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Sensors on PEEK - Advantages of Plastic Substrates in Microsystem and MEMS Technology

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Summary:
Silicon, glass and ceramic substrates are generally used in the field of microsystems technology and MEMS. Thermoplastics play a subordinate role at most in the area of flexible substrates. However, substrates made of polyether ether ketone (PEEK) offer previously unimagined advantages for new sensor application scenarios where conventional substrates reach their limits. Especially the Ensinger Microsystems Technology (EMST) shows the various benefits using PEEK as a substrate material.

Keywords: Sensors, PEEK, Plastic, Substrates, EMST, MEMS

Introduction

Silicon and ceramic substrates are generally used in the field of microsystems technology and MEMS. Thermoplastics play a subordinate role at most in the area of flexible substrates. However, substrates made of polyether ether ketone (PEEK) offer previously unimagined advantages for new sensor application scenarios where conventional substrates reach their limits.

Polyether Ether Ketone

PEEK is a thermoplastic material with high chemical resistance and excellent temperature behavior. The material withstands 250 °C permanently and for bonding processes even 300 °C for short times. The material is also available as a compound material for Laser Direct Structuring and is adapted to metallization processes. The dielectric strength of 17.5 kV/mm shows ideal electrical resistivity for e.g. electronic or sensor applications.

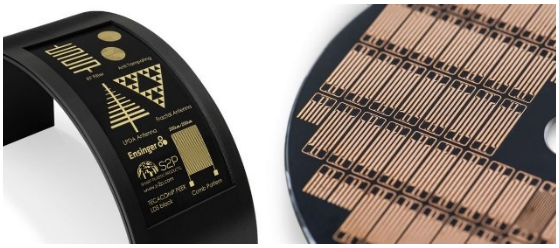

Fig. 1: PEEK based Substrates

Advantages of PEEK Substrates

Fig. 2 shows the properties of PEEK in comparison to the established substrates. Generally, no substrate is superior in every field of interest and the web diagram illustrates that the PEEK based TECAWAFER PEEK LDS substrate is beneficial in terms of electrical and chemical properties. It also has a lower environmental impact and allows for multiple packaging options.

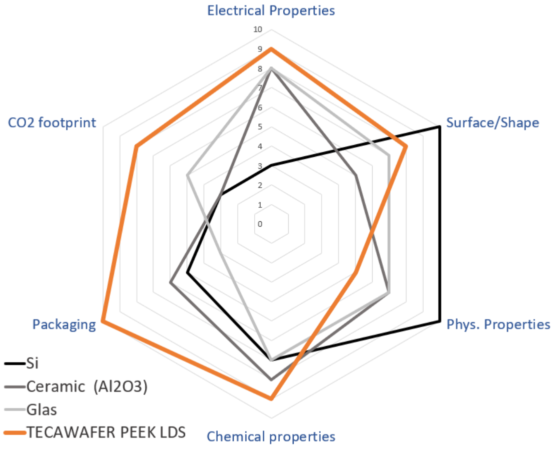

Fig. 2: TECAWAFER PEEK LDS in comparison

Ensinger Microsystems Technology

The Ensinger Microsystems Technology (EMST) consists of three basic process steps.

1. Injection molding
2. PVD coating
3. Chemical Mechanical Polishing (CMP)

Using highly precise molding inlays, microstructures are imprinted by the injection compression molding process into the PEEK material. This way a structural resolution in the single digit micrometer range is achied. Subsequent PVD processes include sputtering, evaporation and for insulation purposes PECVD. The following polishing step removes the applied layer apart from the metallization inside the structured cavities.

Advantages of the EMST Process Chain

The EMST process chain shows advantages not only regarding the number of process steps. It also allows the neglection of the clean room environment and robust choice of substrate material. The high reproducibility and excellent values of standard deviation of this process chain regarding mechanical an electrical values have to be emphasized. The references [1] – [5] show the use cases for the Ensinger Microsystems Technology.

Sensor Examples

Using the Ensinger Microsystems Technology, various thin film based sensors have already been manufactured. The first sensors evaluated on PEEK were temperature sensor elements, which are applicable between -70 and 250 °C [1]. Another major focus of sensor application lays in the field of magnetic field sensors. AMR and GMR Sensors were built using EMST and showed state of the art sensor signal and behavior on PEEK substrates [3]. Also strain gauge based sensor systems like torsion, strain and pressure sensors were evaluated in will be published shortly. A combination of heater and sensor elements can be manufactured in the case of calorimetric flow sensors, which are also available on PEEK substrates [5]. Fig. 4 shows various thin film based sensor samples based on the EMST process chain.

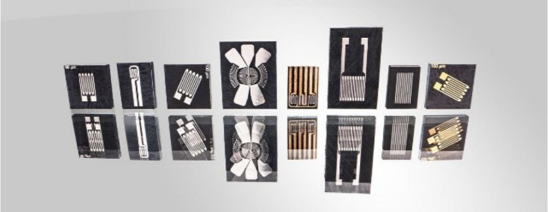

Fig. 4: Various Sensor Examples Based on PEEK and EMST Process Chain

Benefits of PEEK in Sensor Technologies

PEEK as substrate material and especially the used TECACOMP PEEK LDS as substrate for sensor manufacturing - also in the case of the EMST technology - shows various benefits for different sensor applications. Regarding temperature sensors the fast response behavior using PEEK as substrate has to be emphasized. Similar behavior on silicon substrates can only be realized using expensive backside thinning processes using dry etching. In case of calorimetric flow sensors, the same effect can be very beneficial. Flow sensors also need chemical and physical resistance for different media and therefore alternatives are looked for especially where silicon or ceramic show limitations (e.g. acids and alkaline). Looking at the manufacturing of pressure sensors on the basis of strain gauges , usually expensive thinning and mounting of the membranes to the body/housing is challenging and expensive. Using PEEK as a substrate increases the signal and manufacturing can be simplified by mechanical thinning of the membrane or direct production of membrane and housing in one process step.

Conclusion

PEEK as a substrate material opens up new possibilities in terms of manufacturing technologies. Physical and chemical limitations of existing substrate technologies are overcome with PEEK and in particular with TECAWAFER PEEK LDS, creating new possibilities for sensor applications and designs.

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