Stock shapes

Plastics used in semiconductor technology
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.

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.

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.
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; high wear resistance, low contamination, low defecitivity 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, TECAFLEX 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.

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

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

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 even 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 TECAFLEX PVDF: electrostatic dissipative, excellent dimensional stability, high purity, chemical resistance, wear resistance

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

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.

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

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

Plastics in application: wafer processing cycle

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Typical applications of technical plastics in the semiconductor industry

<table>
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<th>CMP applications</th>
<th>Further semiconductor processes</th>
<th>Back-end applications</th>
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<td>Chemical cleaning systems</td>
</tr>
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<td>Chemical cleaning systems</td>
<td>Wafer handling systems</td>
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<td>Glass/particle suspension fluid</td>
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</tbody>
</table>

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, photolithography, 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)
- TECATRON (PPS)
- TECAPET (PEEK)
- TECATOR (PAI)
- TECASINT (PI)
- TECAFLON (PTFE, PVDF)
- TECASON (PSU, PPSU, PES)
- TECAPET (PEEK)
- TECATOR (PAI)
- TECASINT (PI)

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 silicon 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.

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 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

- 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

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

Removal rate (including edge)

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

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

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]

Conditions:
Semi-sperse SS-12 oxide slurry
Rodel CR1C1400-A-3 urethane pad
counter rotating, 150 rpm, 3.8psi

Conditions:
Tungsten W7300-B21 slurry
Rodel CR1C1400-A-3 urethane pad
counter rotating, 150 rpm, 3.8psi

Conditions:
Copper ready CU3900 slurry
Rodel CR1C1400-A-3 urethane pad
counter rotating, 150 rpm, 3.8psi

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

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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:

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.

<table>
<thead>
<tr>
<th>Element (Mg)</th>
<th>TECATRON CMP</th>
<th>TECATRON SE</th>
<th>TECAPEEK CMP</th>
<th>TECAPEEK SE</th>
<th>TECADUR PET CMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium (Al)</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>&lt; 12</td>
<td>&lt; 4</td>
<td>&lt; 10</td>
<td>&lt; 10</td>
<td>n.t.</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>n.t.</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>&lt; 2</td>
<td>&lt; 2</td>
<td>&lt; 4</td>
<td>&lt; 3</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>&lt; 6</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>n.t.</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>n.t.</td>
</tr>
</tbody>
</table>

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)

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

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

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

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 downtime 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 de-burring 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 maintenance 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

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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, particularly resistant to diluted acids
- Very low moisture absorption
- Very good electrical insulation properties

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, particularly 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 CF)
- 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)
- TECAPI GF30 (PEI GF)
- TECASINT 5201 SD (PAI CF GF)
- TECASINT 5051 (PAI GF)
- TECASINT 4111 (PI)
- TECASINT 4011 (PI)
- TECATOR 5013 (PAI)
- TECAPEEK TS (PEEK)
- TECAPEEK CMF (PEEK, ceramic)
- TECAPEEK ELS nano (PEEK, CNT)
- TECAPEEK natural (PEEK)
- TECAPRON natural (PPS)
- TECAPI GF30 (PEI GF)
- TECASINT 5201 SD (PAI CF GF)
- TECASINT 5051 (PAI GF)
- TECASINT 4111 (PI)
- TECASINT 4011 (PI)
- TECATOR 5013 (PAI)
- TECAPEEK TS (PEEK, mineral)
- TECAPRON natural (PPS)
- TECAPI 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 machinability 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
- 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

TECAPRO natural (PEEK)
- 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

TECAPRON 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]**

- TECAPEI GF30
- TECATRON
- TECAPEEK
- TECAPEEK ELS
- TECAPEEK CMF
- TECAPEEK TS
- TECATOR 5013
- TECASINT 4011
- TECASINT 4111
- TECASINT 5051
- TECASINT 5201 SD

**Strength [MPa]**

- TECAPEI GF30
- TECATRON
- TECAPEEK
- TECAPEEK ELS
- TECAPEEK CMF
- TECAPEEK TS
- TECATOR 5013
- TECASINT 4011
- TECASINT 4111
- TECASINT 5051
- TECASINT 5201 SD

**Elongation at break (tensile test) [%]**

- TECAPEI GF30
- TECATRON
- TECAPEEK
- TECAPEEK ELS
- TECAPEEK CMF
- TECAPEEK TS
- TECATOR 5013
- TECASINT 4011
- TECASINT 4111
- TECASINT 5051
- TECASINT 5201 SD

**Ball indentation hardness [MPa]**

- TECAPEI GF30
- TECATRON
- TECAPEEK
- TECAPEEK ELS
- TECAPEEK CMF
- TECAPEEK TS
- TECATOR 5013
- TECASINT 4011
- TECASINT 4111
- TECASINT 5051
- TECASINT 5201 SD

**Thermal expansion (CLTE) 23 - 100 °C, 100 - 150 °C**

- TECAPEI GF30
- TECATRON
- TECAPEEK
- TECAPEEK ELS
- TECAPEEK CMF
- TECAPEEK TS
- TECATOR 5013
- TECASINT 4011
- TECASINT 4111
- TECASINT 5051
- TECASINT 5201 SD

**Specific surface resistance [Ω]**

- TECAPEI GF30
- TECATRON
- TECAPEEK
- TECAPEEK ELS
- TECAPEEK CMF
- TECAPEEK TS
- TECATOR 5013
- TECASINT 4011
- TECASINT 4111
- TECASINT 5051
- TECASINT 5201 SD

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.
Application examples

**FAQs: back-end applications**

**How can burr formation be avoided?**
Burrs form as 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 labor-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 changes, 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.
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.

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

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**Quality management**

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.

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**Traceability**

Due to product coding and statements of conformity Ensinger has direct traceability of the delivered semi-finished 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.

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**

<table>
<thead>
<tr>
<th>Material</th>
<th>Tensile strength 50% (ISO 527-2)</th>
<th>Tensile strength 100% (ISO 527-2)</th>
<th>Compressive strength (1% / 2%)</th>
<th>Flexural strength (ISO 527-2)</th>
<th>Modulus of elasticity (ISO 527-2)</th>
<th>Tensile strength (DIN EN ISO 527-2)</th>
<th>Modulus of elasticity (DIN EN ISO 527-2)</th>
<th>Density (ISO EN ISO 1189)</th>
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</thead>
<tbody>
<tr>
<td>Chemical designation</td>
<td>260</td>
<td>370</td>
<td>290</td>
<td>350</td>
<td>300</td>
<td>250</td>
<td>200</td>
<td>1.54</td>
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<tr>
<td>Fibers</td>
<td>300</td>
<td>350</td>
<td>300</td>
<td>300</td>
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<tr>
<td>Density</td>
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<td>281</td>
<td>171</td>
<td>n.a.</td>
<td>244</td>
<td>151</td>
<td>147</td>
<td>102</td>
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<tr>
<td>Modulus of elasticity</td>
<td>248</td>
<td>253</td>
<td>220</td>
<td>248</td>
<td>325</td>
<td>129</td>
<td>128</td>
<td>230</td>
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<tr>
<td>Electrical properties</td>
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<td>126</td>
<td>126</td>
<td>126</td>
<td>126</td>
<td>126</td>
</tr>
<tr>
<td>Water absorption 24h / 96h (23°C)</td>
<td>0.16 / 0.33</td>
<td>0.12 / 0.27</td>
<td>0.83 / 0.92</td>
<td>0.82 / 0.94</td>
<td>0.86 / 0.93</td>
<td>0.82 / 0.93</td>
<td>0.82 / 0.93</td>
<td>0.82 / 0.93</td>
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<tr>
<td>Resistance to hot water / bases</td>
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<td>-</td>
<td>-</td>
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<td>-</td>
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<tr>
<td>Resistance to weathering</td>
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<tr>
<td>Flammability (UL 94)</td>
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<td>V0</td>
<td>V0</td>
<td>V0</td>
<td>V0</td>
<td>V0</td>
<td>V0</td>
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</tr>
</tbody>
</table>

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 the normal tolerances 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 means of reference dimensions (typically 5 mm x 5 mm) and without mark or marked machined specimens. As the properties depend on the dimensions of the semi-finished products and the orientation in the component.

In molded parts, the material may not be used without material testing under identical circumstances. Data sheet values are subject to periodical review, the most recent update can be found at www.eisengringer.com.
Thermoplastic engineering and high performance plastics are used today in almost all important industries. They often replace other materials due to their economic and power benefits.