

Fast online monitoring of mechanical stress in mass processing of semiconductor wafers for photovoltaic applications

V. Gudelev, A. Smirnov



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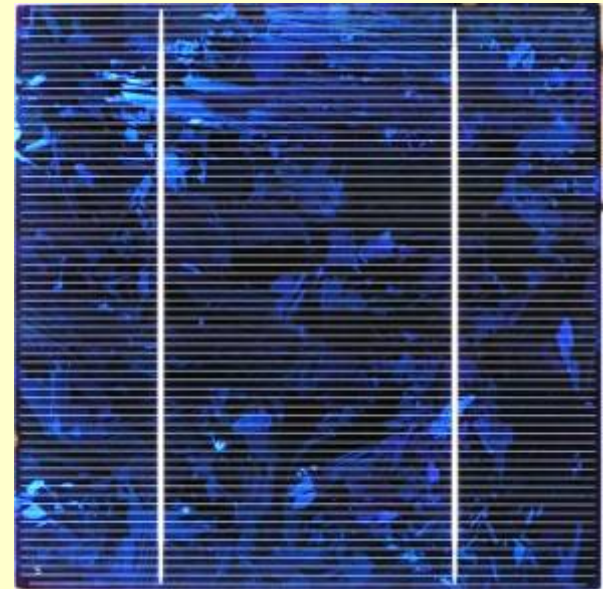
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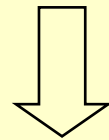
Technical Task

The non-destructive testing method is demanded by the photovoltaic industry to detect microcracks and critical residual stress locations within large-format ultrathin wafer in less than 1 second. The method is to be integrated into the production line to reject cracked wafers from processing.

- Wafer format 160 x 160 x 0.32 mm
- Spatial resolution 100 micron
- Operation speed < 1 s
- Undetected error probability 0
- Locally-resolved measurements Yes
- Wafer types Polycrystalline with polished, rough and metallized surfaces
- Specific conditions Persistent operation in fab environment

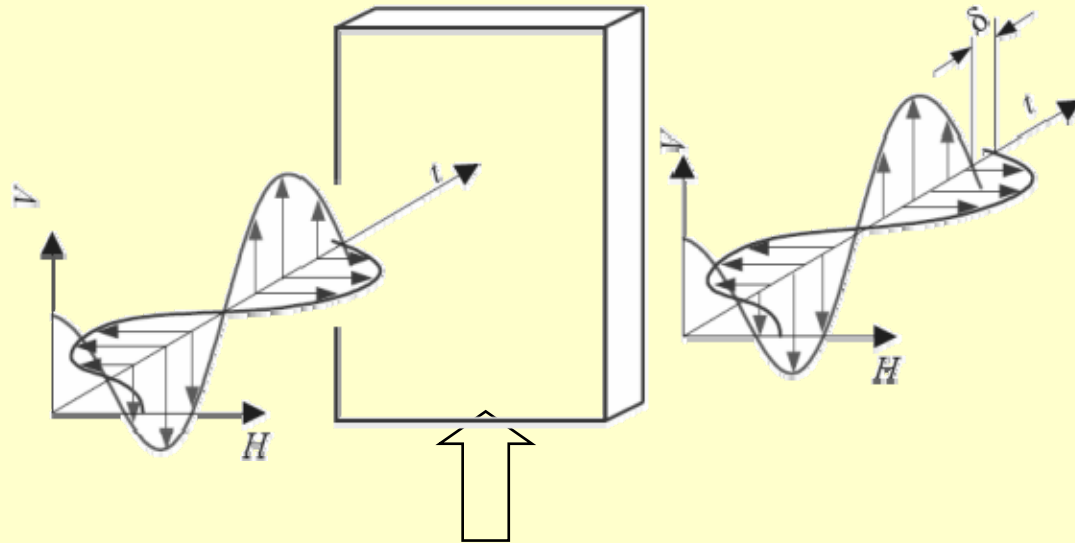


Principle



Stress-Induced Birefringence

H Horizontally polarized
 V Vertically polarized
 δ Birefringent retardation



Mechanical Force

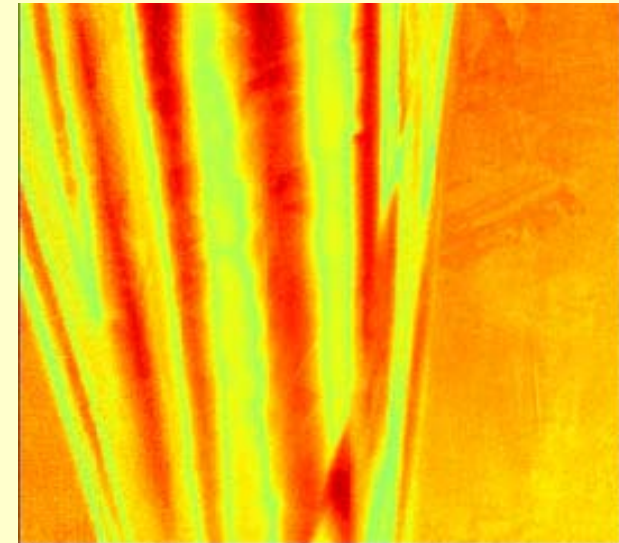


Image of stress-induced
birefringence in plastic



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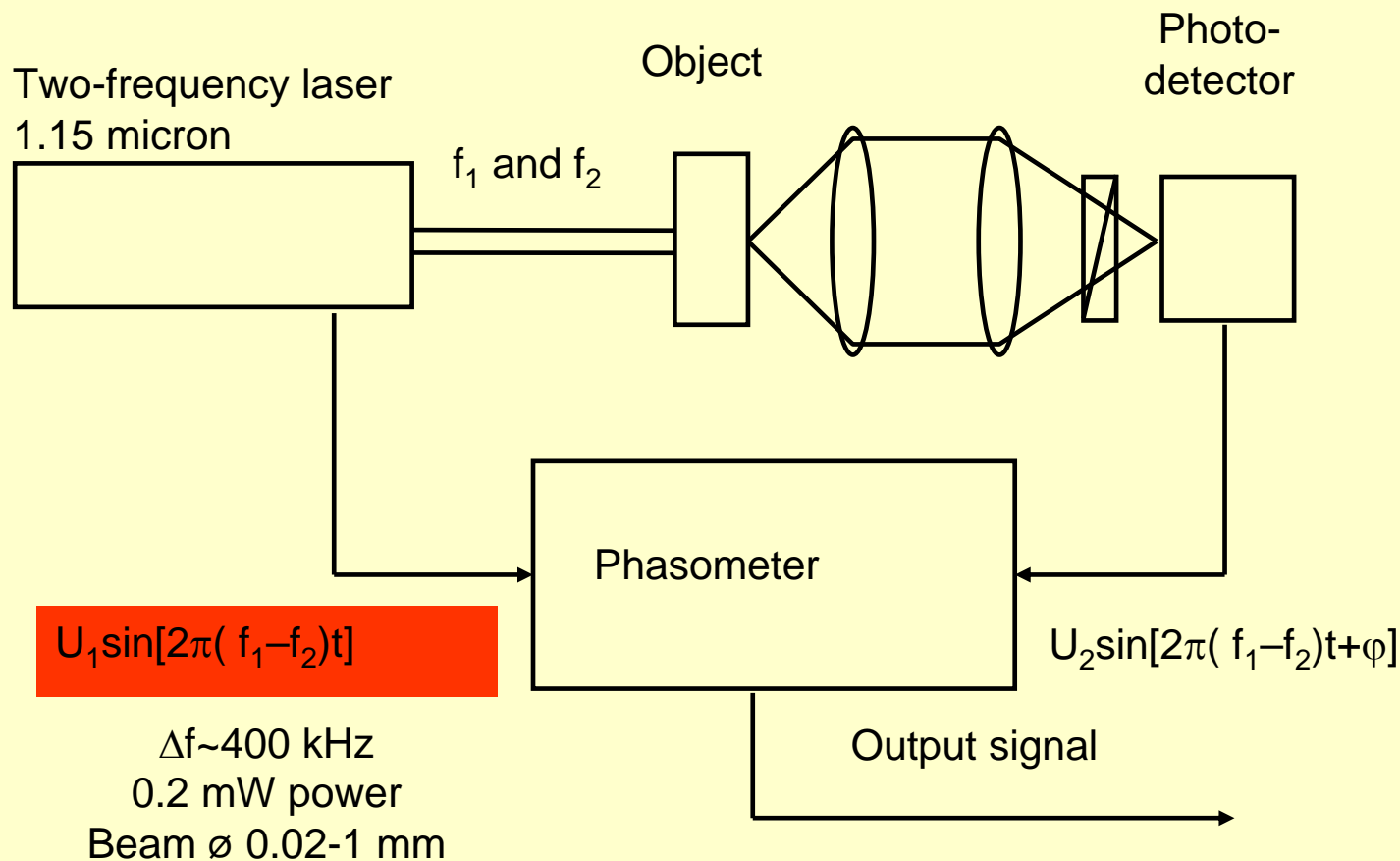
Measuring Stress-Induced Birefringence by Heterodyne Interferometry

Advantages

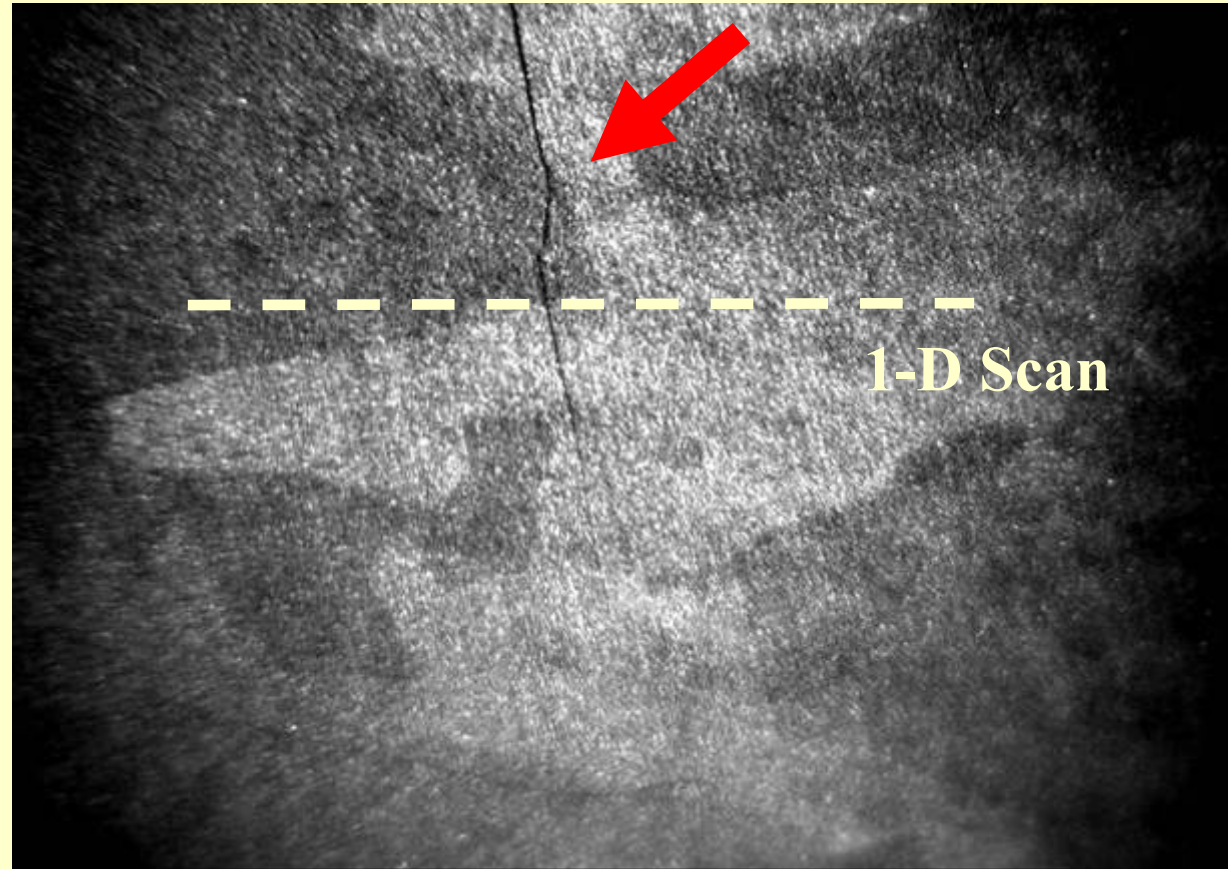
- Measuring optical phase at radio frequency
- Ultimate accuracy, ~ 1 degree
- High stability and good signal/noise ratio



Optical Setup (Transmission)



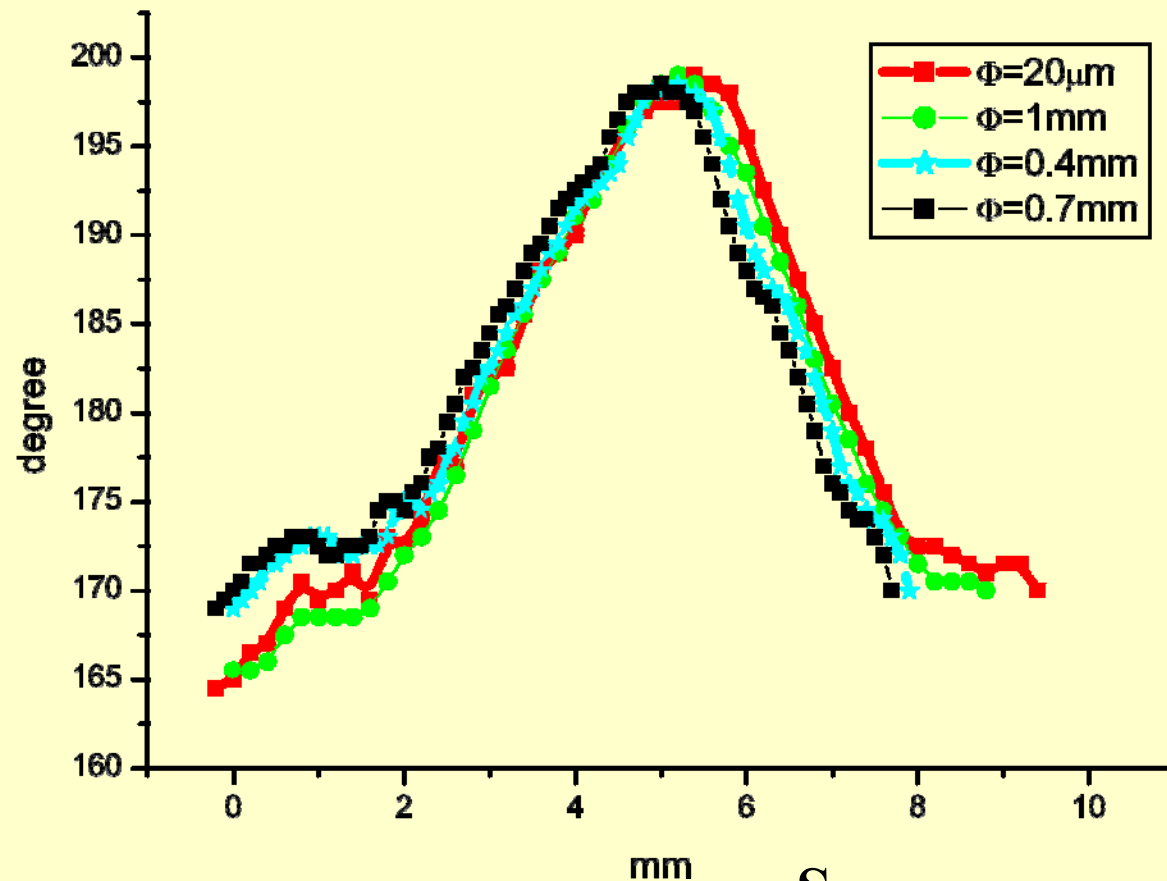
Results (Heterodyne Interferometry)



Hand-made crack



Results (Heterodyne Interferometry)



Scan across a crack by
0.02-0.7 mm beam

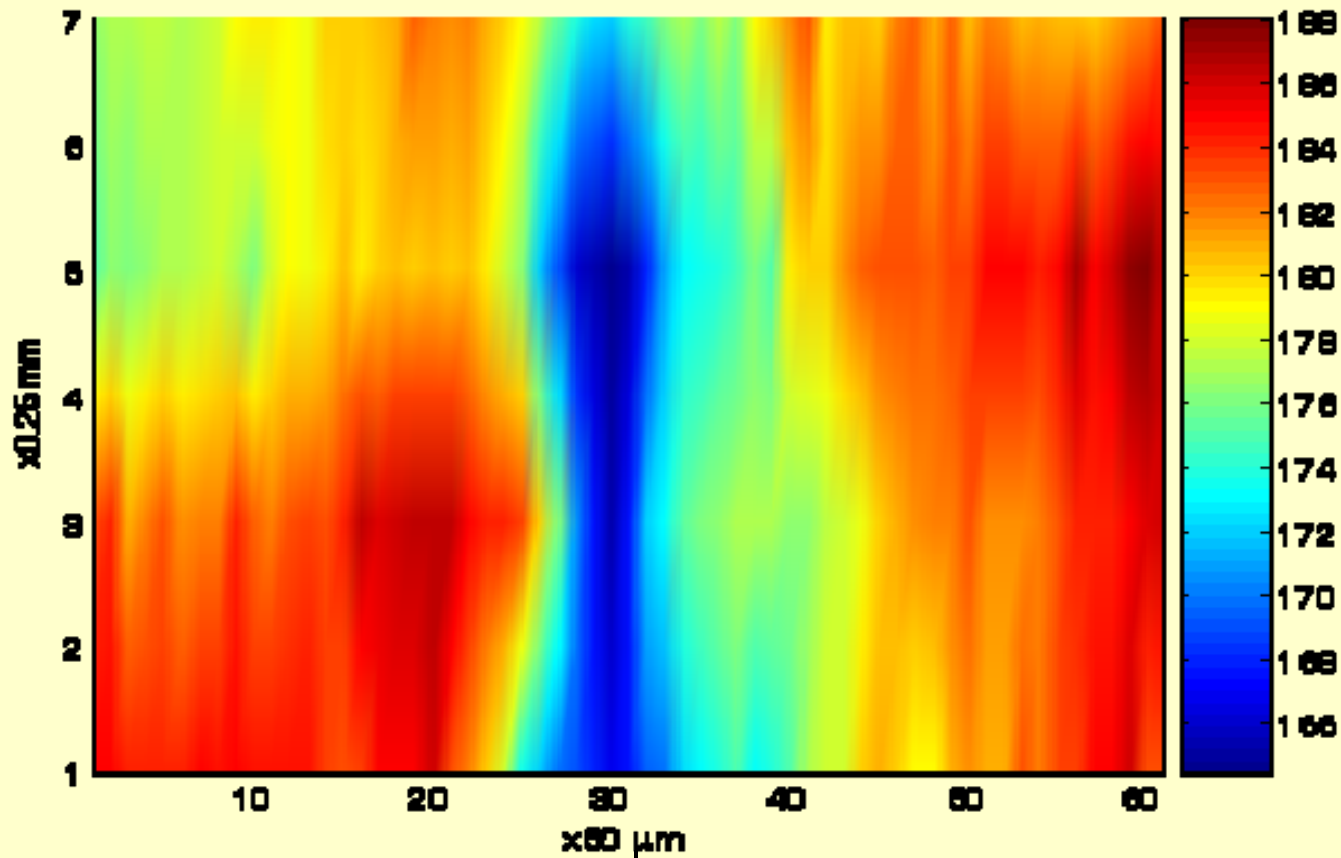


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Results (Heterodyne Interferometry)



61x14 measured points

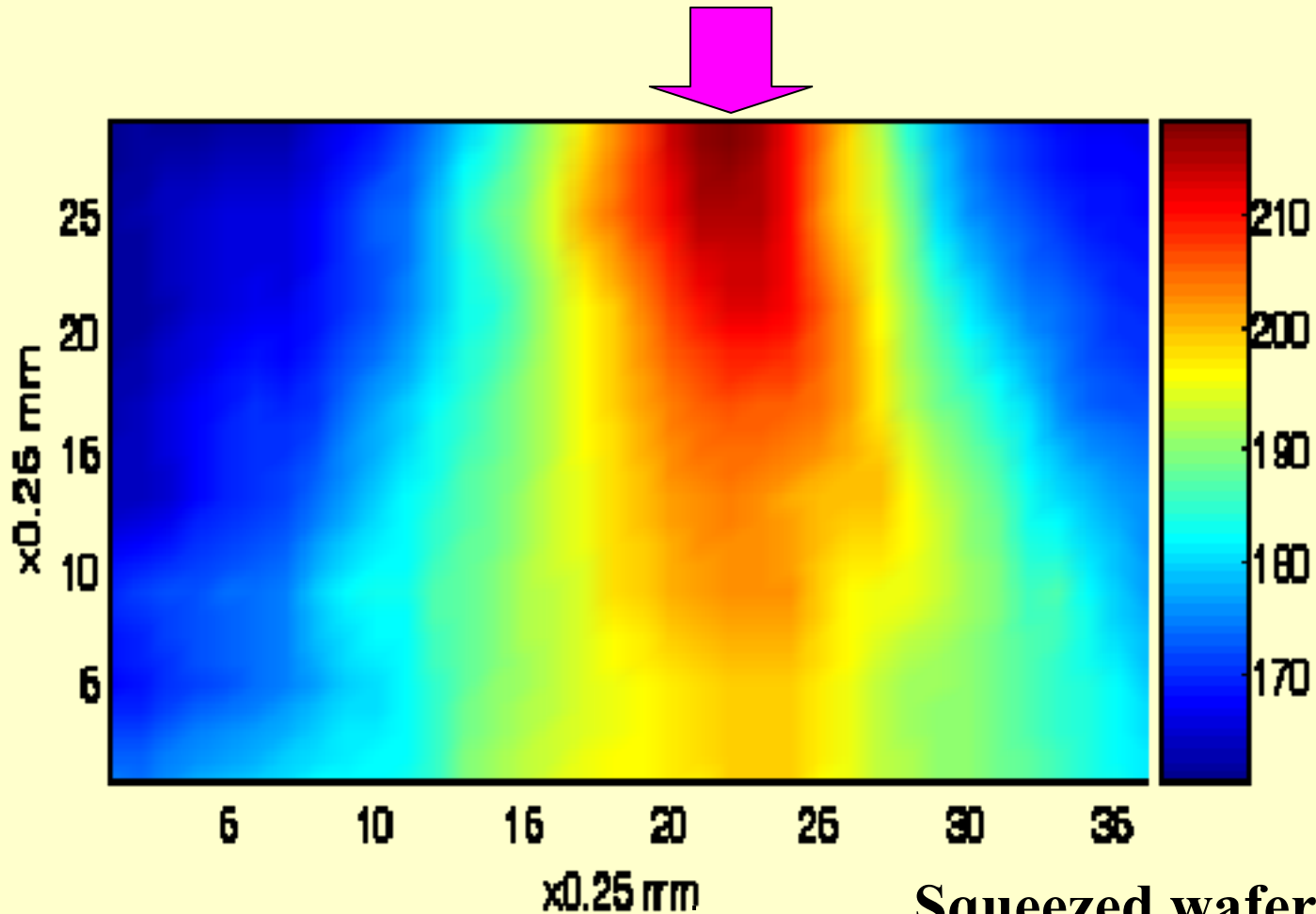


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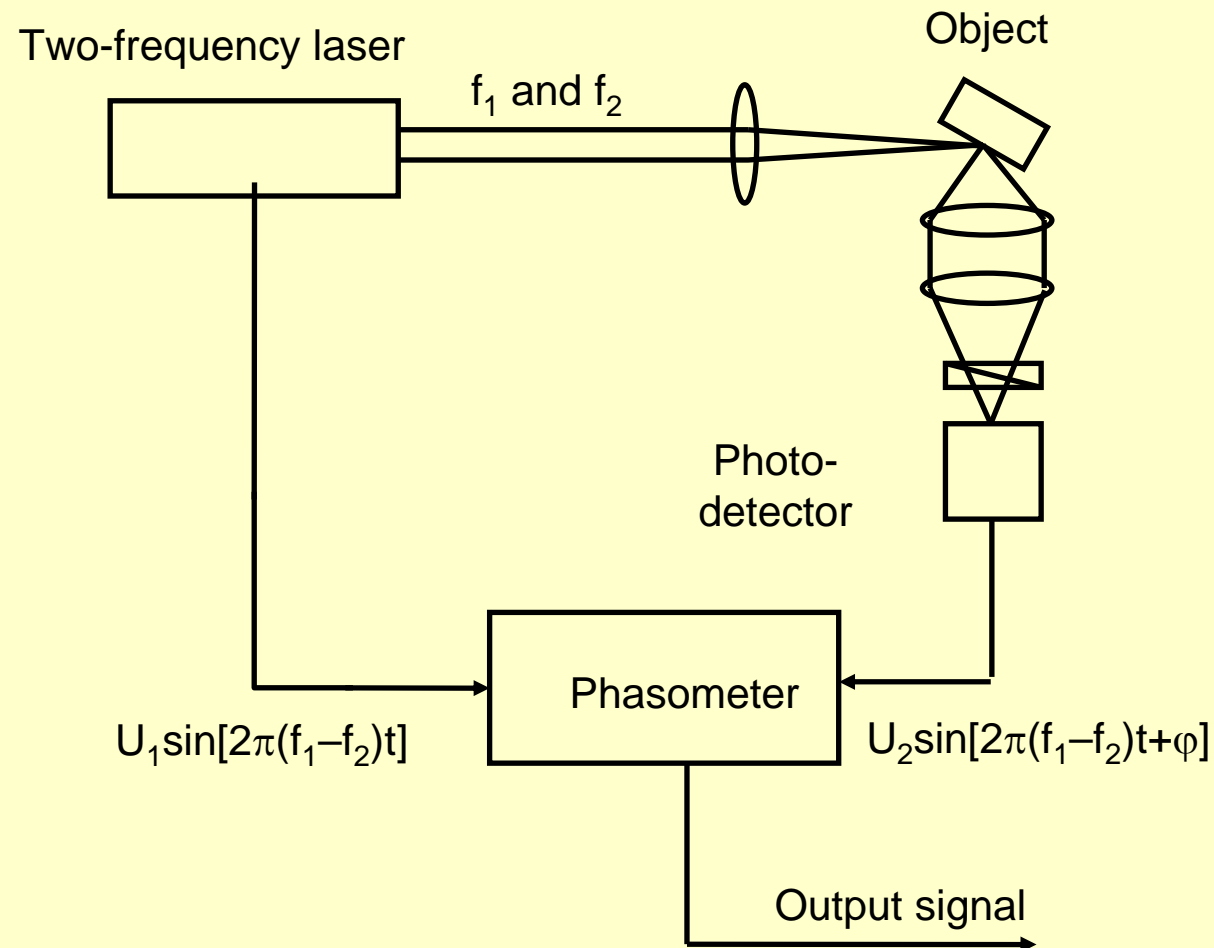
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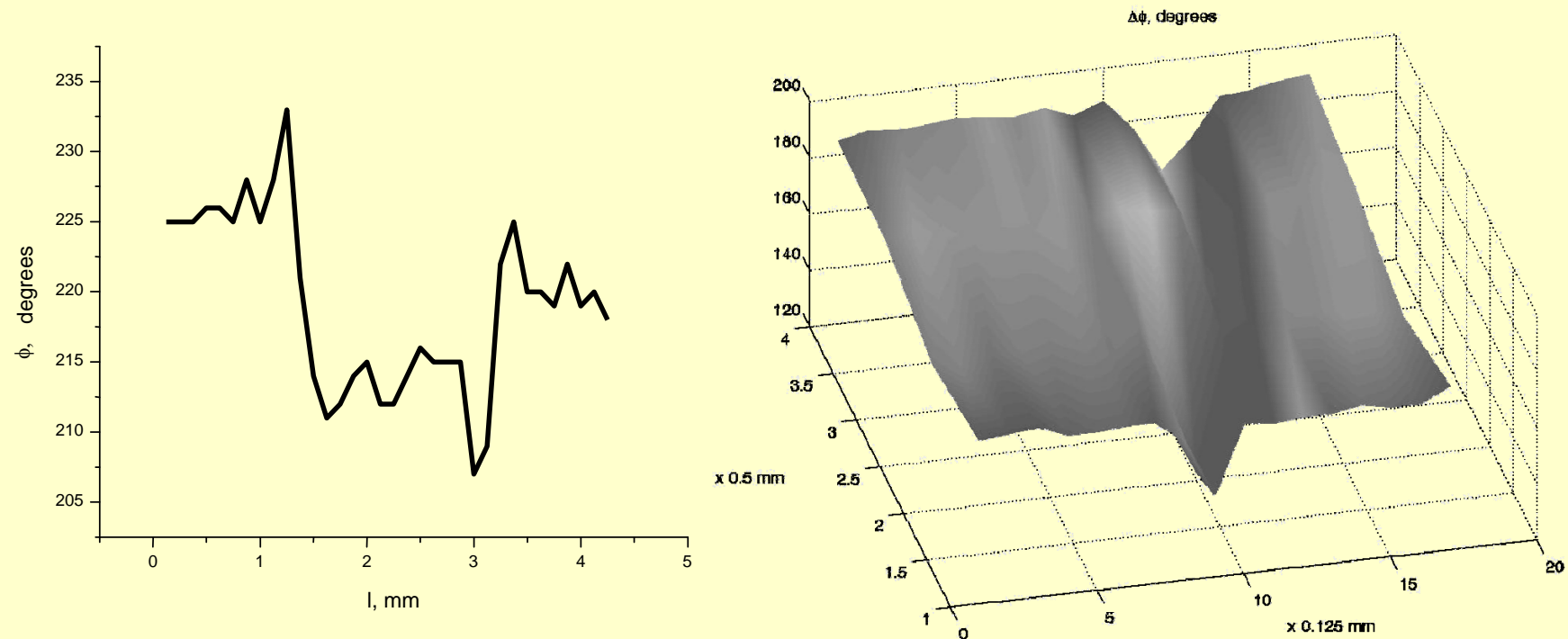
Results (Heterodyne Interferometry)



Optical Setup (Reflection)



Results (Heterodyne Interferometry)



21x4 measured points



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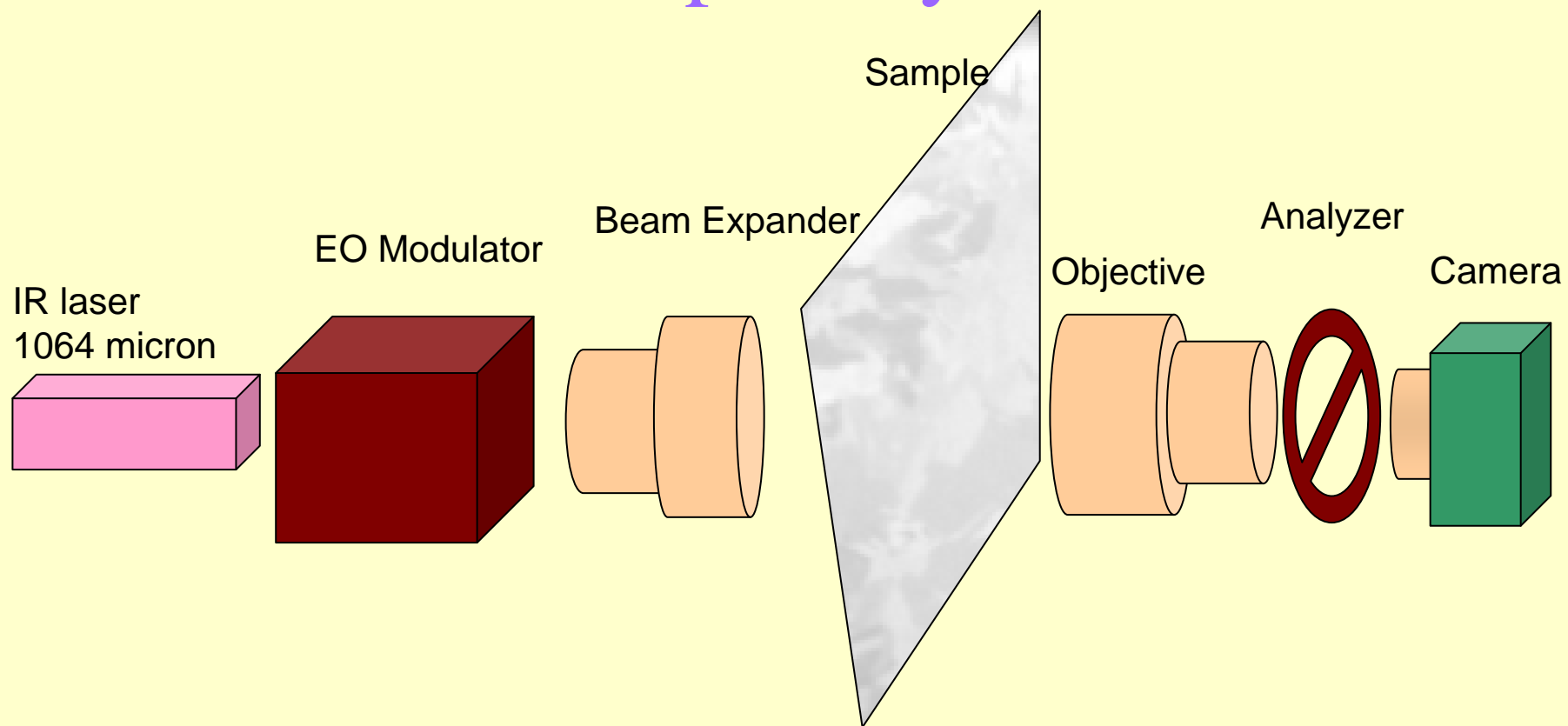


Full-Field Polarizing Interferoscope

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- Specific conditions Persistent operation in fab environment



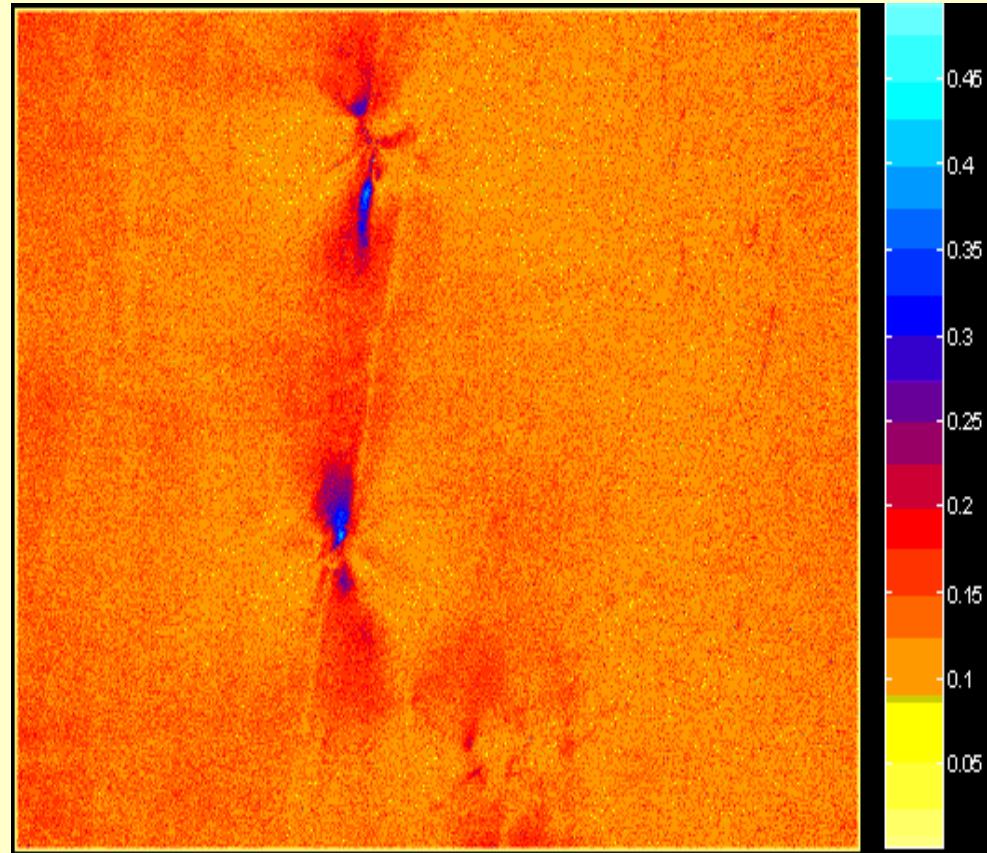
Principal Layout



Results



Poly-Si wafer



Processed phase image with microcrack detectable

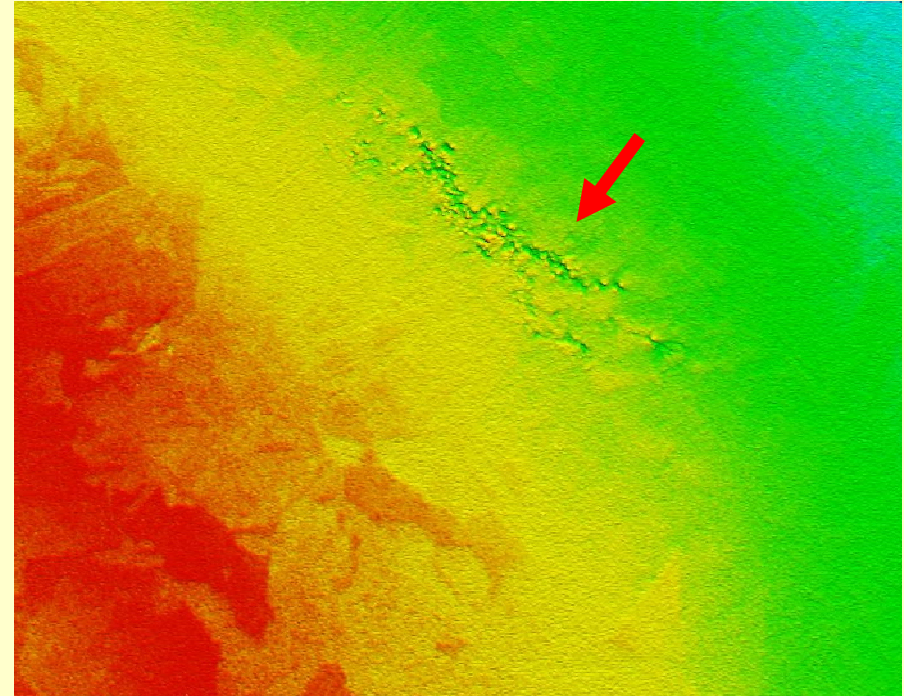
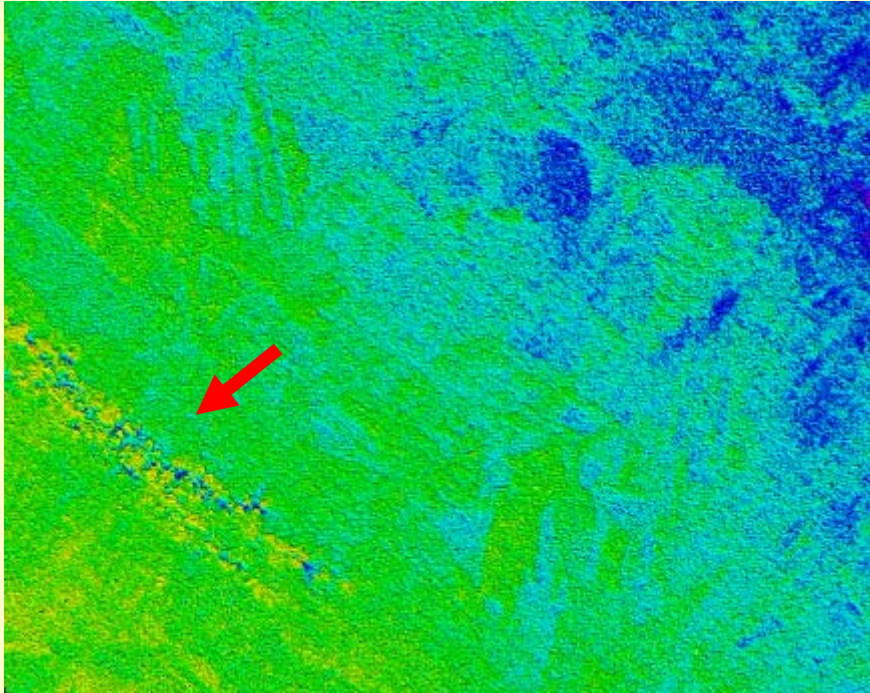


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Results



Processed phase images with microcrack detectable

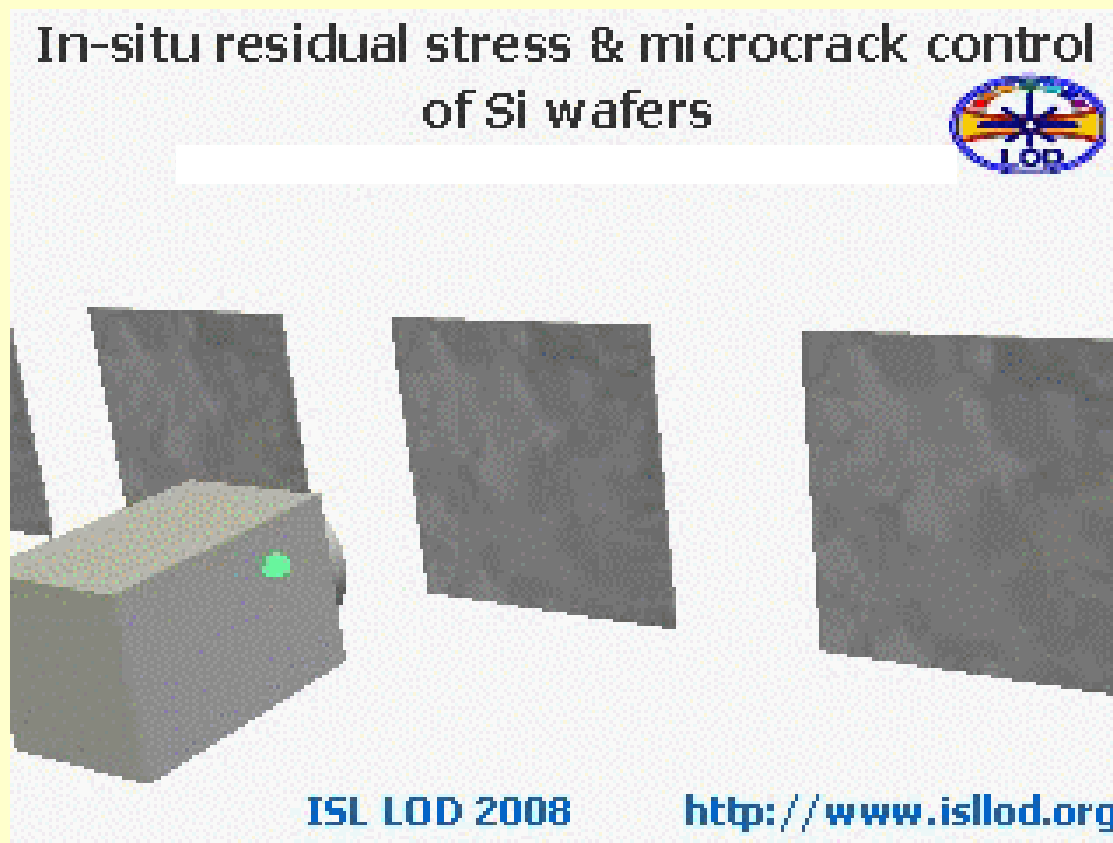


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In-situ Implementation of the Method



Please, wait for the animation



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Conclusion

Major Results

- Feasibility of full-field imaging of stress-induced birefringence in large-format ultra thin poly Si wafers has been demonstrated in in transmitted and reflected light

Advantages

- High accuracy and sensitivity
- High noise immunity
- Fast measurement time
- Large field of view

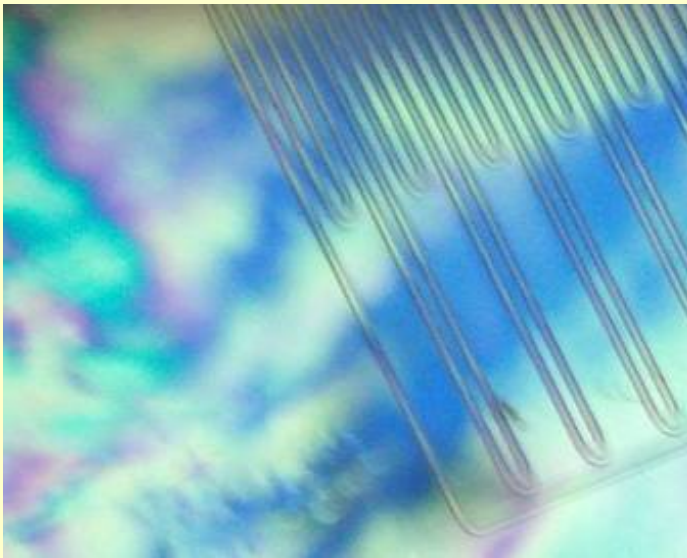
Applications in photovoltaic industry

- On-line quality control of solar cells manufacturing
- Off-line solar cell characterization for improvement of production technology



Other Applications

**3D polarization sensitive imaging by
Digital Microscopy
Optical Tomography
for characterization of various industrial
products**



Stresses in plastic microfluidic component

**Technology can be customized for
characterization of bulk
MEMS components, ceramic and
glass sensors, car windows**



Stresses in MEMS part



Acknowledgements

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Thank you for your kind attention!



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