Application and characteristics of Ag Kα multilayer X-ray optics

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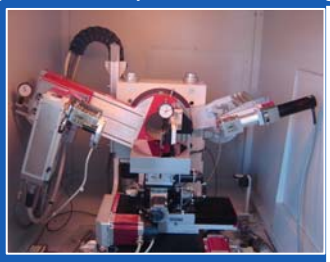
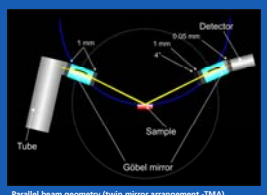
Motivation for Ag Kα parallel beam mirror setup

Covering of a **large q-range up to 20 Å^{-1}** in the reciprocal space (0.1° < 2Θ < 160°)
High penetration depth in metallic samples
Reduced influence of sample fluorescence, displacement errors
and sample transparency in **parallel beam geometry with secondary monochromator**

Experimental setup - Twin Mirror Arrangement (TMA)



experimental setup:
diffractometer XRD 3003 (GE- inspection technology)
for samples of up to 200 mm x 200 mm (Ø 8") and
for measurements from starting at 0° (reflectometry) up to 2Θ = 160° (diffraction)



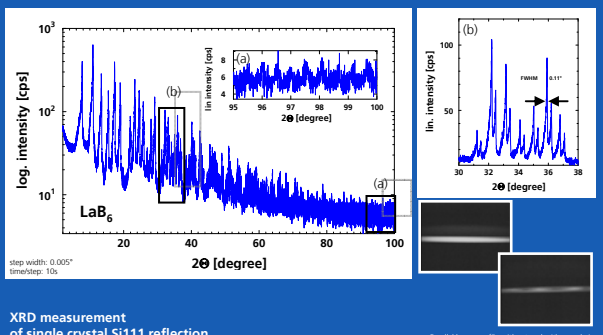
Parallel beam geometry (twin mirror arrangement -TMA)
- schematic view -

TMA - the parallel beam concept with

- high intensity and low divergence
- no influence of sample displacement and transparency on peak position for reflectometry and X-ray diffraction
- superior Kβ suppression
- sample fluorescence suppression
- easy and fast sample alignment

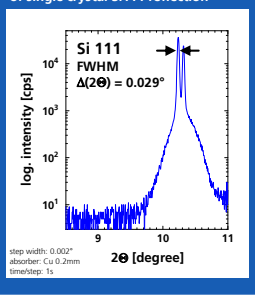
Characteristics of Ag Kα TMA

XRD measurement of LaB_6 powder sample
Generator: 50 kV, 25 mA



Parallel beam profile without and with sample in the beam path
(LaB_6* capillary Ø 500 µm)

XRD measurement of single crystal Si111 reflection

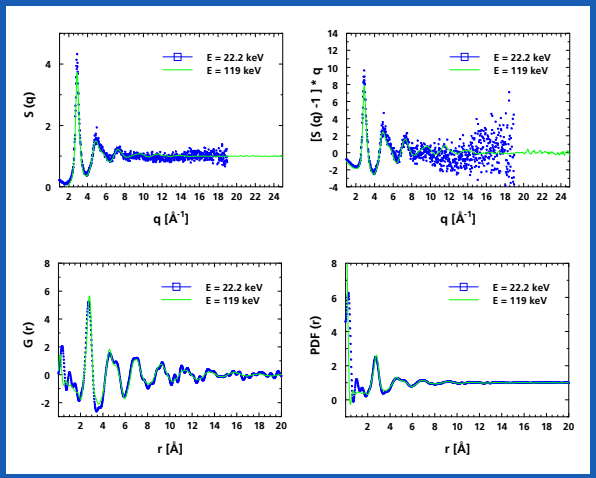


Result:

- intensity ≈ **10^8 cps**
- **I(Ag Kα) : I(Ag Kβ) > 10.000**
- beam **divergence of ΔΘ = 0.015°** (<60 arcsec)
- improved P/B ratio due to suppression of other characteristic emission lines (Ag *Kβ*)
- low background intensity level (<5 cps)
- reflections up to 2Θ = 100° detected for LaB_6

* LaB_6 powder sample was kindly provided by Huber Diffraktionstechnik GmbH

Results

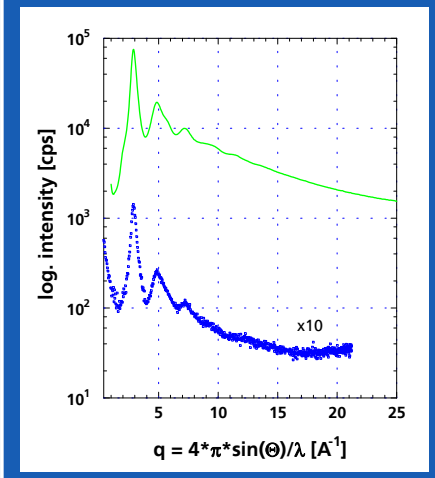


The TMA allows to cover the reciprocal space up to 20 Å^{-1} . The dynamic range of measured intensities is about two orders of magnitude. The low brillance of laboratory X-ray sources limits the correlation determination to the first shells with distances up to 10 Å.
The coincidence between synchrotron and TMA measurements with Ag Kα radiation is clearly visible. A distinction between individual correlation lengths in the PdCuNiP alloy is not possible and was not the aim of this experiment.

Measurements with Ag Kα (E = 22.2 keV) and Synchrotron (E = 119 keV)

sample: $Pd_{40}Cu_{30}Ni_{10}P_{20}$

locked coupled 2:1 scan: 2° < 2Θ < 160° ; Δ(2Θ) = 0.1 ° ; t = 45 s



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Summary:

- Using the TMA, diffraction measurements can be done up to 2Θ=160° to cover a large q-range in reciprocal space
- The intensity on laboratory X-ray sources is limited, but resolution is comparable up to 10 Å^{-1} .
- The second multilayer mirror on the diffracted beam side increases the P/B ratio. Sample fluorescence can be suppressed.
- The low divergence and the small beam width of 0.5mm could allow a local 1dim mapping of structural gradients

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