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CDBS: Coincident Doppler-broadening spectrometer

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Abstract: The CDBS, operated by the Technische Universität München, located at NEPOMUC, allows the detection of open volume defects and their chemical surrounding. Defect distributions can be imaged in 3D by lateral scanning with the energy variable positron beam.

1 Introduction

The Doppler broadening of the 511 keV annihilation line contains information of the electron momentum distribution at the positron annihilation site in the sample. Since the probability of core electron annihilation decreases in open volume defects a narrowing of the annihilation line is observed. For this reason, Dopple broadening spectroscopy (DBS) is particularly suited to detect lattice defects in a sample. DBS with the monoenergetic positron beam allows the analysis of defect profiles, energy dependent 2D imaging of defects, and defect annealing as a function of temperature. In addition, CDBS is applied in order to gain elemental information about the positron annihilation site and hence about the chemical surrounding of defects.

2 Technical Data

2.1 Beam properties

- Positron implantation energy: E = 0.2 − 30 keV
- Mean positron implantation depth: up to several µm (material dependent)
- Beam size: adjustable between 0.3 − 3 mm Ø

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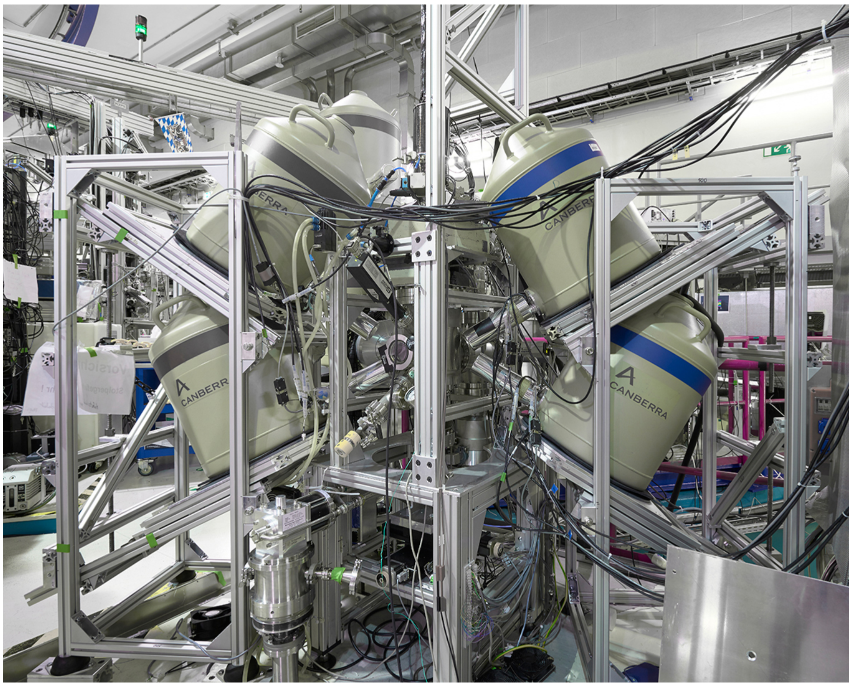

Figure 1: Instrument CDBS at NEPOMUC (Copyright by W. Schürmann, TUM).

2.2 2D x-y-scans

- Scan area: 20 x 20 mm^2
- Step size adjustable between 0.1 and 10 mm

2.3 High-purity Ge detectors

- 30 % efficiency
- Energy resolution: 1.4 keV at 477.6 keV

2.4 Sample

- Size
  optimal size: 6 x 6 mm^2, thickness: 0.1 – 1 mm
  in general: 0.5 x 0.5 x 0.01 mm^3 – 20 x 20 x 3 mm^3
- Optimum 4 samples on one sample holder: $<$ 10 x 10 mm^2
- Temperature: 100 K – 900 K

2.5 Typical measurement times

- DBS: $\sim$ 1 – 2 min / spectrum
- DBS: $\sim$ 8 h full 2D overview scan (with $\Delta x = \Delta y = 1$ mm)
- DBS: $\sim$ 1 h depth profile (t = 2 min, 30 energy values)
- CDBS: $\sim$ 4 – 6 h / spectrum