Application Note

Fries Research & Technology
Rauheit Kontur Topographie

Measurement of flatness, bow, warpage and roughness

The measuring task:
The investigation of flat structures is related to quite a number of questions to be answered. Of course there is the surface roughness which is one of the main key numbers of a surface. In the case of flat surfaces also the roughness is in most cases very small, usually somewhere in the nm or even the sub-nm range.

But the second main feature of a surface is the shape. In our case the shape should be next to zero, meaning the aim is to have a minimum bow or warpage in the surface under investigation. With different words, the surface should have a high grade of flatness.

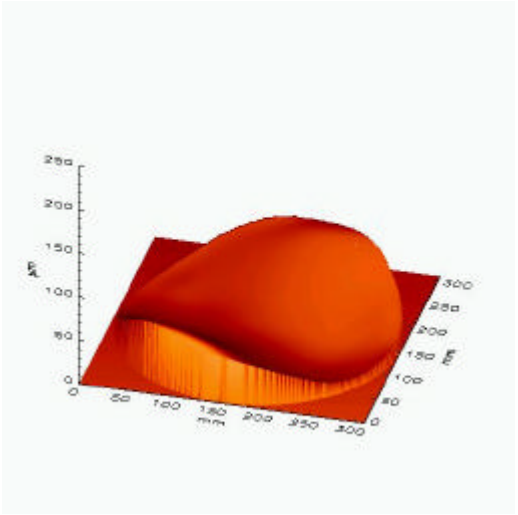


Figure 1: Warpage or fltness measurement of a 300 mm wafer. Note, that the height is only some ten microns, compared to the 300 mm area.

The problem:
The problem is, that most instruments for surface metrology are not able to measure both, roughness and flatness, and they are even not able to do variable modes of one kind. So, for example a lot of flatness or warpage instruments do low resolution shape measurement for a 300 mm wafer, but they can not do a high resolution profile for the whole device, giving a very sophisticated result for even small waviness frequencies. The local roughness can not at all been investigated.

The solution:
The FRT solution is an optical profiler with extremely high z-resolution and a high end x,y scanning stage. This system enables for overall warpage, bow and flatness measurements but also gives the flexibility to do high resolution 3D measurements locally, or to do high resolution single profiles across the complete device. If the local resolution should still not meet the customers needs, FRT combines an AFM (atomic force microscope) within the same machine, giving all available modes of operation at highest resolution.

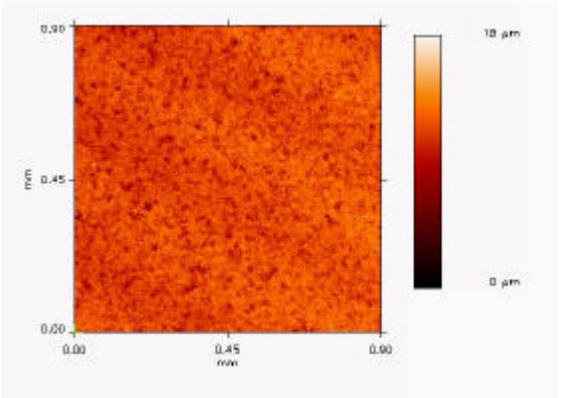


Figure 2: A high resolution measurement within the wafer surface

The optical sensor allows rapid and accurate topography measurements on sample sizes ranging from 200 µ x 200 µ

up to 600 mm x 600 mm. The x,y resolution of this sensor is 1 – 2 µ. The z range may be chosen from 300 µ up to 3 mm without moving the sensor in z direction. The resolution in height is down to 3 nm. The optical sensor is complemented by a positioning camera, which works as an optical microscope and enables for defining the scanning area.

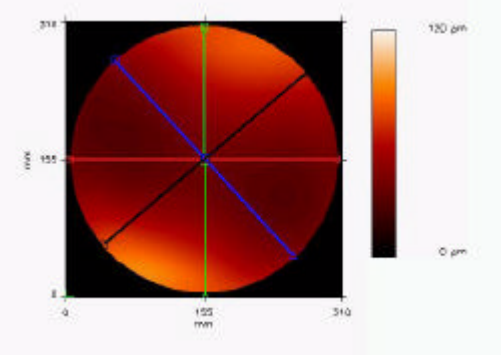


Figure 3: 300 mm wafer flatness with profiles

The sample positioning in AFM is done using either the camera or a previous optical measurement. In this way the point of investigation in AFM is always found quick and precise.

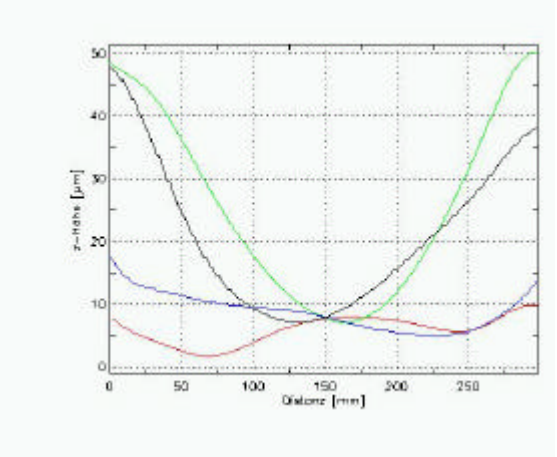
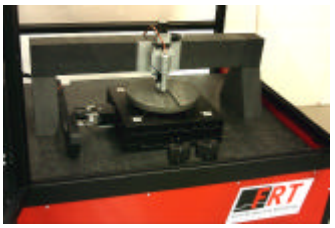


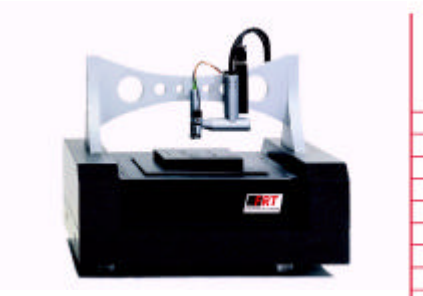
Figure 4: Profiles from figure 3 giving bow and warpage

The following FRT instruments may be used with the combination AFM/chromatic sensor:

The MicroProf® in the 200 mm and 300 mm version.

The MicroGlider® in all versions.
By deducting a reference plane a reproducibility in height of better then 100 nm is achieved for the whole measuring range of 350 mm x 350 mm.





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