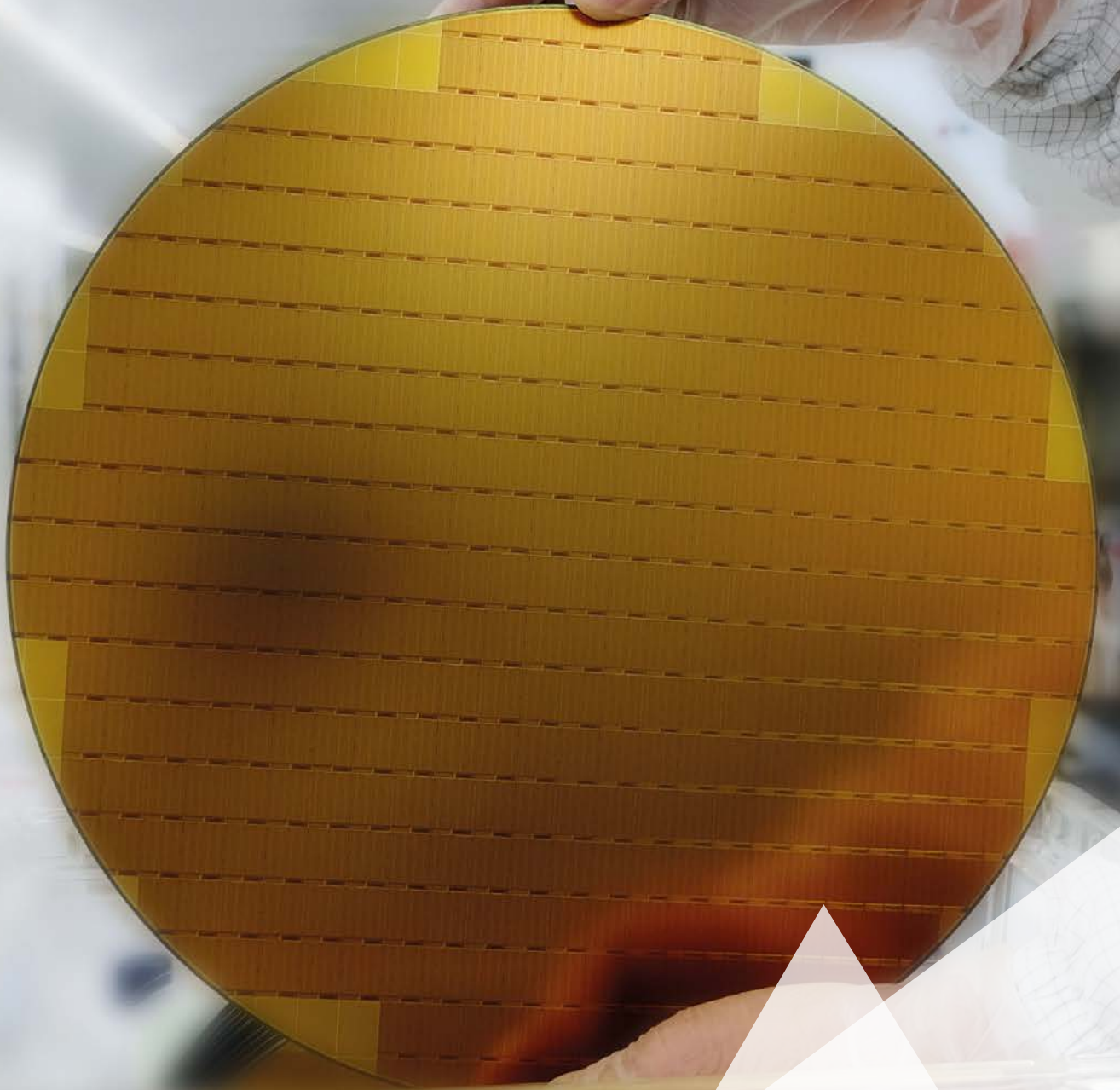


PERFECTING CHUCKS.
VACUUM CHUCKING FOR
WARPED WAFERS.



VACUUM CHUCKING FOR WARPED WAFERS.

With the growing importance of More than Moore, the need for smaller devices with higher bandwidth is driving the market for advanced packaging to enable the 3D-integration of ICs, memory, MEMS and CMOS image sensors. As a result of these technology developments, the number of highly warped wafers is increasing, giving new challenges to supply tools for the semiconductor industry.

While Berliner Glas has proven long-term experience in designing and manufacturing super-flat vacuum chucks for standard (flat) wafers, the vacuum chucking of highly warped wafers with bows up to 1.5 mm requires unique new chuck concepts.

Berliner Glas has the experience to layout, simulate and manufacture vacuum chucks for highly warped wafer chucking adapted to the individual needs of customers.

Each chuck is individually designed according to customer-specific machine and process requirements. Depending on customer specifications, wafers with a wide range of properties can be chucked:

- ▶ Warpage of up to 1.5 mm with arbitrary shape (smiling, crying, saddle-shaped, ...)
- ▶ Different wafer materials (silicon, glass, ...)
- ▶ Different wafer thicknesses (up to a glass thickness of 1.5 mm)

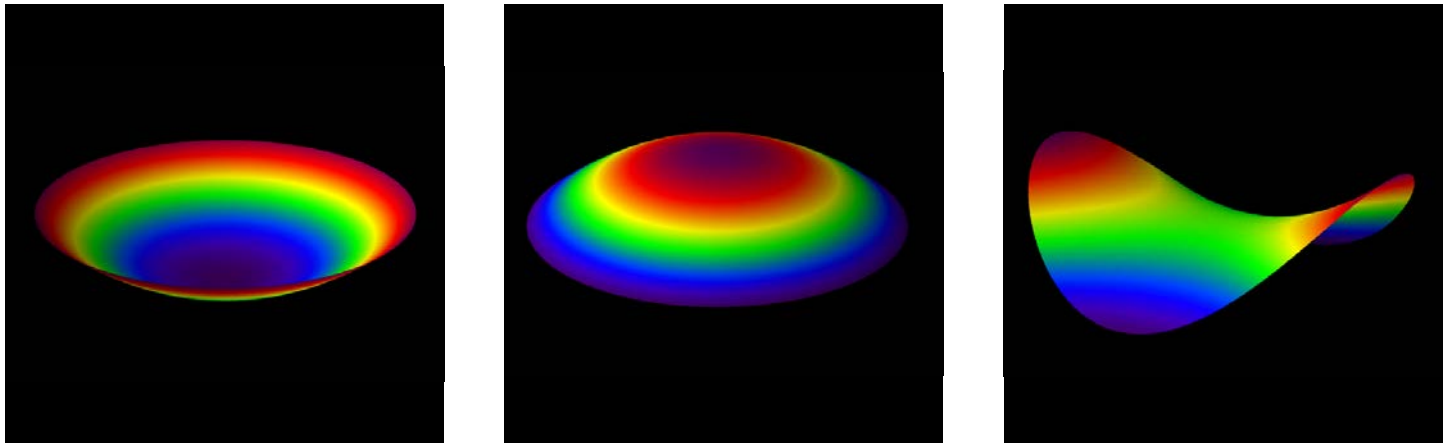


Fig.1: Scaled image of differently shaped warped wafers which were successfully chucked: Smiling/concave (left), crying/convex (middle) & saddle-shaped (right). Various other forms can be chucked as well.

The chuck design can be individually tailored to the customer's requirements. Starting from functional specifications like material choice (high performance ceramics like SiSiC and SiN, CTE adapted glass like Borofloat glass or zero expansion glass ceramic like Zerodur) and geometrical guidelines, a vacuum layout can be derived, which considers the customer's vacuum supply as well as chuck features like slots for end effectors. Creating the vacuum layout includes the dimensioning of vacuum channels, holes and seals as well as the simulation of the flow behavior.

Furthermore, Berliner Glas has the capability to create pin patterns on the chuck surface that are optimally adapted to the vacuum layout and minimize the design impact on the wafer flatness. Different pin heights and distances can be implemented on one chuck to increase the chucking performance.

Special focus lies on the definition of different vacuum zones, which serve to guarantee optimum chucking performance. The evaluation of the chosen layout is part of the subsequent prototype phase.

Vacuum layout evaluation

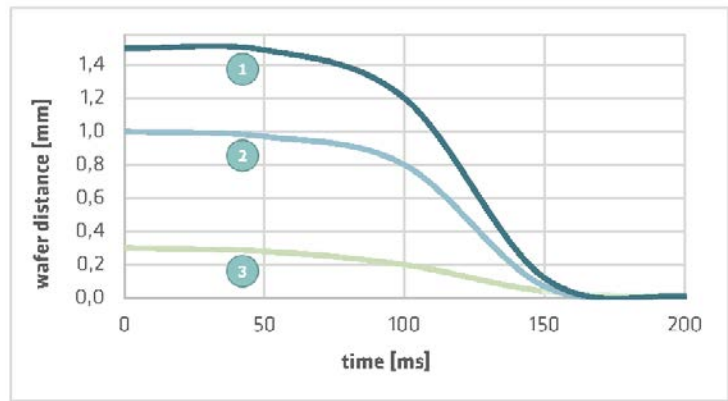
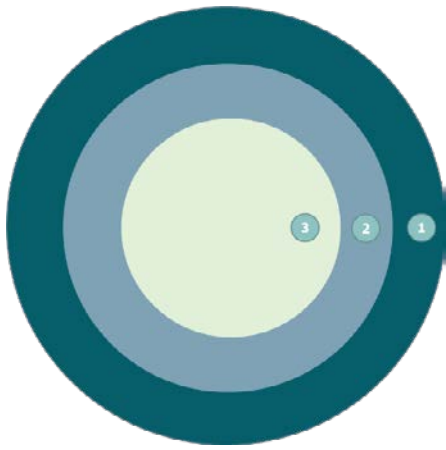
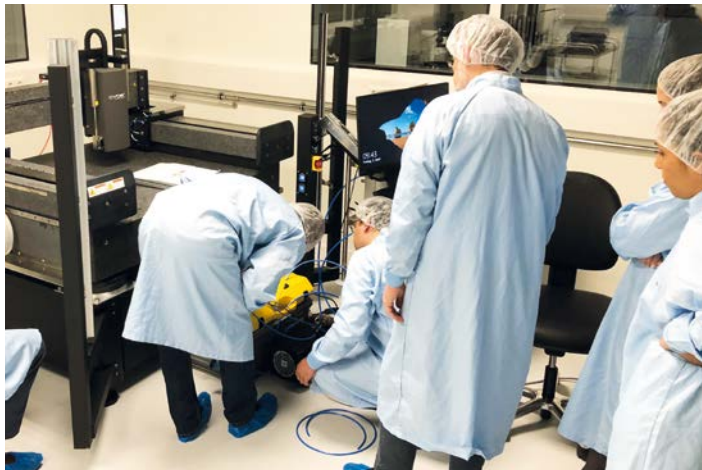
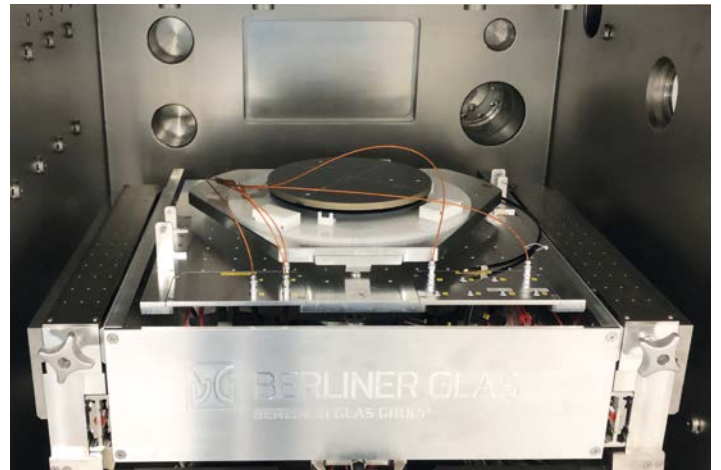


Fig.2: Evaluation of a chuck's vacuum layout: The scheme (left) represents a chuck with the simple case of three concentric vacuum zones. The diagram (right) shows the measured chucking time of a 1.52 mm smiling warped wafer on the given chuck. The graphs correspond to the three points in the different vacuum zones. The verification of the proper arrangement of the vacuum zones is of particular importance to ensure the optimum chucking performance.

The test parts, which are manufactured using the rapid prototyping process, are checked and evaluated in the test center in Berlin which has specially been set up for this purpose. These tests are usually carried out together with the customer. The basic principle of the chuck design is thereby evaluated inexpensively and, above all, quickly. The gained experience and the results of these tests are incorporated into the final design. This minimizes risks, shortens development times and optimizes product properties.



Evaluation of a chuck's vacuum layout in the test center at the Berlin location



The manufactured prototype can be characterized according to customer requirements. Interferometric one shot measurements up to 12 inch diameter to verify the repeatedly perfect fit of the wafers to the chuck can be performed as well as optical profilometer measurements.

Chuck design characterization

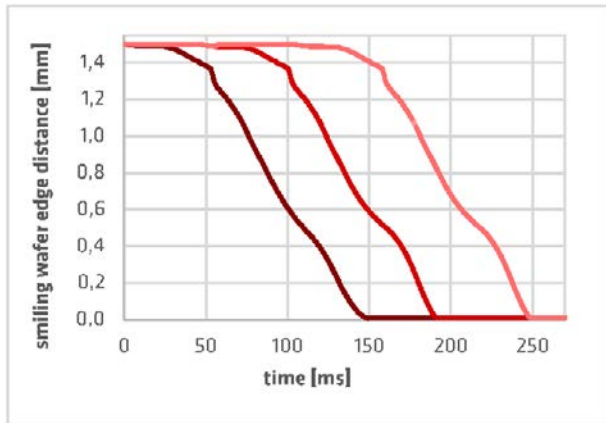


Fig.3: Measured chucking times of a chuck's vacuum layout, depending on vacuum pressure and flow. Graphs show the wafer edge distance over the chuck of a 1.52 mm smiling warped wafer. Depending on the customer's vacuum supply, chucks can be optimized for minimum chucking times and maximum throughput.

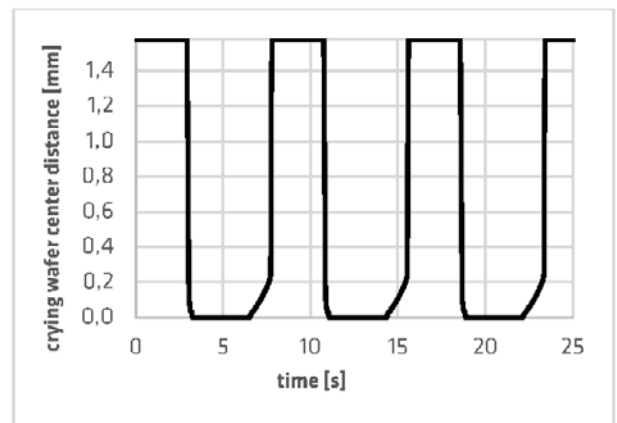


Fig.4: Chucking cycles of a chuck prototype. The graph shows the wafer center distance over the chuck of a 1.58 mm crying warped wafer. The chucking cycles last 4s, at the end of each cycle the vacuum supply is cut off and the wafer is released from the chuck. Exactly reproducible chucking sequences and constant chucking force are a main focus of the chuck design.

As another advantage, Berliner Glas concepts do not require any additional contact parts or bellows, which avoids any additional backside particle contamination of the wafers.

For customers this means a unique chuck design tailor-made for their needs to meet the challenges of More than Moore.

This document belongs to a series of documents that Berliner Glas has published under the title "Perfecting Chucks". Please visit the website for more information: <https://www.berlinerglas.com/perfecting-chucks>