Novel Technologies for Astronomical X-ray Telescopes

R. Hudec, V. Semencová, A. Inneman, M. Skulinová, L. Pína, M. Míka, J. Prokop, J. Šik

Astronomical Institute AS CR Ondřejov,
Czech Technical University Prague
Institute of Chemical Technology Prague,
Reflex sro Prague,
ON Semiconductor Czech Republic
Contact: rhudec@asu.cas.cz

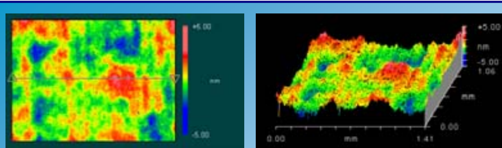
We acknowledge the support provided by the GA AV CR grant IAAX01220701, by the MSMT projects ME918 and ME911 and by Ministry of Industry and Trade of the Czech Republic, FD-K3/052. The investigations related to the ESA XEUS project are supported by the ESA PECS Project No. 98039. M.S. acknowledges the support by the junior grant by GA CR, grant 202/07/P510

Applications of precisely optically formed Si wafers:

- In space X-ray telescopes (like ESA XEUS)
- In solar cells
- In other space and ground-based applications

Preferences:

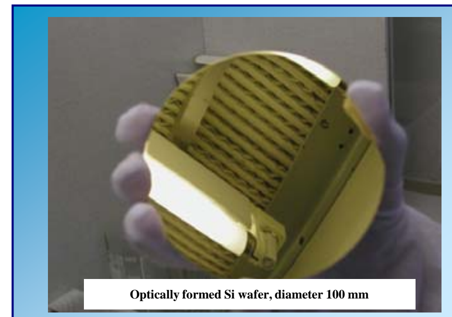
- low weight (2.3 gcm^{-3})
- very smooth (microroughness 0.1 nm)
- flatness (special wafers)
- high thickness uniformity, ...



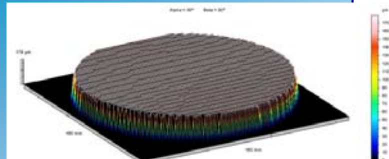
2D chart 3D chart

SIZE	1.4x1.1 mm
PV	0.04 µm
RMS	1.1 nm
Ra	0.9 nm

Optically formed Si wafer measurement by Zygo interferometer



Optically formed Si wafer, diameter 100 mm

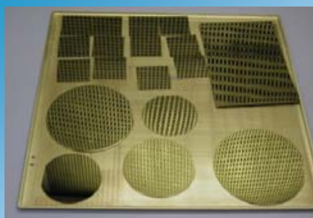


Flat Si wafer (dopant As) measurement by STILL optical profilometer - 3D chart

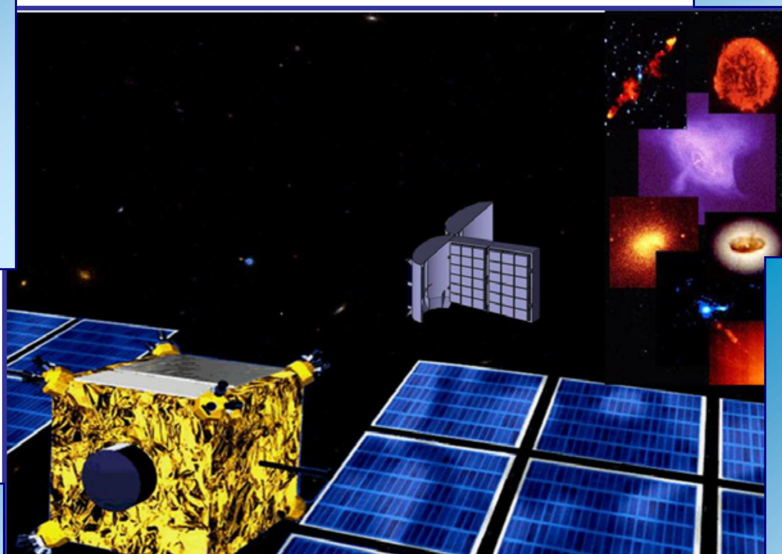
(D = 150 mm, t = 0.625 mm)

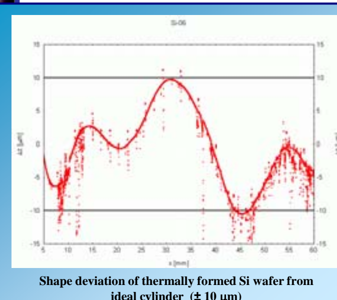
THERMAL FORMING OF SILICON WAFERS
based on plastic deformation at high temperature

thermally formed Si wafer to test cylinder
(R = 150 mm, 72 x 23 x 0.625 mm)



Various samples of flat and shaped Silicon wafers

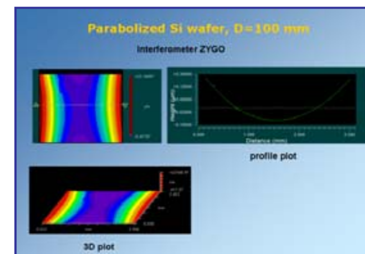


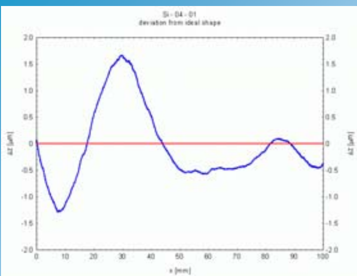


Shape deviation of thermally formed Si wafer from ideal cylinder (± 10 µm)

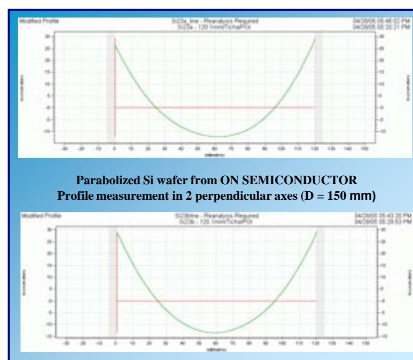
BRAND NEW TECHNOLOGY

Si wafer (D = 150 mm, 1.3 mm thick) - flat (right) and optically bent (left)

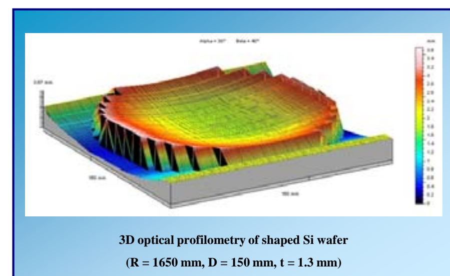




Peak to valley deviations of shaped Si wafer from ideal cylindrical surface (± 1.6 µm)
(diameter 150 mm, thickness 1.3 mm)

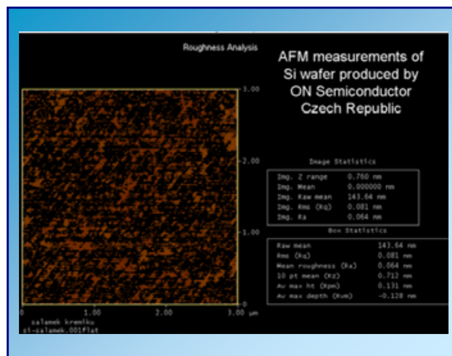


Parabolized Si wafer from ON SEMICONDUCTOR
Profile measurement in 2 perpendicular axes (D = 150 mm)



3D optical profilometry of shaped Si wafer

(R = 1650 mm, D = 150 mm, t = 1.3 mm)



Conclusions

- Silicon wafers have been successfully formed by 3 different technologies to precise optical surfaces
- In the best cases, the accuracy achieved for the 150 mm Si wafer is 1…2 microns PV for deviation from the ideal optical surface
- The experiments continue to further improve the forming accuracy