●	
TECASINT 4011	PI						●		●	●		●					●	●	●	●
TECASINT 2011	PI						●		●	●		●								●
TECATOR 5013	PAI											●	●				●	●	●	
TECAPEEK CMP	PEEK	●																		
TECAPEEK SE	PEEK	●																		
TECAPEEK	PEEK		●	●	●	●		●			●	●	●	●	●		●	●	●	
TECAPEEK GF30	PEEK														●		●	●	●	
TECAPEEK TS	PEEK																●	●	●	
TECAPEEK CMF	PEEK																●	●	●	
TECAPEEK ELS nano	PEEK				●	●					●	●			●	●	●	●	●	
TECATRON CMP	PPS	●																		
TECATRON SE	PPS	●																		
TECATRON	PPS			●	●	●	●	●			●		●							
TECATRON GF40	PPS														●		●	●	●	
TECAPEI GF30	PEI														●		●	●	●	
TECAFLON PVDF	PVDF		●	●	●			●			●									
TECAFLON PTFE	PTFE		●	●				●			●									
TECANAT CMP	PC	●																		
TECADUR PET CMP	PET	●																		
TECADUR PET	PET				●									●	●					

Product portfolio
The basis for wide-ranging applications

We offer a wide spectrum of high-performance and engineering materials for applications in the semiconductor industry. Potential applications are in front-end processes such as silicon manufacturing, plasma etching, photo-lithography, CMP and wafer cleaning, but also in back-end processes such as chip handling and device testing and much more.

Our general product portfolio includes:

→ TECAFINE (PE)
→ TECAFORM (POM)
→ TECAMID (PA)
→ TECAST (PA 6 C)
→ TECAPET (PET)
→ TECANAT (PC)
→ TECAFLON (PTFE, PVDF)
→ TECASON (PSU, PPSU, PES)
→ TECATRON (PPS)
→ TECAPEEK (PEEK)
→ TECATOR (PAI)
→ TECASINT (PI)



Classification of plastics

A specific portfolio for CMP, back-end applications and further semiconductor processes can be found on pages 8, 16 and 18.

Special materials for CMP processes

Ensinger offers a broad and specialized portfolio for CMP applications:

- → TECATRON CMP (PPS)
- → TECATRON SE (PPS)
- → TECAPEEK CMP PEEK)
- → TECAPEEK SE (PEEK)
- → TECANAT CMP (PC)
- → TECADUR PET CMP (PET)

Function:

The Chemical Mechanical Planarization (CMP) process is one of the key steps in silicone wafer production. With the migration towards larger wafer sizes, smaller chips with narrower line widths and feature sizes, engineers are always searching for new materials to meet their needs. Therefore CMP applications require an outstanding product performance in many different areas, such as high chemical resistance to slurries, high wear rates, increased sensitivity to contamination sources and an excellent overall process performance during the total lifetime of the ring.

Outlook:

Ensinger‘s striving towards development includes preparations to produce stock shapes (including tubing) in sizes supporting 450 mm (next wafer generation) component manufacturing.

Benefits:

With its specialized and broad portfolio of materials for CMP applications, Ensinger can always offer the right product of choice for the best cost of ownership.

- → Higher yields and improved throughput due to less microscratching of the wafer
- → Extended wearlife and best in class uniformity results in higher processing and product performance
- → Set up and robust speed, product consistency
- → Overall cost systems reduction and proven return on investment through improved cost of ownership

TECATRON CMP (PPS)

- → Higher abrasion and wear resistance compared to TECATRON SE
- → Improved toughness and machinability
- → Very good chemical resistance
- → Very good thermal and mechanical properties
- → Long-term service temperature up to 230 °C
- → High dimensional stability and low creep tendency
- → Low water absorption

TECATRON SE (PPS)

- → High dimensional stability and low creep tendency
- → Very good chemical resistance
- → Very good thermal and mechanical properties
- → Long-term service temperature up to 230 °C
- → Extreme hardness and rigidity
- → Low water absorption

TECAPEEK CMP (PEEK)

- → Higher ductility compared to TECAPEEK SE
- → Improved tribological properties compared to TECAPEEK SE
- → Very good chemical resistance
- → Excellent mechanical properties
- → High stress crack resistance
- → Good dimensional stability and easy machining properties
- → Long-term service temperatures of up to 260 °C

TECAPEEK SE (PEEK)

- → Very good chemical resistance
- → Excellent mechanical properties
- → High stress crack resistance
- → Good dimensional stability and easy machining properties
- → Long-term service temperatures of up to 260 °C
- → Excellent tribological properties

TECANAT CMP (PC)

- → High toughness
- → Electrically insulating
- → Good machinability
- → Easy to polish
- → Good heat deflection temperature
- → Sensitive to stress cracking
- → Good welding and bonding properties

TECADUR PET CMP (PET)

- → High strength
- → Good slide and wear properties
- → Good wear resistance
- → Good welding and bonding properties
- → Water resistant up to 60 °C
- → High toughness
- → Good chemical resistance
- → High stiffness

Technical data for CMP applications

CMP applications require products with superior performance regarding various aspects. Ensinger CMP grades have been thoroughly tested for quality, wear lifetime and several other key attributes.

In modern polishing machines, the retaining ring is pressed against the polishing pad. Due to the abrasive additives and chemistry in the slurry, the Chemical Mechanical Planarization (CMP) process causes wear on the retaining ring as it evens out irregular wafer topography, resulting in a flat wafer surface.

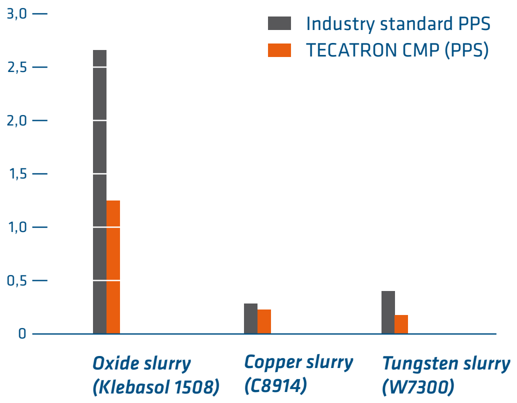
Wear / lifetime

Wear lifetime is the defined property of retaining ring selection criteria, as the longer the retaining ring lifetime, the greater the number of wafers that can be planarized before production is halted to change consumable sets in CMP production equipment.

TECATRON CMP (PPS) demonstrated a lifetime factor greater than 2x over the industry standard PPS in oxide slurry and superior wear rate also in copper and tungsten slurry, as measured recently on production equipment by Ebara Technology, U.S.

Wear rate, UM/min. *[lower value = longer wear]*

Conditions:
pad: IC1000K/SubaIV; process: TT/TR = 90/91 rpm,
TRP (RRP) = 5psi, run = 3hrs

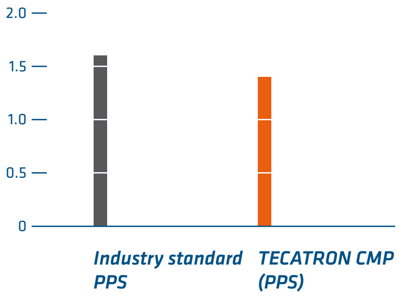


Removal rate (including edge)

Removal rate is the rate at which the CMP process removes excess material to provide a globally planarised wafer surface.

Recent CMP testing conducted by Ebara Technology, U.S. revealed that TECATRON CMP (PPS) was comparable to the industry standard PPS.

WIWNU % (oxide slurry) CS, scan



Defectivity / microscratching

Full process control of the CMP process is as important as material wear properties. Avoiding scratches on the wafer has a direct correlation to wafer throughput and yield.

TECATRON CMP (PPS) has demonstrated superior defectivity and microscratching properties in production tool testing, as performed by Ebara Technology, U.S.

Break In Time

Another CMP cost driver is the time needed following the replacement of process consumables such as retaining rings, until the CMP process can be restarted. The faster the tool can go back into production, the less impact on total productivity.

Retaining rings made of TECATRON CMP (PPS) have demonstrated break-in times comparable to current industry standard PPS on production tools at Ebara Technology, U.S.

Buehler wear testing

The product lifetime of retaining rings is highly influenced by the material loss under rotation and pressure in the chemical surrounding of the CMP process. This can be simulated with the Buehler wear test. It is a theoretical test which gives indication on the expected behaviour and allows direct comparison of different materials under the same test conditions.

Buehler wear data

[percent volume material loss]

Purity

To reduce the risk of metal contamination when manufacturing components for the semiconductor industry, any contact with metal material must be avoided, even from the plastic component. Ensinger high-performance plastics constantly meet or exceed these requirements and have therefore been tested by industry recognized laboratories on 16 common elements. Of these, the most important are:

	TECATRON CMP	TECATRON SE	TECAPEEK CMP	TECAPEEK SE	TECADUR PET CMP
Aluminium (Al)	<1	<1	<1	<1	<1
Calcium (Ca)	<12	<4	<10	<10	n.t.
Copper (Cu)	<1	<1	<1	<1	n.t.
Iron (Fe)	<2	<2	<4	<3	<1
Magnesium (Mg)	<1	<1	<6	<1	<1
Potassium (K)	<1	<1	<1	<1	<1
Zinc (Zn)	<1	<1	<1	<1	n.t.

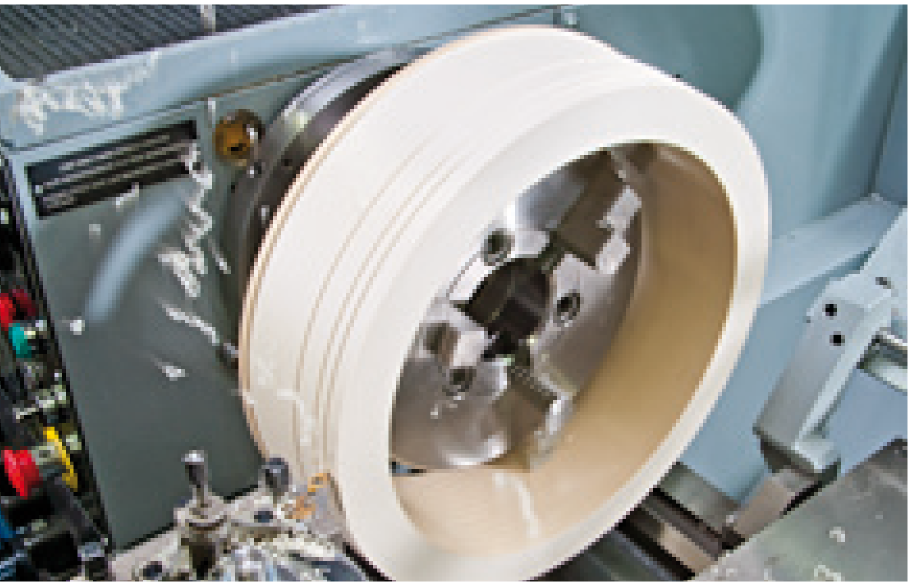
Test in accordance with ICP-MS, concentration levels stated in ppm; (n.t. = not tested)

Machinability

For high quality retainer rings, excellent machinability is an absolute requirement. Good dimensional stability, precise flatness, roughness and roundness of the retainer ring highly influence the quality of the CMP process and help to avoid scratches on the wafers.
In order to support cost-efficient machinability, high toughness and good swarf build-up of the material are important to prevent chipping and scrap and to save deburring time.

Ensinger TECATRON CMP and TECAPEEK CMP, our new special CMP materials, offer longer wear and lifetime in the final application and also improved machinability:

- → Easy to machine (shorter processing times)
- → Improved ductility (improved processing productivity)
- → Long swarf, no powder formation (higher processing performance)
- → Good deburring (system cost reduction)
- → Reduced chipping (less scrap, better yield)
- → Good dimensional stability (better product performance)

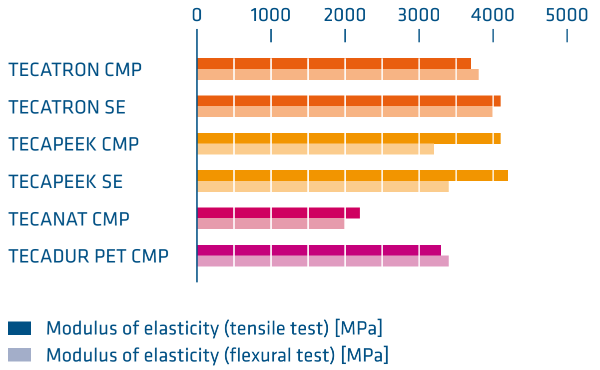


Machinability is an essential part in the processing of retaining rings.

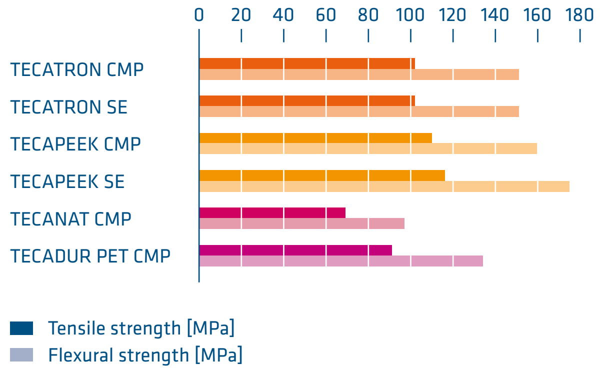
Mechanical data

Excellent mechanical properties are important for efficient machinability of the retaining ring, less scrap during production of the ring and faster equipment set-up in the semiconductor fabrication plant (fab) which means less down-time and greater production output.

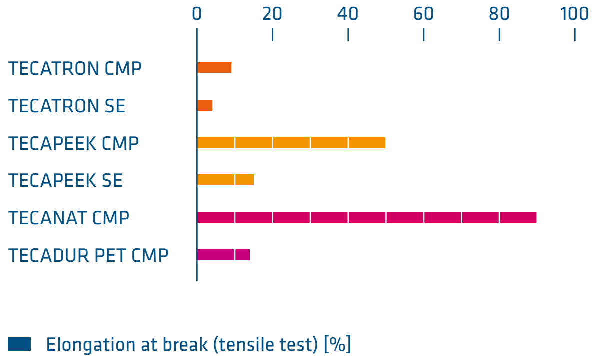
Modulus of elasticity [MPa]



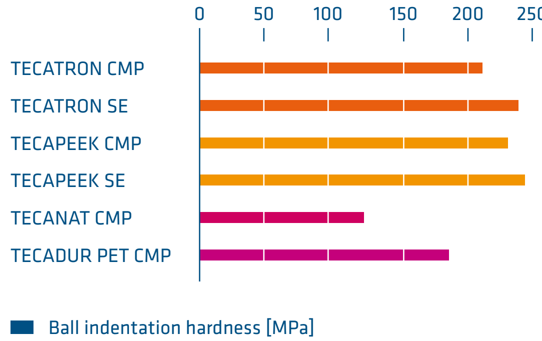
Strength [MPa]



Elongation at break (tensile test) [MPa]



Ball indentation hardness [MPa]

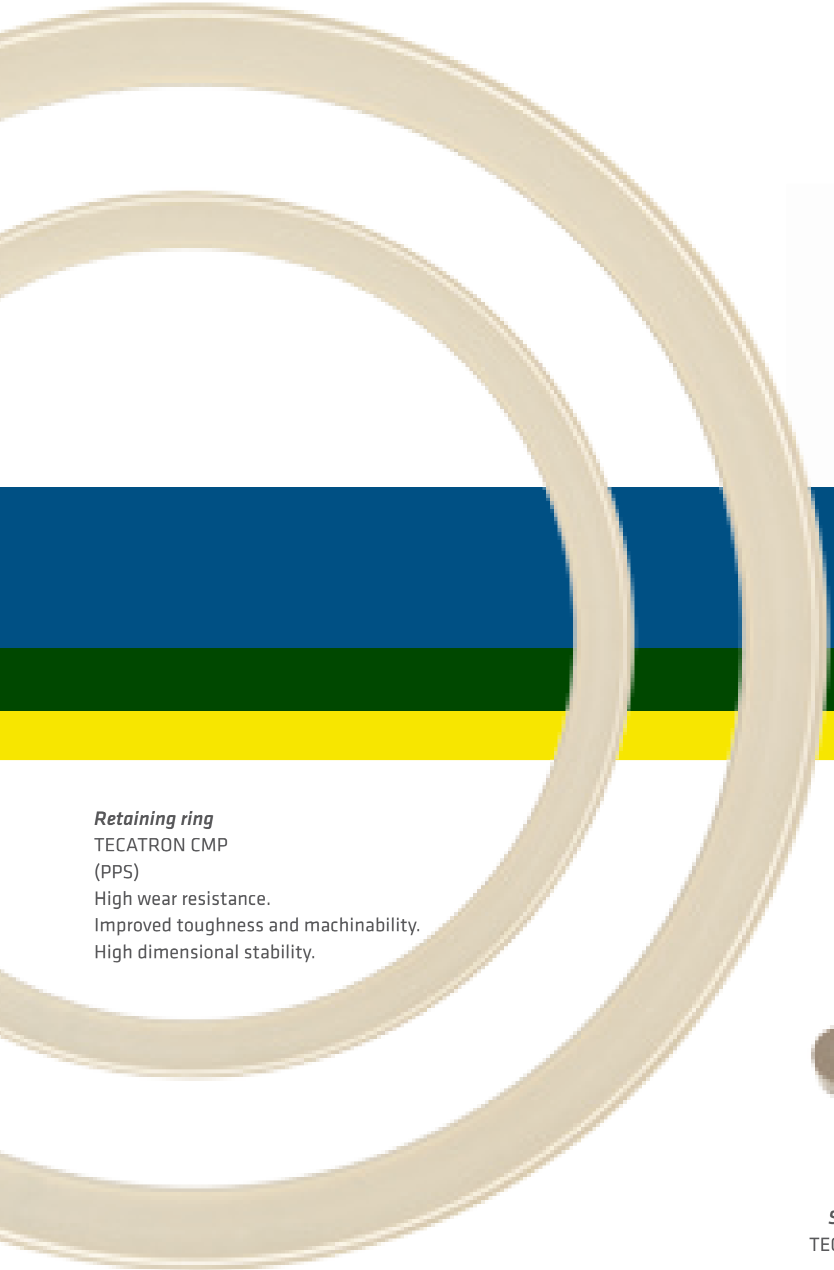


Key facts at a glance

Ensinger CMP grades give market-leading results for retaining ring applications.

Application examples

Vacuum pick up tips
TECASINT 1011
(PI)
Low out-gassing.
Low ion level.
Thermally stable.



Retaining ring
TECATRON CMP
(PPS)
High wear resistance.
Improved toughness and machinability.
High dimensional stability.

Support comb
TECAPEEK GF30
(PEEK GF)
High degree of toughness.
High dimensional stability.
Good chemical resistance.
Electrically insulating.

FAQs: CMP

How does the new TECATRON CMP impact the cost of ownership (COO)?

The CMP process is under constant development due to the drive to smaller process nodes. Consequently the main focus of CMP processes today is how to increase the lifetime of all components (e.g. the retaining ring length of life as measured by the number of wafer planarization touches) and to reduce the defectivity or quantity of microscratches induced onto the wafer. These considerations impact the total cost of ownership.

Length of Life:

The longer the retaining ring performs within normal parameters, the less frequently it will require replacement. This reduces the downtimes of your system and consequently the system costs. The more wafers the retaining ring is able to planarize in a production environment, the lower the cost per wafer. Ensinger's TECATRON CMP (PPS) has demonstrated a length of life more than twice as long as the industry standard PPS.

Balance of consumables:

To increase the lifetime of all components, not only the wear rate of the retaining ring is important, but also the influence on other components like pad, slurry, membrane etc. Due to the increased wear properties of the new Ensinger TECATRON CMP (PPS), there are less wear particles to be found in the slurry, which induce less wear on the pad and membrane. This can positively contribute to a better balance of all consumables and consequently to a longer lifetime of the whole system.

Defectivity:

Measured by how many microscratches the planarization process induces onto the wafer. The fewer microscratches on the wafer, the higher the yield of usable integrated circuits (IC) from the wafer. Defectivity has a direct correlation with wafer sales revenues. Ensinger's TECATRON CMP (PPS) has demonstrated superior microscratching properties (inducing fewer) than the industry standard PPS. This supports improved yield and increased IC sales.

What other benefits do Ensinger's new TECATRON CMP and TECAPEEK CMP offer?

There are benefits for different players in the processing chain of a retaining ring:

The machine shops see a positive impact on their machining costs due to higher ductility and better machinability of the Ensinger CMP materials. Due to significant time saving in deburring compared to the industry standard PPS, the machine shops can yield a shorter overall processing time per retaining ring when machining TECATRON CMP. Combined with less scrap due to reduced chipping and better swarf formation compared to our earlier TECATRON and TECAPEEK SE materials, the total efficiency in machining has significantly improved.

The fabs can benefit from the longer lifetime, less scratches on the wafer and thus improved processing productivity.

How does Ensinger assure the high quality requirements for retaining rings?

Ensinger's high quality standards are reflected in the implementation and maintainance of the international quality standard ISO 9001. Also Ensinger's quality management system benefits from certain industry specific quality management systems, such as the ISO 13485, a quality management system for medical devices, which sets standards even higher. As a result, Ensinger carries out thorough and regular quality checks at each production step. Full traceability is obligatory. Further details can be found on page 24/25.

Do you have any other questions?

Please do not hesitate to contact our technical service:
techservice.shapes@de.ensinger-online.com or by telephone on +49 7032 819 101

Special materials for further semiconductor processes

Products for semiconductor processes such as silicone wafer manufacturing, wafer cleaning and washing, CVD, photolithography, plasma etching, tools, chip handling, chip align and exposure :

- TECASINT 4111 (PI)
- TECASINT 4011 (PI)
- TECASINT 2011 (PI)
- TECAPEEK natural (PEEK)
- TECAPEEK GF30 (PEEK GF)
- TECATRON natural (PPS)
- TECATRON GF40 (PPS GF)
- TECAFLON PVDF (PVDF)
- TECAFLON PTFE (PTFE)
- TECADUR PET (PET)

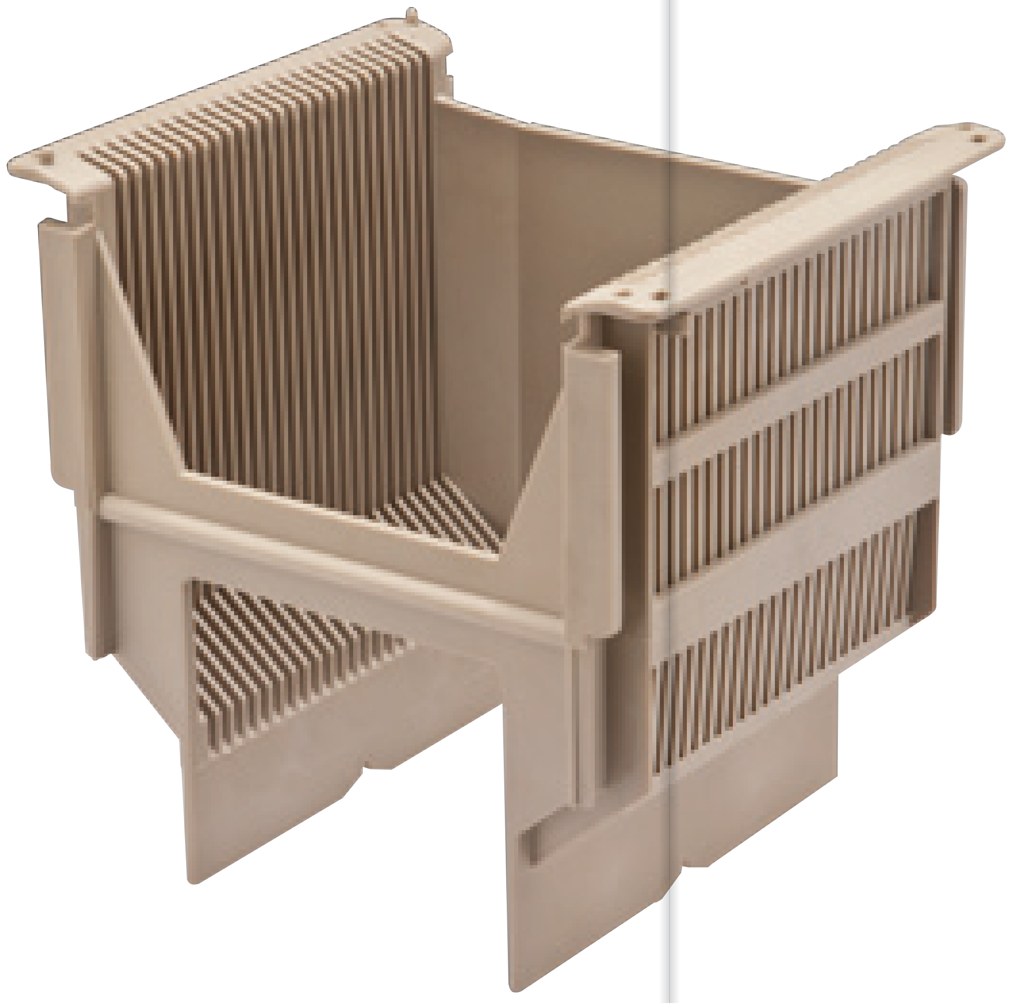
Function:

For applications in the semiconductor industry, the following requirements are important:

- High thermal-mechanical load
- Good electrical insulation
- Low thermal expansion
- Good wear resistance
- Excellent chemical resistance
- High resistance to plasma
- Low out-gassing in vacuum
- High purity

Benefits:

Due to the property profile of plastics suitable for the semiconductor industry, Ensinger can offer products for almost all stages of wafer processing, depending on the individual requirements for each application. These tailored solutions can help to reduce system costs and support applications to improve the semiconductor fabrication process.



TECASINT 4011 / TECASINT 4111 / TECASINT 2011 (PI)

- Non-melting high-temperature polyimides
- Glass transition temperature up to 470 °C
- High purity
- Low out-gassing in vacuum
- Compressive strength and creep resistance
- Excellent thermal and electrical insulation
- High compressive strength, modulus and rigidity

TECAPEEK natural (PEEK)

- High degree of toughness
- High strength, hardness and rigidity
- Good sliding friction properties, good abrasion resistance
- Very good chemical resistance to a wide range of technical media
- High purity, low out-gassing in vacuum
- High thermal stability
- Excellent dimensional stability

TECAPEEK GF30 (PEEK GF)

- Excellent strength and stiffness
- Excellent chemical resistance
- Low tendency to creep
- High thermal stability
- Excellent di-electrical properties

TECATRON natural (PPS)

- High strength, hardness and rigidity
- High thermal stability
- Very high chemical resistance, even at low temperatures
- Very low moisture absorption
- Minimal thermal expansion
- Very good electrical insulation properties
- Low ionic contamination in special types
- Inherently flame resistant, self-extinguishing

TECATRON GF40 (PPS GF)

- Very good rigidity and strength (even at high temperatures)
- Very good chemical resistance
- High thermal stability
- High dimensional stability
- Excellent di-electrical properties

TECAFLON PVDF (PVDF)

- High chemical resistance
- Hydrolysis-resistant
- Very low moisture absorption
- High degree of strength
- Very good welding properties
- PVDF is significantly more resistant to energetic radiation than all other fluoropolymers
- Inherently flame resistant, self-extinguishing

TECAFLON PTFE (PTFE)

- Exceptional chemical resistance
- Particularly low coefficient of friction
- Ideally suited for soft mating partners
- Hydrolysis-resistant
- Very low moisture absorption
- Inherently flame resistant, self-extinguishing

TECADUR PET (PET)

- Good machining properties
- High degree of toughness, spring stiffness
- High strength, hardness and rigidity
- Very good sliding friction properties, abrasion-resistant
- High chemical resistance, particulary resistant to diluted acids
- Very low moisture absorption
- Very good electrical insulation properties

Special materials for back-end applications

Products for back-end chip testing applications such as test socket carriers, contact frames, snap contacts and probe cards, burn-in test sockets, test adapters and spring contacts:

- → TECASINT 5201 SD (PAI)
- → TECASINT 5051 (PAI GF)
- → TECASINT 4111 (PI)
- → TECASINT 4011 (PI)
- → TECATOR 5013 (PAI)
- → TECAPEEK TS (PEEK)
- → TECAPEEK CMF (PEEK)
- → TECAPEEK ELS nano (PEEK)
- → TECAPEEK natural (PEEK)
- → TECATRON natural (PPS)
- → TECAPEI GF30 (PEI GF)

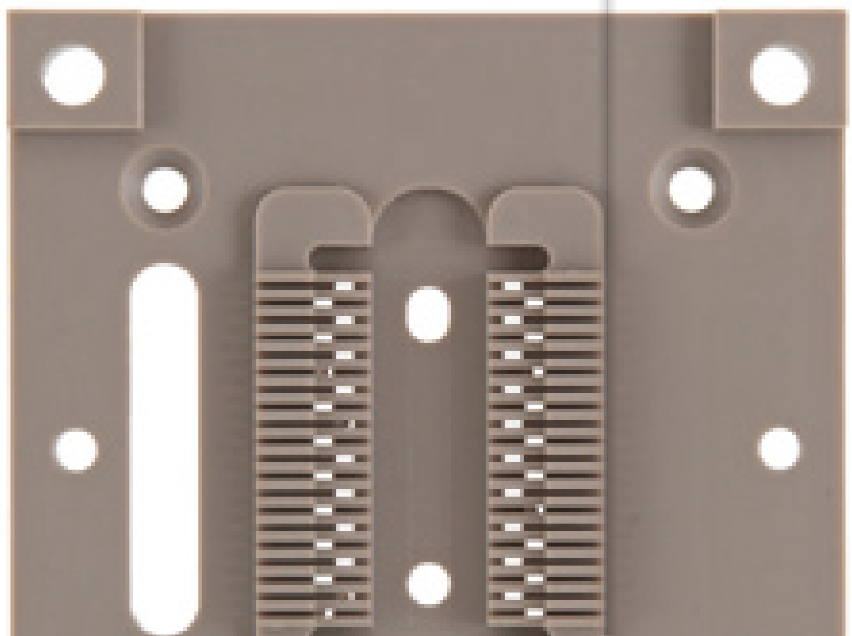
Function:

Test sockets are used in back-end processes, after the circuits have been created on the wafers, for testing their functionality. A large variety of chip designs requires a large variety of test sockets. However, the materials the test sockets are made of have to have the same basic properties: high dimensional stability over a wide temperature range, good machineability with minimal burr formation and good mechanical strength and stiffness.

Benefits:

With Ensinger materials designed for test socket applications these material requirements are combined:

- → Good machineability with low burr formation even with small dimensions
- → Good dimensional stability over a wide temperature range due to minimal CLTE
- → Very low moisture absorption for high dimensional stability
- → Good mechanical strength and stiffness even at high temperatures, minimizing downtime
- → Good degree of toughness to prevent material cracks even at minimal wall thicknesses



TECASINT 5201 SD (PAI CF GF)

- → Static dissipative: surface resistance 10^9 to 10^{11} Ω
- → Reduced thermal expansion for components with tightest tolerances
- → Dimensionally stable and wear resistant
- → Service temperature up to 300 °C

TECASINT 5051 (PAI GF)

- → Reduced thermal expansion for components with tightest tolerances
- → Dimensionally stable and wear resistant for a long service life
- → High thermal-mechanical load properties
- → Good electrical insulation
- → Service temperature up to 300 °C

TECASINT 4111 / TECASINT 4011 (PI)

- → Non-melting high-temperature polyimide
- → High purity
- → Low out-gassing in vacuum conditions
- → Low water absorption
- → Glass transition temperature up to 470 °C
- → High thermo-oxidative stability
- → High mechanical strength, stiffness and creep resistance

TECATOR 5013 (PAI)

- → Rigid, high tensile strength and yet tough at the same time
- → High long-term stability and high fatigue strength
- → Service temperature up to 270 °C

TECAPEEK TS (PEEK, mineral)

- → Excellent hardness and rigidity
- → High strength
- → High dimensional stability
- → Good chemical resistance
- → Low moisture absorption
- → Low burring
- → Good heat deflection temperature
- → Low coefficient of thermal expansion

TECAPEEK CMF (PEEK, ceramic)

- → Good machinability
- → High dimensional stability
- → High strength
- → High stiffness
- → Low thermal expansion
- → Low burring
- → Good heat deflection temperature
- → Very good thermal stability

TECAPEEK ELS nano (PEEK, CNT)

- → Electrically conductive
- → High dimensional stability
- → Continuous service temperature up to 260 °C
- → High strength
- → Very good chemical resistance
- → Good machinability
- → High toughness

TECAPEEK natural (PEEK)

- → Very good chemical resistance
- → Excellent mechanical properties
- → High stress crack resistance
- → Good dimensional stability and easy machining properties
- → Long-term service temperatures of up to 260 °C
- → Excellent tribological properties

TECATRON natural (PPS)

- → Very good chemical resistance
- → Very good thermal and mechanical properties
- → Long-term service temperature up to 230 °C
- → Extreme hardness and rigidity
- → High dimensional stability and low creep tendency
- → Low water absorption

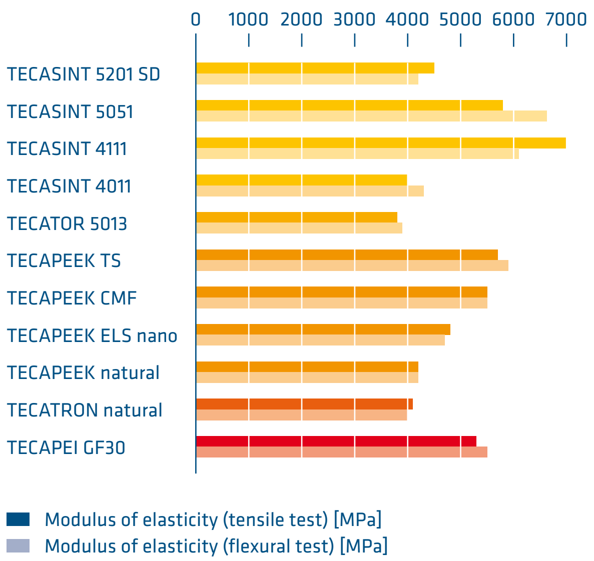
TECAPEI GF30 (PEI GF)

- → High thermal and mechanical capacity
- → Resistance against high energy radiation
- → High dimensional stability
- → Inherent flame retardant

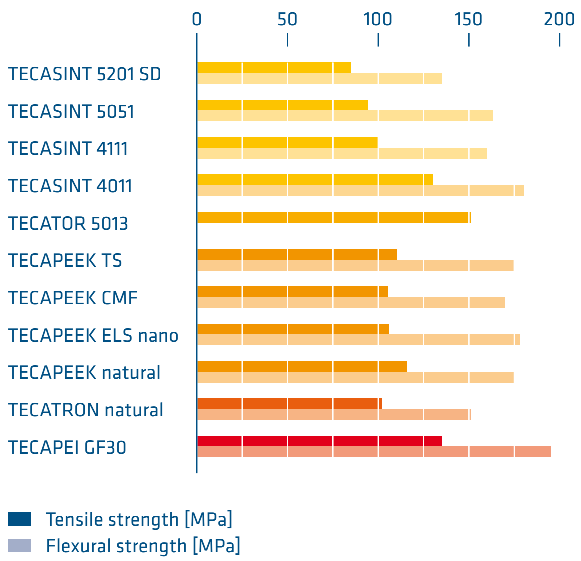
Technical data for back-end applications

The continuing reduction of component sizes in microchip production has placed increasing demands on materials of a new generation. Materials used for back-end applications have to show excellent properties in different areas: long term applications in wide temperature ranges, very good stiffness and strength and excellent dimensional stability with low reaction to thermal elongation or moisture absorption.

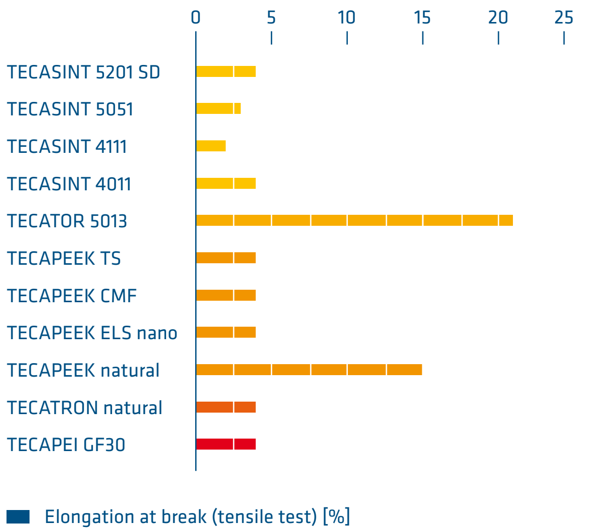
Modulus of elasticity [MPa]



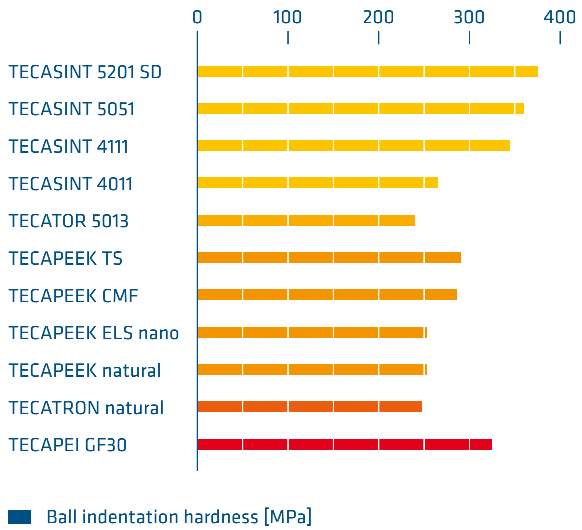
Strength [MPa]



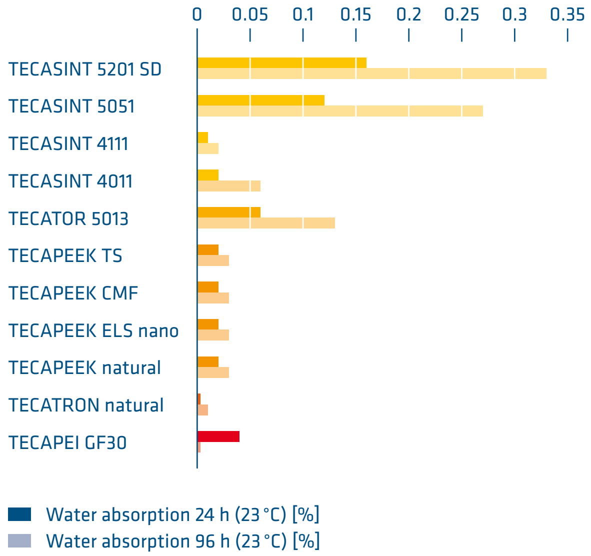
Elongation at break (tensile test) [MPa]



Ball indentation hardness [MPa]

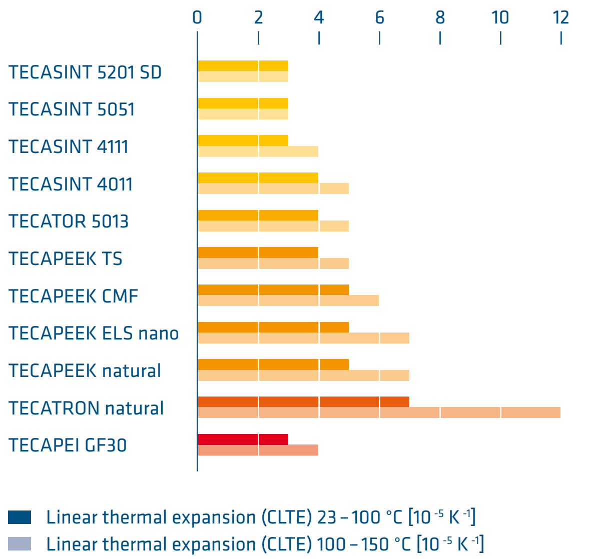


Water absorption 24h, 96h (23 °C)



Moisture or water absorption is the ability of a material to absorb moisture from its environment (air, water). The degree of moisture absorption depends on the type of plastic and the ambient conditions such as temperature, humidity and contact time. This can primarily influence material properties such as dimensional stability, mechanical strength and electrical properties such as electrical conductivity and the dissipation factor.

Thermal expansion (CLTE) 23 – 100 °C, 100 – 150 °C



The coefficient of linear thermal expansion specifies the extent of a change in the length of a material due to rising or falling temperature. Due to their chemical structure, plastics generally demonstrate a significantly higher coefficient of linear thermal expansion than metals.

Electrical properties

The insulating effect or static conductivity of Ensinger high performance plastics is achieved by the selective addition of electrically active substances. These include special conductive carbon black, carbon fibres, CNT or inherently conductive materials. Unmodified plastics have insulating properties.

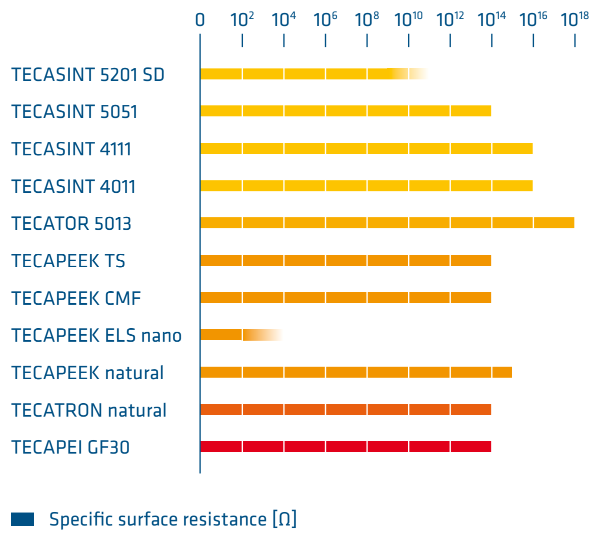
The specific surface resistance describes the resistance that a material exerts against the flow of electricity at the surface. This is expressed by the ratio of applied voltage (in Volts) and the created current (in Amperes) with the aid of Ohm's law.

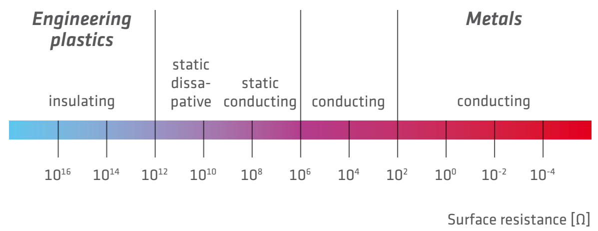
Consequently the unit used to describe specific surface resistance is Ohm (1 Ω = 1 V/A). For measurement, a standardized set-up must be used, as the specific surface resistance depends on different factors:

- → Material
- → Humidity
- → Surface contamination
- → Measurement set-up

It is also impossible to prevent volume resistivity from entering the equation to an indeterminable degree when measuring surface resistance.

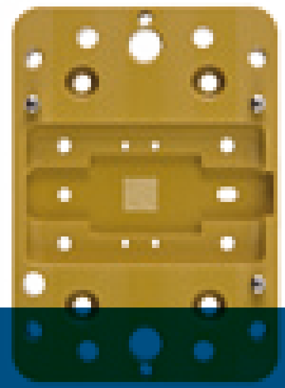
Specific surface resistance [Ω]



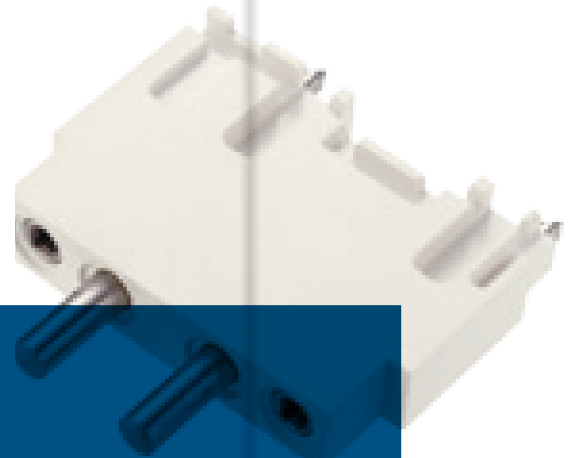


Application examples

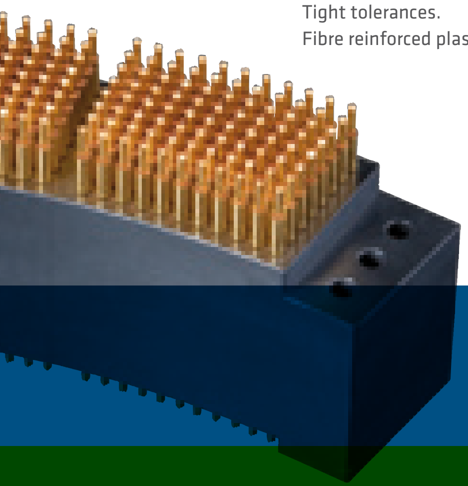
Contact frame
TECASINT 4051
(PI GF)
Reduced thermal expansion at
high temperatures.
Wear resistance.
Dimensionally stable.
Good machinability.

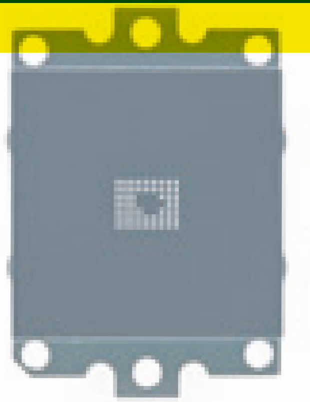


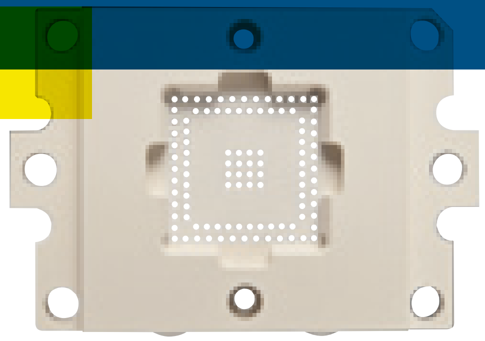
Workpiece holder
TECAPEEK CMF
(PEEK, ceramic)
High dimensional stability.
Excellent hardness and rigidity.
Good electrical insulation.
High abrasion resistance.



Snap Contact
TECATRON GF40
(PPS GF)
Tight tolerances.
Fibre reinforced plastic.







Test socket
TECAPEEK TS
(PEEK, mineral)
High dimensional stability.
Excellent rigidity and hardness.

Test socket
TECAPEEK CMF
(PEEK, ceramic)
High dimensional stability.
Good electrical insulation.

FAQs: back-end applications

How can burr formation be avoided?

Burr formation is a parameter that depends on materials, tools, tool condition, machining parameters such as feed rate, cutting speed, cooling etc. It is therefore difficult to give a general answer to this question. Particularly in the machining of plastics, the above-mentioned parameters have a great influence on burr formation: soft and tough materials (e.g. PTFE, PE) are more likely to tend towards burr formation than hard and stiff materials (e.g. PPS, PEEK, reinforced materials). The risk of burr formation can be reduced by selecting the right material, however the machining process itself should also be considered.

How can plastics be deburred?

Due to its flexibility, the most common way of deburring is manual deburring which is labour-intensive but also combines the deburring process with inspection of the finished parts. Another common way of deburring is abrasive blasting, where a stream of abrasive material (e.g. sand, beads blasting) is forcibly propelled against a surface under high pressure to remove surface contaminants. Another method is cryogenic deburring where burrs and flashes are removed from plastic parts at cryogenic temperatures (approx. –195 °C) below the material's embrittlement temperature. Other deburring methods are hot-air deburring, infrared deburring, thermal explosion machining (TEM), electrochemical machining (ECM) and hydro erosive grinding (HEG).

Which characteristics influence the dimensional stability of plastics?

There are various aspects which can influence the dimensional stability of a component: moisture uptake of plastic materials leads to swelling of the material. This process is reversible and may also lead to a shrinkage when moisture is released. To avoid this effect, materials like TECAPEEK CMF or TECAPEEK TS should be used for minimal moisture uptake.
During temperature chages, materials generally change their dimensions due to specific thermal expansion. Plastics tend to have higher thermal expansion than metals (approx. 10 times higher). The thermal expansion of plastics can be reduced with special fillers.

How can deformation of the machined parts be avoided?

The processing of plastics may cause residual stress in the semi-finished parts. This residual stress may be relieved over time and cause deformation. To reduce this and prevent your finished parts from warpage, semi-finished goods at Ensinger are subjected to an annealing step after production. This positively contributes to dimensional stability during and after processing and machining. It may also be wise to subject critical components to an intermediate annealing step where tight tolerances are required. For additional dimensional stability, one-sided machining should be avoided.

I have problems with machining parts, where can I get support?

Ensinger has decades of experience in the field of machine processing of engineering and high-temperature plastics. Our Technical Service Department will be pleased to share our know-how and help you guarantee high quality standards. Please see contact details below. For further information please also see our machining guidelines:

Do you have any other questions?

Please do not hesitate to contact our technical service:
techservice.shapes@de.ensinger-online.com or by telephone on +49 7032 819 101

Quality management

The Ensinger quality assurance system monitors our high-performance plastic products continuously from the time of arrival of the incoming resin through to their delivery as semi-finished products. This allows us to guarantee the highest possible standard of product quality and to minimize defects and complaints. This quality assurance process entails the performance of various tests at every stage of the work process.

High purity takes top priority for plastics used in the electronics and semiconductor industry as well as in medical technology. Ensinger extrudes a proportion of its special products in cleanrooms - in full compliance with the relevant standards.

1. ***Suppliers***
   - → Selective choice
   - → Supplier agreement
   - → Regular audits
   - → Product-compatible storage

2. ***Incoming goods***
   - → Examination of quantity, type and obvious damages
   - → Examination of critical characteristics

3. ***Compounding***
   - → In-process testing and inspection
   - → Release testing in compliance with specifications

4. ***Extrusion***
   In-process testing and inspection such as:
   - → Dimensions
   - → Surface
   - → Shape
   - → Cavities / pores / black specks
   - → Machining tests
   - → Manufacture of test bodies
   - → Customer-specific tests

5. ***Annealing***
   In-process testing and inspection such as:
   - → Surface
   - → Shape
   - → Annealing duration
   - → Temperature
   - → Post-shrinkage

6. ***Entry into storage***
   - → Visual inspections for damage

7. ***Shipment***
   - → Inspection for completeness
   - → Visual inspections for damage
   - → Customer-specific inspections
   - → Customer-specific packaging guidelines

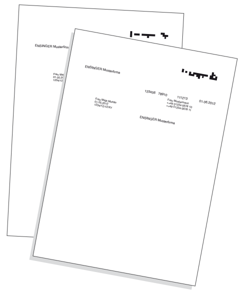
Traceability

Due to product coding and statements of conformity Ensinger has direct traceability of the delivered semifinished product.

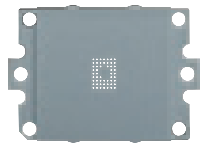
1. ***Invoice / delivery note***
   The order and invoice number is shown on the invoice / delivery note, for semi-finished products the batch number is also shown on the delivery note. This allows goods to be traced back using these numbers. A certificate to ISO 10204 is issued on an order-specific basis.

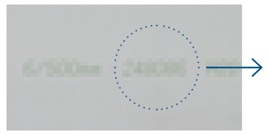
Customer · Order · Invoice
988885 · 123456 · DRA12345

Production number 248086

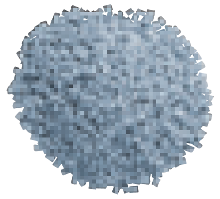


2. ***Semi-finished products***
   The production and manufacturing number is located on the semi-finished product. Starting with the production or manufacturing number, data from the production process can be traced (production data, production protocol, control cards).

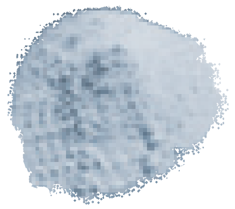




3. ***Compounds***
   The lot number of the compound can be determined from the production / manufacturing number of the semi-finished product.



4. ***Raw materials***
   The lot number of the compound is traceable back to the formulation and so to the delivered raw material batch, the relevant raw material specification and the safety data sheet.



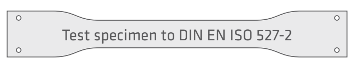
Key facts at a glance

Ensinger secures foolproof traceability from the delivery note to the raw material.

Material standard values

Material		TECASINT 5201 SD	TECASINT 5051	TECASINT 4111	TECASINT 4011	TECASINT 2011	TECATOR 5013	TECAPEEK CMP	TECAPEEK SE	TECAPEEK	TECAPEEK TS
Chemical designation		PAI	PAI	PI	PI	PI	PAI	PEEK	PEEK	PEEK	PEEK
Fillers		carbon fibres, glass fibres	30 % glass fibres								mineral filler
Density (DIN EN ISO 1183)	[g / cm^3]	1.54	1.57	1.46	1.41	1.38	1.4	1.31	1.31	1.31	1.49
Mechanical properties											
Modulus of elasticity (tensile test) (DIN EN ISO 527-2)	[MPa]	4500	5800	7000	4000	3700	3800	4100	4200	4200	5700
Tensile strength (DIN EN ISO 527-2)	[MPa]	85	94	100	130	118	151	110	116	116	110
Tensile strength at yield (DIN EN ISO 527-2)	[MPa]						151	110	116	116	110
Elongation at yield (DIN EN ISO 527-2)	[%]							4	5	5	4
Elongation at break (DIN EN ISO 527-2)	[%]	4.0	3.4	1.7	4.5	4.5	21	50	15	15	4
Modulus of elasticity (flexural test) (DIN EN ISO 178)	[MPa]	4200	6625	6100	4300	3600	3900	3900	4200	4200	5900
Flexural strength (DIN EN ISO 178)	[MPa]	135	163	160	180	177		160	175	175	175
Compression modulus (EN ISO 604)	[MPa]		2590	2500	2100	1713		3200	3400	3400	4300
Compressive strength (1% / 2%) (EN ISO 604)	[MPa]							15 / 34	23 / 43	23 / 43	17 / 34
Compressive strength at break (EN ISO 604)	[MPa]	240	260	250	486						
Impact strength (Charpy) (DIN EN ISO 179-1eU)	[kJ / m^2]	17.8	27.3	24	87	87.9		n.b.	n.b.	n.b.	n.b.
Notched impact strength (Charpy) (DIN EN ISO 179-1eA)	[kJ / m^2]	2.8	5.1	1.1	9.6	9.3	13.2	4	4	4	7
Ball indentation hardness (ISO 2039-1)	[MPa]	375	360	345	265	260	240	240	253	253	290
Thermal properties											
Glass transition temperature (DIN 53765)	[°C]	340	340		260 (b)	370	280	151	150	150	151
Melting temperature (DIN 53765)	[°C]						n.a.	340	341	341	339
Service temperature, short term	[°C]						270	300	300	300	300
Service temperature, long term	[°C]	300	300			-	250	260	260	260	260
Thermal expansion (CLTE), 23 – 100°C (DIN EN ISO 11359-1;2)	[$10^{-5} K^{-1}$]	3	3	3	4	4	4	6	5	5	4
Thermal expansion (CLTE), 100 – 150°C (DIN EN ISO 11359-1;2)	[$10^{-5} K^{-1}$]	3	3	4	5	5	5 (c)	7	7	7	5
Specific heat (ISO 22007-4:2008)	[J / (g*K)]				1.04	0.925		1.1	1.1	1.1	
Thermal conductivity (ISO 22007-4:2008)	[W / (m*K)]			0.35	0.4	0.22	0.29 (e)	0.27	0.27	0.27	
Electrical properties											
Specific surface resistance (DIN IEC 60093)	[Ω]	10^{11}	10^{14}	10^{16} (g)	10^{16} (g)	10^{15}	10^{18} (g)	10^{15}	10^{15}	10^{15}	10^{14}
Volume resistance (DIN IEC 60093)	[Ω*cm]			10^{16} (g)	10^{16} (g)	10^{15}	10^{15} (g)	10^{15}	10^{15}	10^{15}	10^{14}
Dielectric strength (DIN EN 60243-1)	[kV / mm]						23 (i)	73	73	73	
Resistance to tracking (CTI) (DIN EN 60112)	[V]							125	125	125	
Miscellaneous data											
Water absorption 24h / 96h (23°C) (DIN EN ISO 62)	[%]	0.16 / 0.33	0.12 / 0.27	0.01 / 0.02	0.02 / 0.06	0.14 / 0.30	0.06 / 0.13	0.02 / 0.03	0.02 / 0.03	0.02 / 0.03	0.02 / 0.03
Resistance to hot water / bases							-	+	+	+	+
Resistance to weathering								-	-	-	-
Flammability (UL94) (DIN IEC 60695-11-10;)		V0	V0	V0	V0	V0	V0		V0	V0	V0

Data generated directly after machining (standard climate Germany). For polyamides the values strongly depend on the humidity content.



+	good resistance
(+)	limited resistance
–	poor resistance (depending on concentration, time and temperature)
n.b.	not broken
n.a.	not applicable

(a)	according to ASTM D 4894
(b)	according to DIN EN ISO 11357
(c)	according to ASTM D 695
(d)	according to ASTM E1530
(e)	according to ASTM C 177
(f)	according to ASTM D 257
(g)	according to DIN EN 61340-2-3
(h)	according to DIN EN 61340-2-3

Material		TECAPEEK CMF	TECAPEEK ELS nano	TECATRON CMP	TECATRON SE	TECATRON	TECAPEI GF30	TECAFLON PVDF	TECAFLON PTFE	TECANAT CMP	TECADUR PET CMP
Chemical designation		PEEK	PEEK	PPS	PPS	PPS	PEI	PVDF	PTFE	PC	PET
Fillers		ceramic	CNT				glass fibres				
Density (DIN EN ISO 1183)	[g / cm^3]	1.65	1.36	1.34	1.36	1.36	1.51	1.78	2.15	1.19	1.39
Mechanical properties											
Modulus of elasticity (tensile test) (DIN EN ISO 527-2)	[MPa]	5500	4800	3700	4100	4100	5300	2200		2200	3300
Tensile strength (DIN EN ISO 527-2)	[MPa]	105	106	102	102	102	135	62	22	69	91
Tensile strength at yield (DIN EN ISO 527-2)	[MPa]	102	106	100	100	100	135	62		69	91
Elongation at yield (DIN EN ISO 527-2)	[%]	3	4	4	4	4	4	8		6	4
Elongation at break (DIN EN ISO 527-2)	[%]	4	4	9	4	4	4	17	220 (a)	90	14
Modulus of elasticity (flexural test) (DIN EN ISO 178)	[MPa]	5500	4700	3800	4000	4000	5500	2100		2300	3400
Flexural strength (DIN EN ISO 178)	[MPa]	170	178	151	151	151	195	77		97	134
Compression modulus (EN ISO 604)	[MPa]	4300	3600	3300	3300	3300	4200	1900		2000	2800
Compressive strength (1% / 2%) (EN ISO 604)	[MPa]	25 / 46	27 / 47	15 / 33	20 / 38	20 / 38	18 / 39	16 / 28		16 / 29	21 / 38
Compressive strength at break (EN ISO 604)	[MPa]										
Impact strength (Charpy) (DIN EN ISO 179-1eU)	[kJ / m^2]	65	58	94	29	29	51	150		n.b.	150
Notched impact strength (Charpy) (DIN EN ISO 179-1eA)	[kJ / m^2]						6			14	
Ball indentation hardness (ISO 2039-1)	[MPa]	286	253	220		248	325	129		128	194
Thermal properties											
Glass transition temperature (DIN 53765)	[°C]	151	147	97	97	97		-40	20	149	81
Melting temperature (DIN 53765)	[°C]	339	341		281	281		171		n.a.	244
Service temperature, short term	[°C]	300	300	260	260	260	200	150	260	140	170
Service temperature, long term	[°C]	260	260	230	230	230	170	150	260	120	110
Thermal expansion (CLTE), 23 – 100°C (DIN EN ISO 11359-1;2)	[$10^{-5} K^{-1}$]	5	5	7	7	7	3	18		8	10
Thermal expansion (CLTE), 100 – 150°C (DIN EN ISO 11359-1;2)	[$10^{-5} K^{-1}$]	6	7	12	12	12	4				
Specific heat (ISO 22007-4:2008)	[J / (g*K)]	1.0	1.1		1.0	1.0		1.3		1.3	
Thermal conductivity (ISO 22007-4:2008)	[W / (m*K)]	0.38	0.46		0.25	0.25		0.25	0.20 (f)	0.25	
Electrical properties											
Specific surface resistance (DIN IEC 60093)	[Ω]	10^{14}	10^{5} (h)	10^{14}	10^{14}	10^{14}	10^{14}		10^{17} (g)	10^{14}	10^{14}
Volume resistance (DIN IEC 60093)	[Ω*cm]	10^{14}	10^{5} (h)	10^{14}	10^{14}	10^{14}	10^{14}		10^{17} (g)	10^{14}	10^{14}
Dielectric strength (DIN EN 60243-1)	[kV / mm]	57							80 (i)		
Resistance to tracking (CTI) (DIN EN 60112)	[V]	175									
Miscellaneous data											
Water absorption 24h / 96h (23°C) (DIN EN ISO 62)	[%]	0.02 / 0.03	0.02 / 0.03	< 0.01 / 0.01	< 0.01 / 0.01	< 0.01 / 0.01	0.04 / < 0.1	< 0.01 / < 0.01		0.03 / 0.06	0.02 / 0.03
Resistance to hot water / bases		+	+	+	+	+	+	+		–	–
Resistance to weathering		–	(+)	–	–	–	–	+		(+)	–
Flammability (UL94) (DIN IEC 60695-11-10;)		V0	V0	V0	V0	V0	V0	V0	V0	HB	HB

The corresponding values and information are not minimum or maximum values, but guideline values that can be used primarily for comparison purposes for material selection. These values are within the normal tolerance range of product properties and do not represent guaranteed property values. They shall not, therefore, be used for specification purposes. Unless otherwise noted, these values were determined by tests at reference dimensions (typically rods with diameter 40-60 mm according to DIN EN 15860) on extruded, cast, compression moulded and machined specimens. As the properties depend on the dimensions of the semi-finished products and the orientation in the component (esp. in reinforced grades), the material may not be used without separate testing under individual circumstances. Data sheet values are subject to periodic review, the most recent update can be found at www.ensinger-online.com

Technical changes reserved.

Ensinger Germany

Ensinger GmbH
Rudolf-Diesel-Straße 8
71154 Nufringen
Tel. +49 7032 819 0
Fax +49 7032 819 100
www.ensinger-online.com

Ensinger GmbH
Mercedesstraße 21
72108 Rottenburg a. N.
Tel. +49 7457 9467 100
Fax +49 7457 9467 122
www.ensinger-online.com

Ensinger GmbH
Wilfried-Ensinger-Straße 1
93413 Cham
Tel. +49 9971 396 0
Fax +49 9971 396 570
www.ensinger-online.com

Ensinger GmbH
Borsigstraße 7
59609 Anröchte
Tel. +49 2947 9722 0
Fax +49 2947 9722 77
www.ensinger-online.com

Ensinger GmbH
Mooswiesen 13
88214 Ravensburg
Tel. +49 751 35452 0
Fax +49 751 35452 22
www.thermix.de

Ensinger worldwide

Austria
Ensinger Sintimid GmbH
Werkstraße 3
4860 Lenzing
Tel. +43 7672 7012800
Fax +43 7672 96865
www.ensinger-sintimid.at

Brazil
Ensinger Indústria de
Plásticos Técnicos Ltda.
Av. São Borja 3185
93.032-000 São Leopoldo-RS
Tel. +55 51 35798800
Fax +55 51 35882804
www.ensinger.com.br

China
Ensinger (China) Co., Ltd.
1F, Building A3
No. 1528 Gumei Road
Shanghai 200233
P.R.China
Tel. +86 21 52285111
Fax +86 21 52285222
www.ensinger-china.com

Czech Republic
Ensinger s.r.o.
Prùmyslová 991
P.O. Box 15
33441 Dobřany
Tel. +420 37 7972056
Fax +420 37 7972059
www.ensinger.cz

Denmark
Ensinger Danmark A/S
Rugvænget 6B
4100 Ringsted
Tel. +45 7810 4410
Fax +45 7810 4420
www.ensinger.dk

France
Ensinger France S.A.R.L.
ZAC les Batterses
ZI Nord
01700 Beynost
Tel. +33 4 78554574
Fax +33 4 78556841
www.ensinger.fr

India
Ensinger India Engineering
Plastics Private Ltd.
R.K Plaza, Survey No. 206/3
Plot No. 17, Lohgaon,
Viman Nagar
411 014 Pune
Tel. +91 20 2674 1033
Fax +91 20 2674 1001
www.ensinger.in

Italy
Ensinger Italia S.r.l.
Via Franco Tosi 1/3
20020 Olcella di Busto
Garolfo
Tel. +39 0331 568348
Fax +39 0331 567822
www.ensinger.it

Japan
Ensinger Japan Co., Ltd.
3-5-1, Rinkaicho,
Edogawa-ku, Tokyo
134-0086, Japan
Tel. +81 3 5878 1903
Fax +81 3 5878 1904
www.ensinger.jp

Poland
Ensinger Polska Sp. z o.o.
ul. Geodetów 2
64-100 Leszno
Tel. +48 65 5295810
Fax +48 65 5295811
www.ensinger.pl

Singapore
Ensinger International GmbH
(Singapore Branch)
63 Hillview Avenue # 04-07
Lam Soon Industrial Building
Singapore 669569
Tel. +65 65524177
Fax +65 65525177
www.ensinger.com.sg

Spain
Ensinger S.A.
Girona, 21-27
08120 La Llagosta
Barcelona
Tel. +34 93 5745726
Fax +34 93 5742730
www.ensinger.es

Sweden
Ensinger Sweden AB
Stenvretsgatan 5
SE-749 40 Enköping
Tel. +46 171 477 050
Fax +46 171 440 418
www.ensinger.se

United Kingdom
Ensinger Limited
Wilfried Way
Tonyrefail
Mid Glamorgan CF39 8JQ
Tel. +44 1443 678400
Fax +44 1443 675777
www.ensinger.co.uk

USA
Ensinger Inc.
365 Meadowlands Boulevard
Washington, PA 15301
Tel. +1 724 746 6050
Fax +1 724 746 9209
www.ensinger-inc.com

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