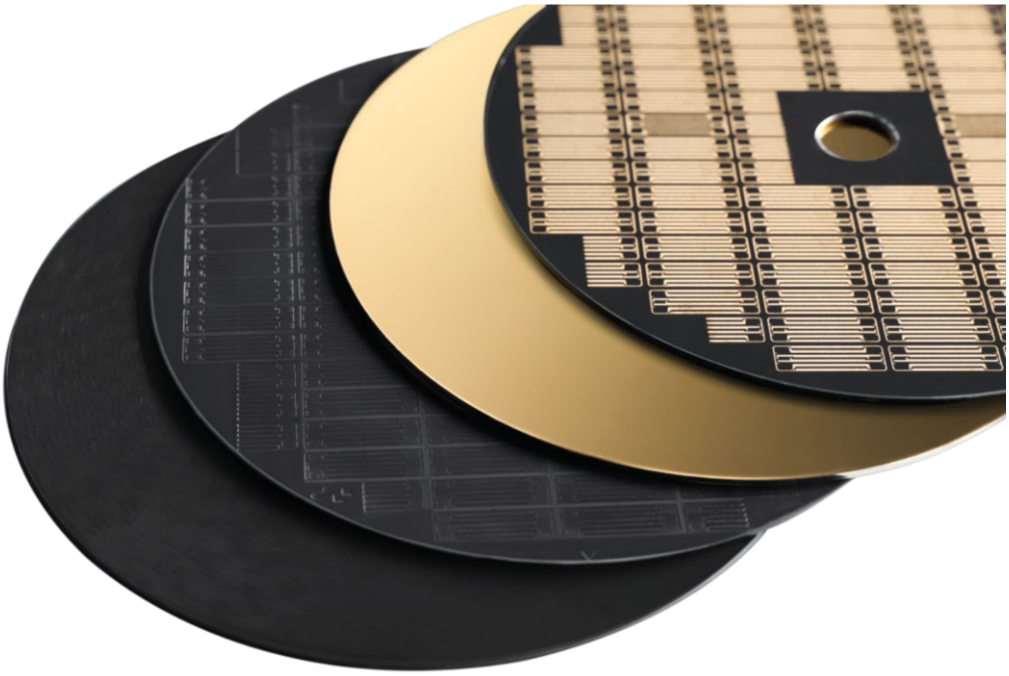
GUIDELINES TECAWAFER PEEK LDS/TECASUB PEEK LDS - Properties, Processes and Application

Insights into the process possibilities on TECAWAFER PEEK LDS and TECASUB PEEK LDS for microsystems technology



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Properties, Processes and Application

Introduction

Substrates in microsystems technology have historically been limited to a few materials. These materials are usually silicon, ceramics such as aluminum oxide or aluminum nitride, glass or, more recently, gallium nitride for high-voltage applications. In the field of polymer materials, either PCB-based solutions such as FR4® or film substrates such as Kapton® made of polyimide are used. Inorganic materials such as silicon, glass or ceramics are primarily used due to their chemical inertness to the solvents used in lithography, as well as their temperature resistance and surface properties. The semiconductor properties of silicon are only rarely required in microsystems technology. PI-based materials are mainly used in the area of flexible conductors due to their physical properties and high chemical and temperature resistance. However, a serious disadvantage of polyimides is their price, processability and production.

With this in mind, Ensinger GmbH has developed a new type of substrate material based on polyether ether ketone (PEEK). Ensinger GmbH offers a specially developed compound that is optimized for metallization by PVD processes and electroplating processes and also has the property of laser direct structurability. Based on this compound, TECACOMP PEEK LDS, Ensinger GmbH now offers substrates on which microtechnological processes can be carried out, such as lithography, PVD, PECVD and electroplating. The advantages of this new type of substrate material are, for example, high electrical insulation, low thermal conductivity, low thermal expansion, high chemical resistance, temperature resistance up to 250°C and free design options for the substrate contour. Film substrates such as TECASUB PEEK LDS or wafer substrates such as TECAWAFER PEEK LDS can be offered with very good surface qualities in terms of average surface roughness Ra or planarity.

This guide is intended to show the properties of the material and substrates based on TECACOMP PEEK LDS. Furthermore, the processes that can be carried out on the substrates and the areas of application of the manufactured microsystems are to be identified.

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1. Properties:

This chapter highlights the material properties of polyether ether ketone and focuses in particular on the compounds TECACOMP PEEK LDS black and TECACOMP PEEK LDS med.

1.1 Properties PEEK

Since Ensinger was founded, PEEK has played a key role in the strategic orientation along the value chain of thermoplastic compounds. Whether extruded or injection-molded, we develop high-performance PEEK compounds for all possible applications and requirements. In addition to tribologically optimized compound materials, we focus on detectable and laser direct structurable materials (LDS).

1.2 Properties TECAPEEK LDS black

The compound TECACOMP PEEK LDS black is optimized with black copper-chromite spinel additives and mineral filler and enables LDS functionality. With the laser direct structuring process (LDS), injection-molded surfaces or housings can be provided with conductor path structures and equipped with SMDs (surface mounted devices). By modifying the high-performance plastic, the coefficient of thermal expansion in the direction of copper is optimized and thermal conductivity is increased. The special Ensinger filler concept enables very fine conductor spacing (fine pitch).

TECACOMP PEEK LDS is the only PEEK with LDS functionality approved by LPKF Laser & Electronics AG. Components made from the Ensinger compound can be structured directly by laser, are reflow solderable and have a high adhesive strength of the conductor track. Through-hole plating using laser drilling (VIA Vertical Interconnect Access) is possible with a very high aspect ratio.

Thanks to their special properties, TECACOMP PEEK LDS compounds are used in electrical engineering, mechanical engineering, medical technology, the automotive sector and offshore applications.

Typical areas of application include components on heating elements (camera, radar, lidar or sensors), safety elements (screw connection safety devices for wind turbines, components on elevators or roller coasters) or in microsystems technology (thermoplastic wafers, thin-film sensors or LDS transformers). Laser-direct structurable high-performance plastics are also increasingly being used for antenna applications in the 5G sector. Especially for high-frequency applications with >20GHz or when isotropic properties are required. Compared to LCP LDS, TECACOM PEEK LDS has significantly better weld line strength and is therefore used in particular for components with critical holes and openings.

The base polymer PEEK has one of the highest heat resistances (up to 260 ℃ continuous use) and mechanical strengths among plastics. It is characterized by high purity, excellent chemical resistance, inherent flame resistance (UL94 V-0), low outgassing and outstanding radiation resistance.

The TECACOMP PEEK LDS black compound is also available as filament TECAFIL PEEK LDS black for 3D printing. Sample plates (60 x 60 x 1 mm) and tensile test rods are available for laser and metallization tests.

Fig. 1: TECAPEEK LDS black

1.3 Properties TECACOMP PEEK LDS med

TECACOMP PEEK LDS med grey is a compound based on the high-performance plastic PEEK that has been modified with a TiO2-based LDS additive and mineral filler. It is the extension of TECACOMP PEEK LDS grey, but is also suitable for medical applications.

With TECACOMP PEEK LDS med grey, a substrate has been developed that is laser-direct structurable, can be welded and has been tested for biocompatibility. For more information visit TECACOMP PEEK LDS grey.

The material has been tested for biocompatibility in accordance with the ISO 10993-4, -5, -18 standard and meets the specified requirements for contact with skin and tissue for up to 24 hours and indirect contact with blood if necessary. Information on testing in accordance with USP Plastic Class VI and ISO 10993 is available for the base polymer used.

Fig. 2: TECAPEEK PEEK LDS med

1.4 Properties TECAWAFER PEEK LDS

The TECAWAFER PEEK LDS is a four-inch substrate for the manufacturing of microsystems using classic manufacturing techniques in microsystems technology. The wafer is available in various thicknesses from 0.9 to 1.5 mm and has a number of innovative properties. The wafer consists of a thermoplastic base material (PEEK) which is manufactured using special injection molding technologies. It has an outstanding surface quality of roughness R_a in the range of 20 to 50 nm. With special tool inserts, roughnesses of less than 10 nm can even be achieved. The wafers also have very good planarity in the range of 50 to 100 µm over a diameter of 100 mm, as well as a thickness variation TTV (Total Thickness Variation) of approx. 40 µm. The material impresses with an adapted coefficient of thermal expansion in the range from 20 to 100 °C of approx. 16 ppm/K. Detailed values regarding the wafer properties can be found in the data sheet in the appendix.

The wafer stands out in particular due to its poorer thermal conductivity compared to ceramics or silicon and is therefore particularly suitable for temperature and flow sensor applications and, due to the material, impresses with the very fast response behavior of the sensors mentioned. The TECAWAFER PEEK LDS also impresses in the field of high-frequency applications up to 77 GHz due to its low attenuation capacity. Just like the compound, the wafer can be structured directly by laser, making it ideal for functionalization in packaging technology. Via structures can thus be realized by laser drilling in a very short time: 13 vias/sec with a substrate thickness of 1 mm. Added to this is a very high dielectric strength of 17.5 kV/mm. An overview of the properties of TECAWAFER compared to silicon (Si), ceramics (Al_2O_3) and glass is shown in the table below. Figure 2 shows a TECAWAFER PEEK LDS grey. TECAWAFER can also be structured using appropriate tools or its outer contour can be adapted to customer requirements.

Fig. 3: *TECAWAFER PEEK LDS* aus *TECACOMP PEEK MED LDS*

Table 1: Comparison between TECAWAFER, silicon, ceramics and glass

	Si	**Ceramic (Al_2O_3)**	**Glas**	**TECAWAFER**
Electrically insulating	🟥	🟩	🟩	🟩
Low thermal conduction	🟥	🟥	🟥	🟩
Diffusion	🟩	🟥	🟩	🟩
Structuring	🟩	🟥	🟥	🟩
Price	🟥	🟩	🟩	🟩
Contour freedom	🟥	🟩	🟥	🟩
Planarity	🟩	🟥	🟩	🟩
Roughness	🟩	🟥	🟩	🟩
Energy consumption	🟥	🟥	🟥	🟩
Recyclability	🟥	🟥	🟩	🟩
Handling	🟥	🟩	🟥	🟩
Static charging problematic	🟥	🟩	🟩	🟥
Supply chain	🟥	🟥	🟩	🟩
Frequency behavior	🟥	🟩	🟩	🟩
VIA structuring	🟩	🟥	🟥	🟩
Outgassing behavior	🟩	🟥	🟩	🟥
Thermal expansion	🟩	🟥	🟥	🟥
Surface adhesion	🟩	🟩	🟩	🟩
Cracking	🟥	🟩	🟩	🟩
Substrate thickness	🟩	🟥	🟩	🟥
Flexibility	🟥	🟥	🟩	🟩
Stiffness	🟩	🟩	🟥	🟥
Machinable	🟥	🟩	🟥	🟩
Anisotropic etching / structuring	🟥	🟥	🟥	🟥
Biocompatible	🟥	🟥	🟩	🟩
AVT / Packaging	🟥	🟥	🟥	🟩
Dicing (efficiency)	🟥	🟥	🟥	🟥
Dissolution	🟩	🟩	🟩	🟩
CO2	🟥	🟥	🟥	🟩
Robustness	🟥	🟥	🟥	🟩
Bulk material	🟥	🟩	🟥	🟩
Elasticity	🟥	🟥	🟥	🟩
LDS	🟥	🟩	🟥	🟩
Water absorption	🟩	🟩	🟩	🟩
Plasma resistance	🟩	🟩	🟩	🟥
Acid resistance	🟥	🟥	🟥	🟩
Dielectric strength	🟥	🟩	🟩	🟩
Environmental resistance	🟩	🟩	🟩	🟩

1.5 Properties TECAWAFER PEEK LDS

TECASUB PEEK LDS is a film substrate which, like TECAWAFER, is based on TECACOMP PEEK LDS. This film substrate is available in various dimensions up to a width of 600 mm. The thicknesses can be adjusted to any customer requirement with a tolerance of 15 µm, as long as the substrate thickness varies within a range of 100 µm to 1000 µm. This film material can be used to map large-area LDS structures in order to map high-resolution routing structures such as those required for interposer applications. In addition, these substrates can be used to create a large number of vias in a very short time using laser drilling, thus enabling highly efficient vias on large-area substrates. The material has a surface roughness of 60 to 100 nm R_a and a planarity of approx. 100 µm per 100 mm.

2. Processes

The second chapter deals with the processes that can be carried out on the TECAWAFER PEEK LDS substrate and partly on the TECASUB PEEK LDS. Classic microsystems technology processes are highlighted here, as well as the usable and innovative assembly and connection technology.

2.1 Cleaning

The TECAWAFER PEEK LDS is made of the highly inert TECACOMP PEEK LDS and is therefore highly resistant to solvents. Only toluene and benzene should be avoided. Conventional cleaning processes in microsystems technology, such as water, acetone or isopropanol, can be used for cleaning without any further concerns.

2.2 Handling

The TECAWAFER PEEK LDS is usually offered as a 4 inch round or 4 inch square substrate. The material is brittle-hard and can be handled without handling tools. In contrast to ceramic, glass or silicon, the material is not at risk of breaking or cracking due to falling or jamming. In contrast to silicon, it can be clamped without any problems.

2.3 Lithography

Photolithography, especially with mask exposure or direct exposure, has been extensively tested on the TECAWAFER PEEK LDS. Various coating systems have been used and tested. It is possible to use spin coating, spray coating or dip coating. Positive resists such as A10xt from Microchemicals, AZ5214 from Microchemicals and SU8® resist or polyimide resists were tested and used for microsystems. Fig. 4 to Fig. 6 show various lithography results on the TECAWAFER PEEK LDS. The SU8® coating was used in particular for the construction of optical fibers with high demands on surface roughness. Optical fibers on the TECAWAFER can be seen in figure 6 .

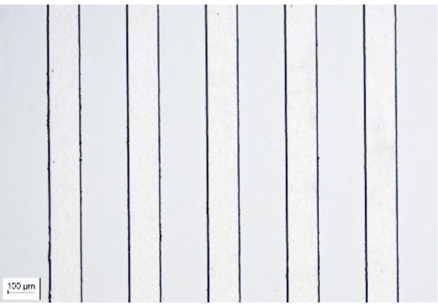

Fig. 4: Positive Resist A10xt

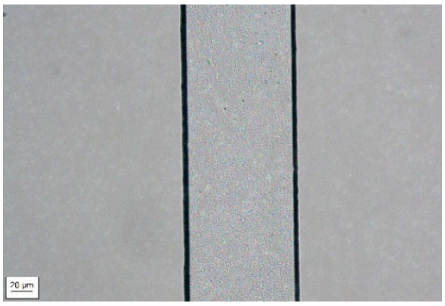

Fig. 5: Negative Resist AZ5214

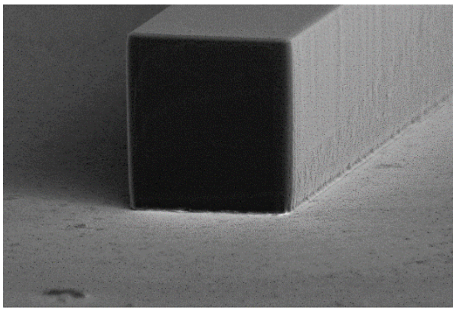

Fig. 6: Lithographically structured wafer SU8® for the construction of optical fibers (Source: IMPT University of Hanover)

Fig. 7: Lithographically structured wafer with Microchemicals n10xt (AMR sensor meander)

2.4 PVD (Physical Vapor Deposition)

PVD processes (vapor phase deposition) are processes that take place under high vacuum - process pressures between 1x10-3 and 1x10-6 mbar. In vacuum processes, the water content of the substrate and outgassing are the primary issues and place the highest demands on polymer-based substrates. In many cases, polymers tend to absorb water and can therefore have a significant impact on coating processes. Thin films that can be coated without pre-treatment are nickel up to approx. 1 µm nickel-iron (81/19) up to approx. 1 µm, nickel-chromium (60/40) up to approx. 1 µm as well as chromium, tantalum or titanium as adhesion promoters. Copper and gold should be applied with an adhesion promoter. Pre-treatment with oxygen plasma increases the roughness of the substrate and should therefore be viewed critically as far as surface-critical applications are concerned, but increases the adhesion of pure gold layers on the TECAWAFER PEEK LDS.

Fig. 8 shows a TECAWAFER LDS black coated with gold. Cathode sputtering was used as the process (magnetron sputtering). Different process gases during sputter etching and the use of adhesion promoters lead to an improvement in surface roughness. AFM measurements (Atomic Force Microscopy) sometimes show surface roughness R_a of up to approx. 6 nm. Pre-treatment with oxygen plasma is effective, but this increases the surface roughness of the substrate material. The adhesion of, for example, gold layers on the TECAWAFER PEEK LDS black was investigated. A comparison was made between thermal vapor deposition and sputtering. The coating adhesion was tested using the Scotch Tape Test (TESA 4308). Adhesion of the thin films is generally given with and without adhesion promoter. However, either NiCr, Ni or Cr layers should be used as adhesion promoters or a pre-treatment with oxygen plasma should be selected, which, however, increases the roughness. Platinum in NiFe layers can also be applied without adhesion promoter and pre-treatment by means of sputtering.

Fig. 8: Wafer coated with gold PVD (cathode sputtering)

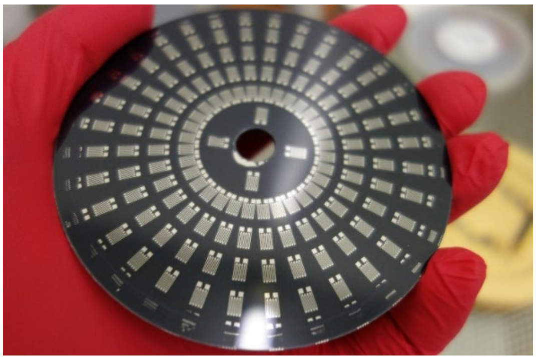

Fig. 9: Lithographically structured and PVD-coated wafer (100 nm NiFe)

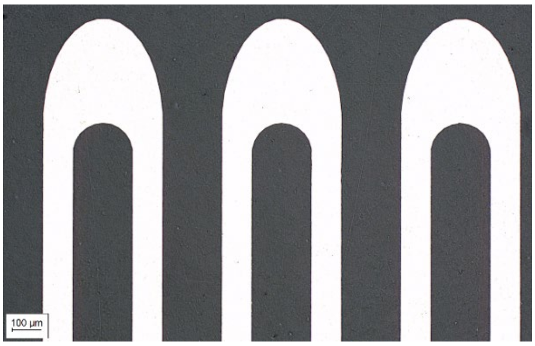

Fig. 10: Lithographically structured and PVD-coated wafer (100 nm NiFe)

2.5 PECVD (Physical Enhanced Chemical Vapor Deposition)

PECVD processes (Physical Enhanced Chemical Vapor Deposition) are coating processes with which insulation layers such as silicon nitride or silicon dioxide are usually deposited from the gas phase. These processes are usually carried out at temperatures above 300 °C. However, there are also low-temperature PECVD processes that run at around 150 °C. These processes were tested for the deposition of insulating layers of up to 1 µm silicon nitride and 1 µm silicon dioxide. These insulation layers were mapped on the TECAWAFER in a target-oriented manner and were functional with regard to the desired properties. No cracking or delamination of the layers was observed. A Scotch tape test was carried out successfully.

2.6 Etching Processes

Etching processes and, in particular, dry etching such as ion beam etching or plasma etching are important process steps in lithography in order to expose the desired structures. The substrate must have a certain resistance and vacuum process reliability so that these processes can be carried out. The TECACOMP PEEK LDS fulfills the requirements for these dry etching processes and can be mapped in the process chain.

2.7 LDS (Laser Direct Structuring)

Laser direct structuring is a process from the field of MID - Mould Interconnect Devices. The process is based on special compounds that are functionalized by means of additives (particles) and can be activated by laser ablation. The process was developed and industrialized by LPKF Laser&Electronics AG. The process has become established in the field of antenna technology in mobile phone technology, where three-dimensional antenna structures have been incorporated into telephone housings. The process chain of laser direct structuring can be seen in figure 11..

The metallization processes are based on the electroless deposition of copper on the areas activated by the laser. After nucleation in the copper electrolyte and the growth of the metallic thin film, nickel is also deposited electrolessly in a second step. The nickel serves as a diffusion barrier for the final gold layer. This layer stack has a thickness of 3 to 15 µm and, like the ENIG process in PCB technology, can now be joined using various soldering processes, such as conventional soldering or reflow soldering. The plastics used as substrates can be various thermosets or high-performance plastics from Ensinger, such as LCP LDS or TECACOMP PEEK LDS, from which TECAWAFER or TECASUB are made. A substrate for microsystems technology that can be laser structured is a novelty on the market and can demonstrate the unique selling point of TECAWAFER and TECASUB. This “new” process chain on a substrate is a key to completely new and innovative packaging processes such as TPV - Through Plastic Via, which, in contrast to TSV (Through Silicon Via), can be mapped extremely efficiently - e.g. 13 vias/sec with a substrate thickness of 1 mm. Figure 13 shows the electrical infrastructure with conductor tracks and 1056 vias on a TECAWAFER PEEK LDS. It can be shown that VIA structures with diameters of approx. 22 µm can be produced. These VIAs can also be metallized and can be used, for example, as backside contacts for sensor systems. Figure 17 shows an application example of an AMR sensor with so-called daisychain contacting of the sensor tracks. (Source: IMPT University of Hanover DeWall/Bengsch)

Fig. 11: LDS Process chain (Source: LPKF Laser & Electronics GmbH)

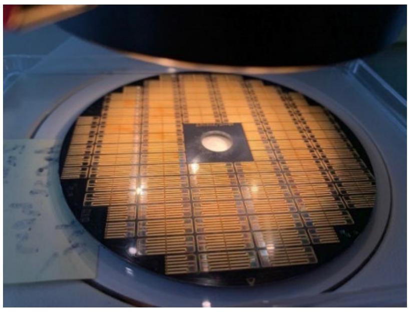

Fig.12: Laser direct structured electrical infrastructure of flow sensor

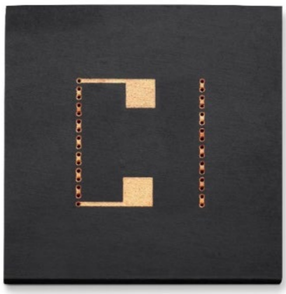

Fig.13: Laser direct-structured through-hole plating (rear side) of a daisy-chain AMR sensor

2.8 Assembly and Joining technology (Packaging)

The assembly and joining technology (packaging) on the TECAWAFER PEEK LDS and the TECASUB PEEK LDS can be considered in a completely new way in comparison to conventional substrates such as silicon or aluminum oxide ceramics. At this point, some procedures and processes are shown that should be emphasized and considered in particular.

2.8.1 Soldering

Conventional soldering, also known as hand soldering, is generally possible on the TECAWAFER or TECASUB with solder systems that form a eutectic below 260°C. These soldering systems can be soldered using a soldering iron and lead-free silver-based solders or lead-based solders can be used. The soldering processes can be carried out on corresponding ENIG (Electroless Nickel Immersion Gold) layers, as they are also produced in the LDS process. Solderable layers can also be created using PVD processes. Various solderable layer stacks are possible as a PVD system.

2.8.2 Reflow Soldering

Reflow soldering usually consists of the process steps of solder paste application (through a mask), placement and the soldering process within a reflow oven. Several requirements are placed on the substrate. The substrate must be extremely flat so that the paste only reaches the desired areas when the solder paste is squeegeed on. Furthermore, the substrate must be metallizable with a solderable layer of usually Cu/Ni/Au. In the case of TECAWAFER, this can take the form of laser direct structuring or PVD processes. This can create a great deal of design freedom that cannot be achieved on ceramics or even silicon and thus transfer the advantages of the PCB directly to the functionalized substrate, thus neglecting packaging steps. Fig. 14 to Fig. 16 show the different steps of reflow soldering on a 2 inch TECAWAFER with LDS through-hole plating and PVD coated Cu/Ni/Au layer of 1 µm Cu, 50 nm nickel and 200 nm Au. The reflow heating curve is shown in fig. 17.

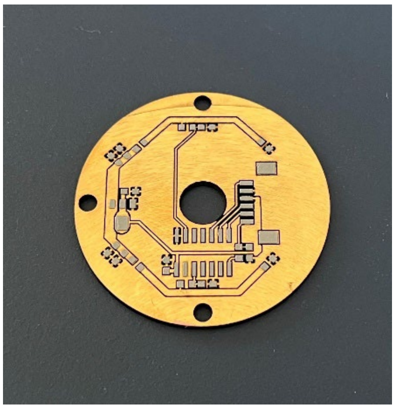

Fig. 14: Apply Solder Paste

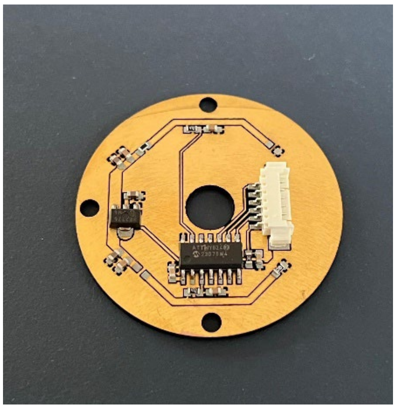

Fig. 15: Mounting

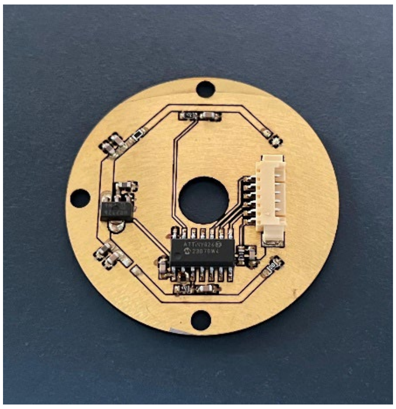

Fig. 16: Reflow Soldering

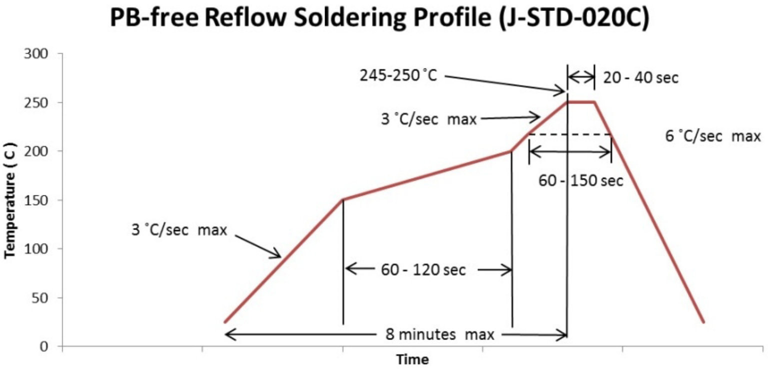

Fig. 17: Temperature curve during the reflow process (PC/JEDEC J-STD-020)

2.8.3 Thermo-Compressive-Soldering

Thermo-compressive soldering is a rather rare but very interesting joining process. It can be used particularly efficiently and gently in the low-temperature range from 80 to 137°C. It should be emphasized here that semiconductor components exist that must not exceed 130°C and conventional soldering processes reach their limits here. Based on the TECAWAFER, it can be shown that extremely robust solder systems for assembly and connection technology can be realized by means of PVD applied solder layers of 1 µm Sn and 1 µm In. Joining pressures should be in the range of 1 - 1.5 MPa.

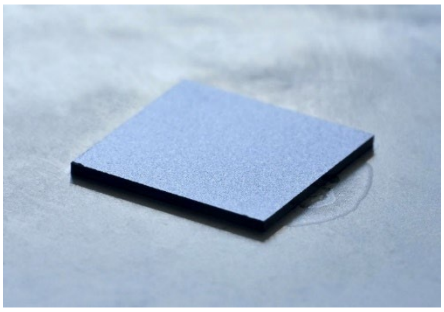

Fig. 18: Thermo-compressively joined silicon chip (InSn solder - vapor-deposited) on TECAWAFER PEEK LDS black

2.8.4 Bonding

Bonding on the TECAWAFER or TECASUB substrate can be carried out with isotropic or anisotropic conductive adhesives. We recommend the product Chemtronics CW 2400 ™ for contacting. Epoxy resins or cyanoacrylate can be selected for joining TECACOMP plastics.

2.8.5 Laser Welding

In order to create a secure joint between two PEEK-based components, the TECACOMP PEEK LDS can be joined with unfilled (laser-transmissive) PEEK - e.g. PEEK film - which can be used as a very efficient packaging process in the case of components based on the TECAWAFER. Fig. 19 shows a PEEK-based MID component that has been sealed with unfilled PEEK film using a laser welding process.

Fig. 19: PEEK foil welded onto temperature sensor

2.8.6 Wire Bonding

Wire bonding, whether it is ball-wedge or wedge-wedge bonding, is a very common contacting process, especially for connecting unhoused semiconductor components to housings or interposer structures. Wire bonding is also usually produced with gold/gold or gold/aluminum wires or connections. Increasing miniaturization poses particular challenges with regard to wire diameters. Thin wire bonding in the range of 17 µm to 25 µm wire diameter places very high demands on the surface roughness of the substrates on which bonding takes place. The surfaces on semiconductor substrates and corresponding PVD layers in the range of 200 nm layer thickness offer the best conditions for this. However, thin-wire bonding on classic galvanic layer systems on printed circuit boards and on MID components metallized using LDS processes present major challenges for thin-wire bonding due to the surface roughness of the galvanic or electroless metallized layer systems, which is often in the one to two-digit micrometre range (average roughness value R_a)

At this point, the TECAWAFER or the TECASUB substrate can show clear advantages, as metallizations with PVD layers can be imaged here as on silicon substrates or ceramics (R_a 20 - 40 nm, sometimes less than 10 nm), so thin wire bonding can be carried out on the TECAWAFER or TECASUB. High resolutions can be generated here using various methods in order to demonstrate application scenarios for interposer applications. See chapter Interposer.

Fig. 20: Thin wire bonds on 200 nm Au (PVD) on TECAWAFER PEEK LDS black

3. Areas of Application

The following chapter shows which microsystems can be built on the basis of TECAWAFER PEEK LDS and TECASUB PEEK LDS, for example, and which specific advantages can be created and emphasized on the basis of the substrate material TECACOMP PEEK LDS.

3.1 Temperature Sensors

Temperature sensors are usually made of platinum or nickel thin films on ceramic substrates. The use of ceramic substrates is also based on the fact that ceramics, especially Al_2O_3 ceramics, have a similar thermal expansion coefficient to platinum, are highly thermally stable and are chemically resistant in order to withstand the various process steps of photolithography. One disadvantage of ceramics, glass or silicon, however, is their high thermal conductivity compared to polymers, which has a negative impact on the response behavior of the sensors and therefore requires the substrate to be thinned in some cases. However, TECAWAFER PEEK LDS can offer a possibility to build temperature sensors from the thermally “less” conductive polymer PEEK and to use this material behavior to the advantage with regard to the response behavior.

3.2 Flow Sensors

Flow sensors, especially calorimetric flow sensors, which consist of at least one temperature sensor and one heating element, utilize the same advantages as temperature sensors when they are mounted on the TECAWAFER PEEK LDS. The poor thermal conductivity of the substrate also ensures that the sensors respond quickly and that the heating element only heats up locally. Based on the TECACOMP PEEK MED LDS, applications for biomedical technology in particular can be focused on, as potentially biocompatible flow sensors can be constructed here.

3.3 Strain Sensors

Strain gauges are usually made of nickel-chromium or constantan on flexible substrates such as PI foils (Kapton®) or directly on steel. A major disadvantage of flexible strain gages is the indirect sensor signal, which is attenuated by the adhesive used to bond the sensor to the component to be measured. Direct application to steel requires a reliable insulating layer which must be applied to each component, as well as sophisticated contacting. The structuring of both sensor types (Kapton® and steel) is usually created with lasers and expensive systems such as femto second lasers must be used.

3.4 Pressure Sensors

Pressure sensors based on strain gauges are usually made of nickel-chromium or constantan based on PVD thin films. Silicon, glass or even steel is usually used as the substrate. The challenge of pressure sensors on conventional substrates is the manufacture of the diaphragm, which has to absorb the change in ambient pressure. These membranes are often produced by expensive etching processes (chemical or dry chemical) or by complex assembly processes of thinned membrane chips. The TECAWAFER PEEK LDS can already have the membrane structures by pre-structuring via the injection moulding process or can be produced extremely process-optimized and efficiently by milling the thermoplastic on the back. This design variant thus eliminates the need for time-consuming assembly or etching processes.

3.5 AMR Magnetic Field Sensors

AMR magnetic field sensors are based on the anisotropic magnetoresistive effect and are produced specifically in nickel-iron based alloys. The alloy NiFe 81/19 is used for thin-film-based AMR sensors. The thin films are produced using PVD processes, in this case cathode sputtering. AMR sensors are usually built on silicon substrates due to the absence of magnetic properties and the very good surface roughness. The surface roughness plays a decisive role for the AMR effect - reduction of the basic resistance of a conductor to which a magnetic field is orthogonally aligned. The better the roughness of the substrate, the lower the influence of the alternating magnetic field on the domain alignment. Accordingly, the requirements for the construction of magnetic field sensors are correspondingly high in relation to the substrate quality. TECAWAFER PEEK LDS, with its very good surface qualities and low-stress PVD layer system structures, provides a reliable substrate for the construction of magnetoresistive sensor systems. Even highly sophisticated GMR sensors have already been successfully built on TECAWAFER PEEK LDS.

3.6 Interposer

Interposers are used in many fields of application and are generally used to “re-route” from a high-resolution contacting level to a “coarser” contacting level in order to reliably contact semiconductor-based components. Interposers are usually made conventionally from silicon or directly on the printed circuit board (PCB). Silicon-based interposers are significantly more expensive to manufacture than PCB-based interposers, but score points with their high resolution and versatile joining options. However, silicon interposers often reach their application limits due to their frequency behavior, maximum size and price. In contrast, the low-cost PCB-based interposers quickly reach the limits of the technology in terms of resolution. This results in a gap in the market in terms of interposer resolutions and processing capabilities. This is where the TECAWAFER PEEK LDS can be used. Due to the very good lithography processability, the PVD coatability in combination with laser direct structuring, resolutions can be generated that are higher than with the PCB and allow design freedom in terms of shape, thickness or design that would be difficult to realize even with a PCB. With the LDS process, 13 vias/sec can be generated through a 1 mm substrate.

This is extremely fast and cost-efficient compared to the Deep Reactive Ion Etching (DRIE) process on silicon. With the TECASUB PEEK LDS, large-area and even thinner substrates can be produced (min. 100 µm thick).

4. Environmental Tests

The following chapter lists the environmental tests carried out and the corresponding results for the compound, the TECAWAFER and TECASUB

4.1 Continuous Service Temperature

The continuous service temperature of TECACOMP PEEK MED LDS and TECACOMP PEEK LDS is 250°C to 260°C and can also be increased to 300°C for short periods, e.g. for soldering processes. The TECAWAFER has been exposed to continuous operating temperatures in accordance with MIL STD. 883 and, depending on the microsystem, can be used in application scenarios from -70°C to 250°C. However, there are microsystems, especially magnetic systems or magnetic field sensors, which do not allow temperatures above approx. 200°C due to recrystallization processes of the metallic thin films or the Curie temperature of some materials.

4.2 Thermal Shock Tests

The TECAWAFER PEEK LDS has been tested according to MIL STD 883 for temperature cycling. The substrate shows no negative changes to the surface or planarity in the maximum range of -70°C to 250°C. No cracking could be detected in a variety of metallic thin films such as Ni, NiFe, Au, Pt, NiCr, Cu.

4.3 Water Absorption

The TECACOMP PEEK LDS has a water absorption of only 0.2 % and can therefore be used in vacuum systems. The TECAWAFER PEEK LDS can be used for PECVD, PVD and ALD processes when deposited in a vacuum between 1×10^{-3} and 1×10^{-6} mbar.

4.4 Outgassing Behavior Under Vacuum

The TECAWAFER PEEK LDS can be used for PECVD, PVD and ALD processes when deposited in a vacuum between 1×10^{-3} and 1×10^{-6} mbar. Outgassing measurements in comparison with aluminum oxide ceramics show a similar outgassing behavior.