Fraunhofer ENAS

Technologies

Low temperature adhesive bonding by using biocompatible Parylene C

Fast Facts

- Low bonding temperatures ≤ 300 °C
- Short bonding times of down to 5 min
- Chip and wafer bonding
- Bonding at different pressures (vacuum or atmospheric)
- Bonding of various materials
- High tensile strengths up to 40 MPa and high shear
- strengths up to 80 MPa
- Good hermeticity and reliability

General Description

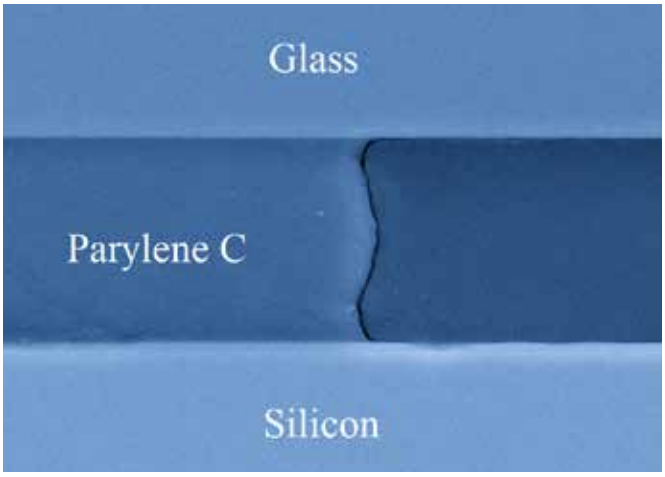
Following the trends of microsystems technology, new materials and components such as polymers and organic materials need to be integrated. Furthermore, due to ongoing miniaturization and increasing complexity of microsystems high-performance bonding processes are required, which keep small mechanical components, such as springs and membranes, movable. For smart medical implants, additionally biocompatibility and biostability is required as well as hermetic packages. For highly impermeable packages also hermetic bond interfaces are needed.

Parylene is a thermoplastic polymer which combines are variety of excellent properties, such as low permeability for gases and moisture, hydrophobicity, chemical inertness against all common acids, bases and solvents, optical transparency, dielectric properties, thermal stability, and dry-film lubricity. Additionally, some types of Parylene, such as Parylene C, are biostable and biocompatible according to ISO 10993. Parylene is deposited from the gas phase by a CVD process at room temperature. Hence, the obtained layers feature an excellent 3D conformity and are free of internal mechanical stresses. Parylene coatings can be patterned by oxygen plasma etching with a resist mask or laser ablation.

A new and innovative bonding process for 6 inch and 8 inch wafers uses Parylene C as an adhesive. The bonding process itself requires only low temperatures of ≤ 300°C, low bonding pressure and only short bonding times of down to 5 minutes. Successful bonding was demonstrated for a variety of different materials, for a wide range of Parylene thicknesses as well as for unpatterned and patterned Parylene down to geometries of 50 µm width only. Furthermore, the process can be performed in vacuum and at atmospheric pressure as well as on chip and wafer level. The obtained bond interface is highly realiable featuring high tensile and shear strength, excellent temperature stability (cycling) and low permeability for gases. This high reliability enables the compatibility of the wafer compounds with subsequent processes such as dicing.

Advantages of the Bonding Technology

- Highly 3D conformal coating of adhesive at room temperature on all vacuum suitable susbtrates
- Bonding suitable within a high range of adhesive thickness of 500 nm … 10 µm
- Dielectric / Electrical isolating properties of Parylene C with high electrical breakthrough strengths
- ISO 10993 certified biocompatible Parylene adhesive
- PatternableParylene adhesive by plasma etching (resist mask) or laser ablation
- Optical transparency of adhesive enables optical applications and MOEMS when bonded with glass



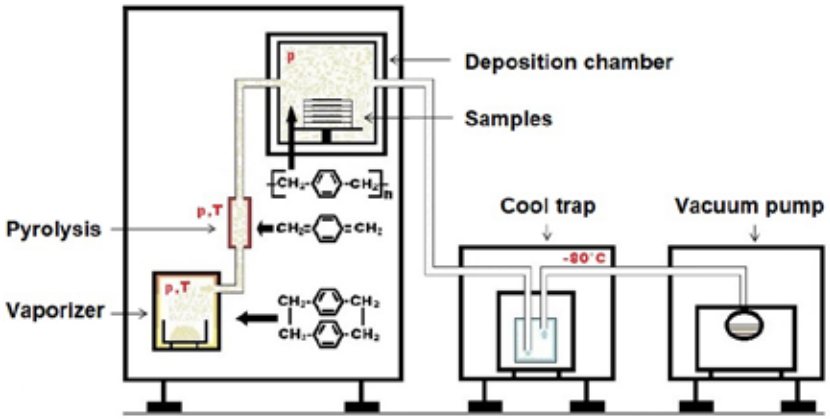
Cross-sectional SEM image of a Parylene-bonded Silicon-Glas compound.

Successfully Bonded Material Combinations

- Silicon / Parylene C / Silicon
- Silicon / Parylene C / Silicon dioxide
- Silicon / Parylene C / Silicon nitride
- Silicon / Parylene C / Glass
- Silicon / Parylene C / Aluminium
- Silicon / Parylene C / Parylene C

Suggested Applications

- Smart Systems
- Microsystems
- Optical devices
- Medical devices



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TECHNISCHE UNIVERSITÄT CHEMNITZ

Fraunhofer ENAS is part of

Forschungsfabrik Mikroelektronik Deutschland

Contact

Franz Selbmann
Phone +49 371 45001-491
franz.selbmann@enas.fraunhofer.de

Dr. Maik Wiemer
Phone +49 371 45001-233
maik.wiemer@enas.fraunhofer.de

Fraunhofer ENAS
Technologie-Campus 3
09126 Chemnitz | Germany

www.enas.fraunhofer.de

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