# **Experimental Beamlines of**

# **GSI** Materials Research

CARAT Workshop \* GSI \* 13. – 15.12.2009

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## **GSI - Facility**



Cave A High Energy





# Sample irradiation



### Heavy ion irradiation

# X0 Autosampler



- Automatic load-lock system
- Defocused beam (5x5cm<sup>2</sup>)
- Random ion distribution
- Fluence regime: 1 – 1E13 ions/cm<sup>2</sup>
- Single ion irradiation
- 50 samples per hour (for 1E8 ions/cm<sup>2</sup> per sample)

### Ion track membranes



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## Heavy-ion beam Microprobe









## Materials **Biology Setup** Research Fast and perfect dose control 10 µm microscope lens vacuum holder flange sample stage illumination ions LEDs ~ 0 window imaging assembly ··· Si surface barrier channeltron sample holder Unsurpassed targeting accuracy

## Heavy-ion beam Microprobe



100µm





## single-ion lithography



• Single ion irradiation

- Accuracy:
- ... in vacuum: below 1µm
- ... into air: 1.5 µm
- Speed: ~ 100 Hz

10.000 ions in regular pattern etched PET

# Sample characterization





# In-situ and On-line sample characterization









### M1 – Electron Microscopy



Fixed beam spot size: diameter = 3mm

On-line beam diagnostic (aperture current)

### M1 – In-situ SEM



Materials

• Zeiss SUPRA 40 highresolution scanning electron microscope (1.3 nm at 15 keV)

• 5-axes motorised eucentric sample stage

• In-situ imaging without exposing the irradiated sample to air

## M2 – In-situ XRD



- Small beam spot
- Scanning ion beam system (extreme homogeneous irradiation with high flux)
- On-line beam diagnostic (aperture current)





- SEIFERT 4-circle x-ray diffractometer (Cu-Kα)
- Position sensitive detector
- Investigation under any angle of incidence enables the quantitative analysis of structural modifications









## Sample curvature detection



Irradiation-induced material stress measured by sample curvature detection



University of Jena (Wesch, Steinbach)



### Materials **On-line FT/IR Spectroscopy** Research 0,02 -0,00 -0.02 Transmission FT/IR spectroscopy -0,04 -0,06 Real on-line measurement Absorbance 80'0 possible -0,10-• Elimination of errors by sample -0,12preparation -0,14 -0,16

2345

2340

Wavenumbers (cm-1)

2335





## High temperature irradiation



Sample temperature up to 950 °C (area 4x4cm<sup>2</sup>)



# Within a second BMBF project starting 2010

- On-line Raman spectroscopy
- In-situ AFM in an UHV Chamber
- High energetic ERDA (UHV)
- Photoluminescence



### Thanks to...



... GSI Materials Research group

... collaborating Universities of the M-Branch (Darmstadt, Dresden, Göttingen, Heidelberg, Jena, Stuttgart)

... and thanks for your attention!

# END







# Ion track membranes



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 $2 \mu m$ 

etching time [min]



