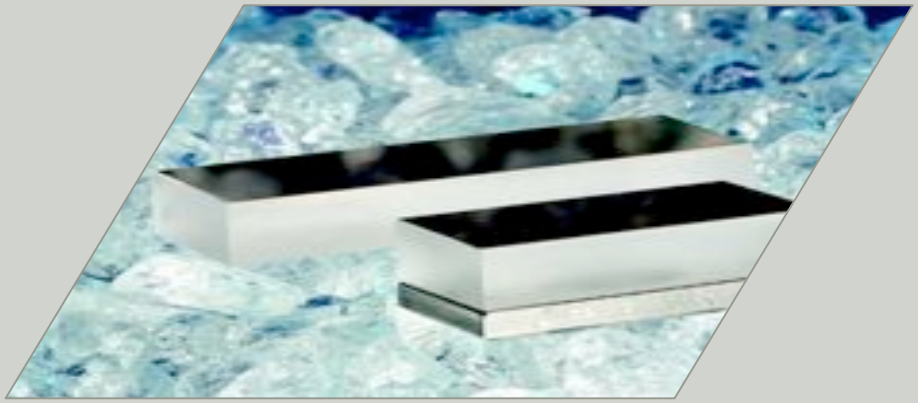
INCOATEC
innovative coating technologies gmbh

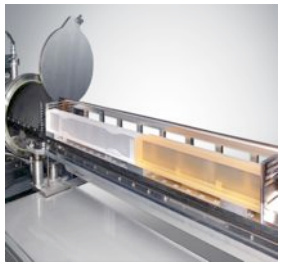
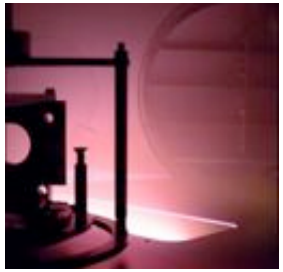


2nd workshop on X-ray and XUV active optics

State-of-the-art thin film X-ray optics for synchrotrons and FEL sources

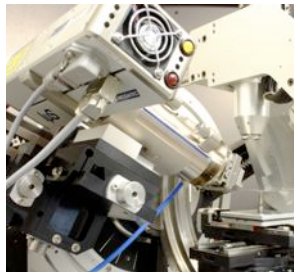
Frank Hertlein – Incoatec GmbH – Geesthacht, Germany

Incoatec:
Innovative Coating Technologies


- Incoatec is founded with Bruker AXS in 2002
- Own R&D activities and application lab
- over 12 years of experience in X-ray optics and
  over 18 years of experience in thin film technology

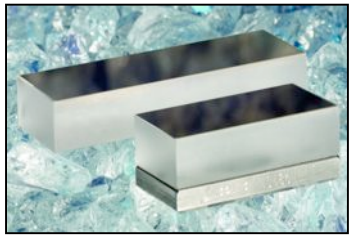


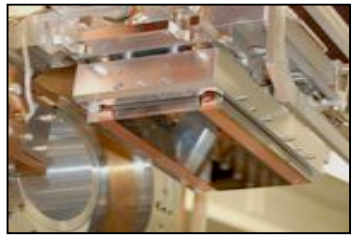



Outline

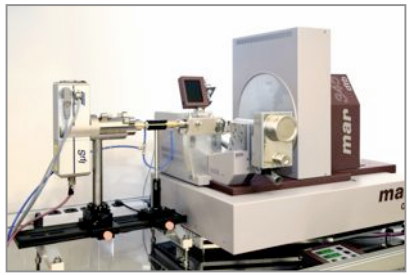
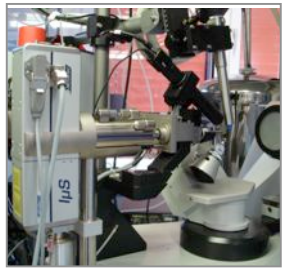
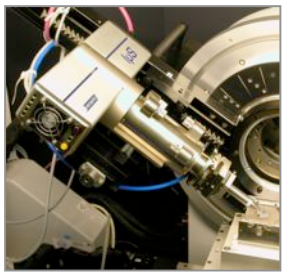
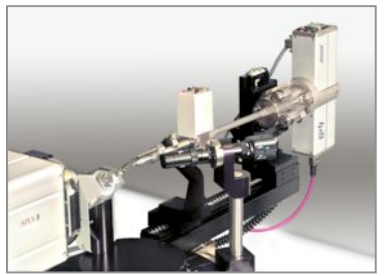
- Products & Services
- Multilayer coating
- Deposition of thin films
- Characterization
- Applications
  - Total reflection optic for FEL
  - Multi-stripe optic for Tomography Beamline
- Conclusion

Products & Services



- Multilayer mirrors
- Customized coatings for synchrotron mirrors and other applications

- Incoatec Microfocus Source IμS™
- Upgrades of existing equipment

Products:
Incoatec Microfocus Source – IμS

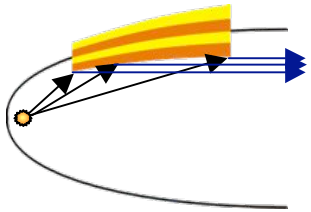
- High brilliance low-power microfocus source
- For Cu or Mo
- Air-cooled
- New type of 2D beam shaping Montel Optics:
  The Quazar™ Optics
- New easy-to-align housing, optional with motors
- Low maintenance
- Tube change as easy as for conventional sealed-tubes
- 3 Years warranty

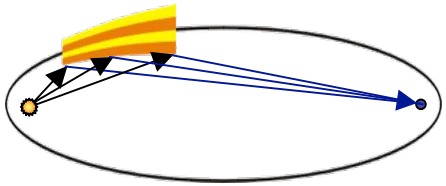
High performance at only 30 W

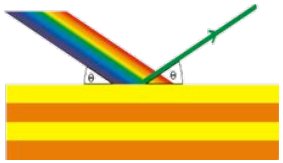
Products:
Multilayer Mirrors

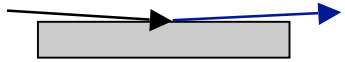
INCOATEC

XRD	SCD	XRF	Synchro -tron



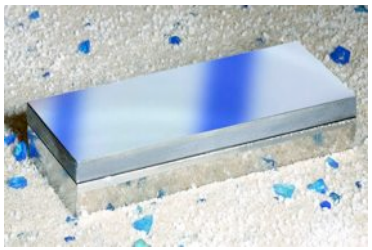




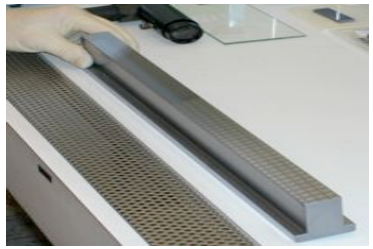


Göbel Mirror

Montel Mirror



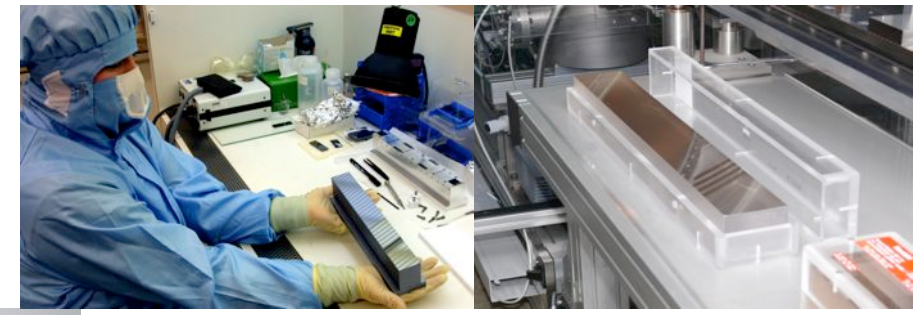
XRF - Multilayer Analysator

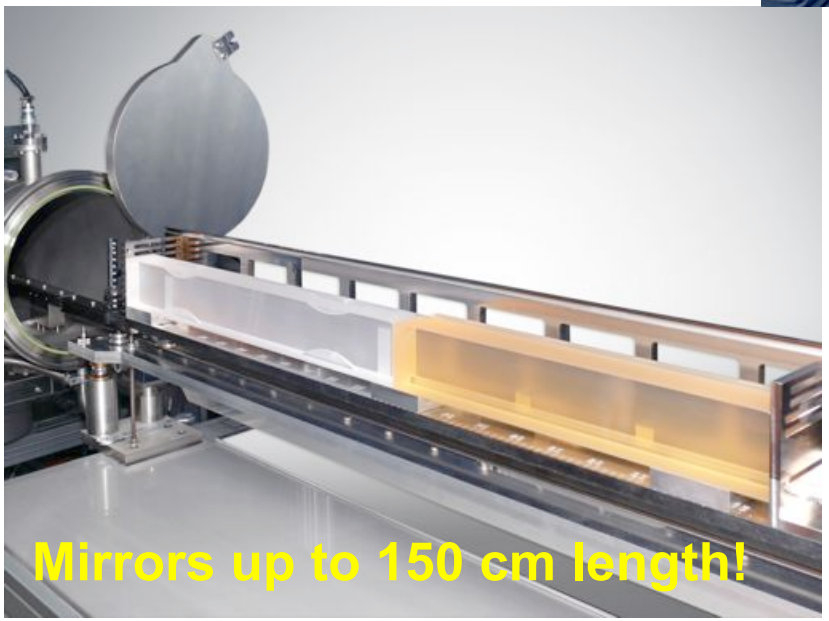


Coating of Synchrotron Mirror
up to 150 cm

Products:
X-ray Optics for Synchrotron Beamlines

Typical mirror substrate materials:
Fused Silica, Zerodur, Silicon, …





- **Special Carbon Coatings:** for High Flux Beamlines like FEL at DESY
- **Multilayer (Stripes) Coatings:** optimized for the most different applications, dimensions and shapes
- **Cooperation with GKSS:** R&D for film and deposition technology

We produce the coating for your optic as you like!

Deposition by Magnetron Sputtering

Optimized deposition facilities
for different sizes, gradients and precisions

Deposition of Thin Films

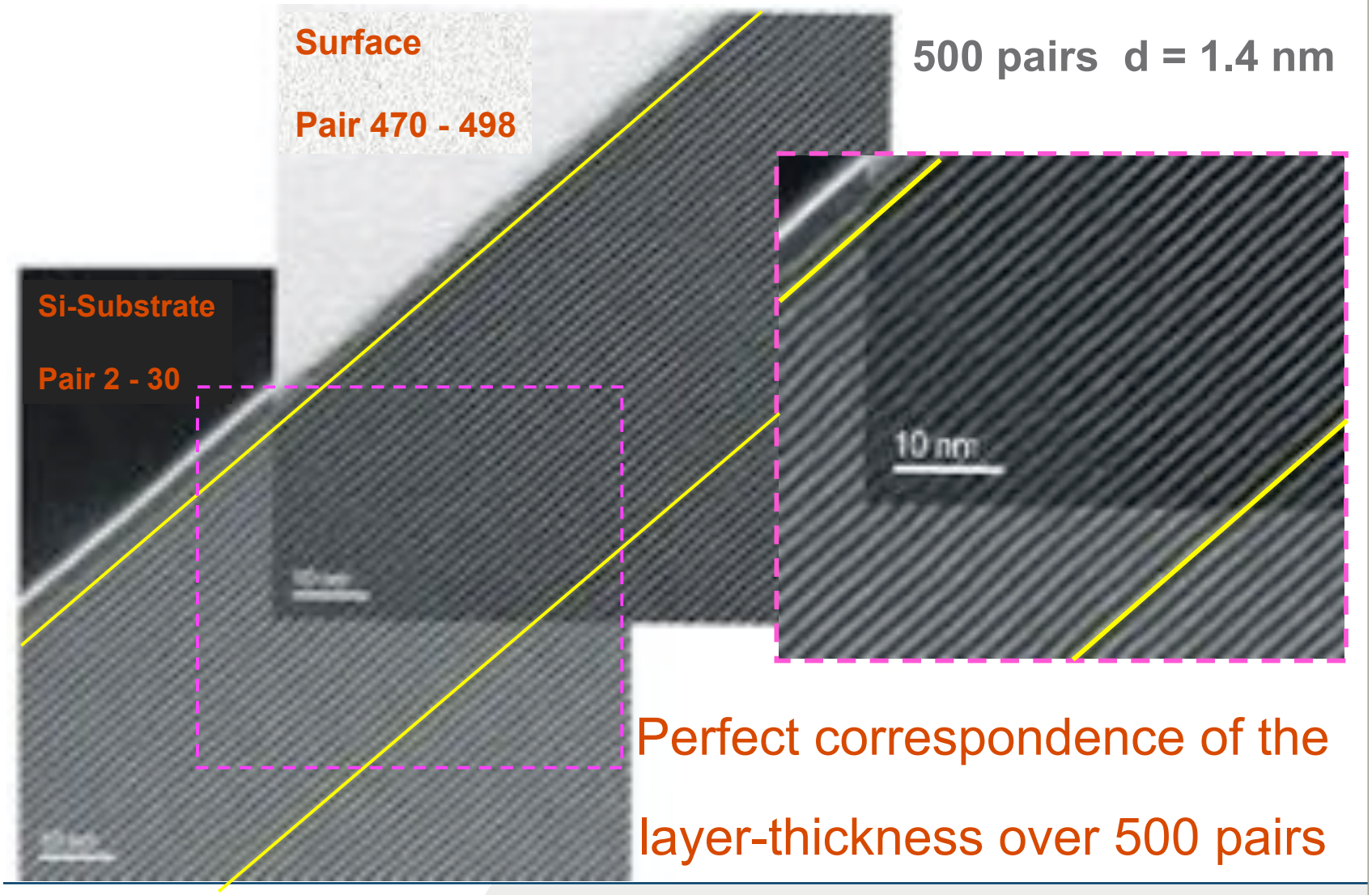
Magnetron Sputtering

- **Monolayer, Multilayer, Graded-Multilayer, Stripe-Multilayer**
- **area for deposition**:
  up to 150 x 12 x 12 cm
  or 6'' diameter
- **film thickness:** single layer 1..500 nm
- **Precision:** typical ±1%, up to ±0.1%

Requirement for coating

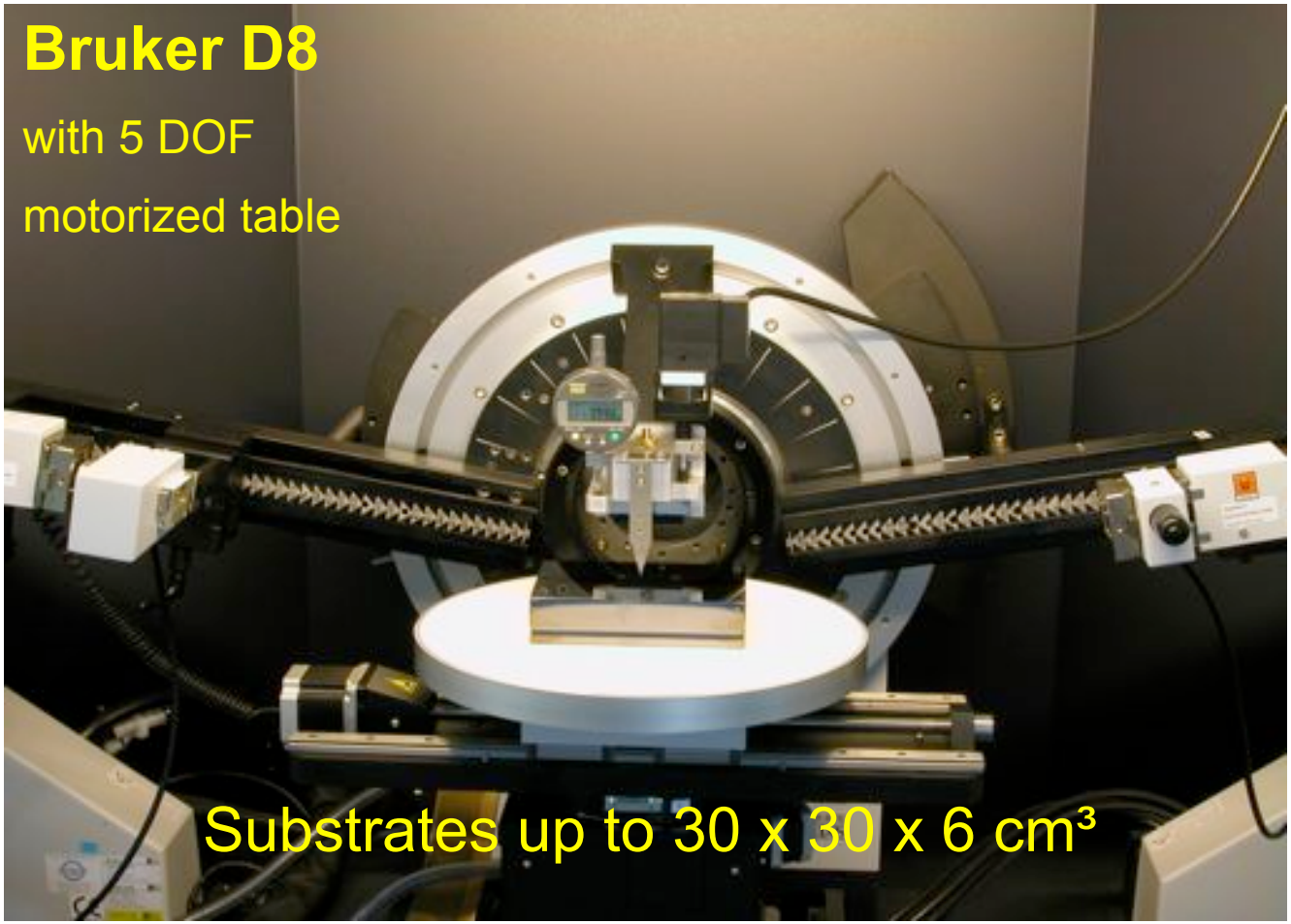
- good homogeneity over the whole mirror, up to 0.2%
- exact d-spacing over the whole stack, with up to several hundred pairs
- low roughness, better than 0.3 nm
- sharp interfaces, none interdiffusion

TEM-Picture of a multilayer coating

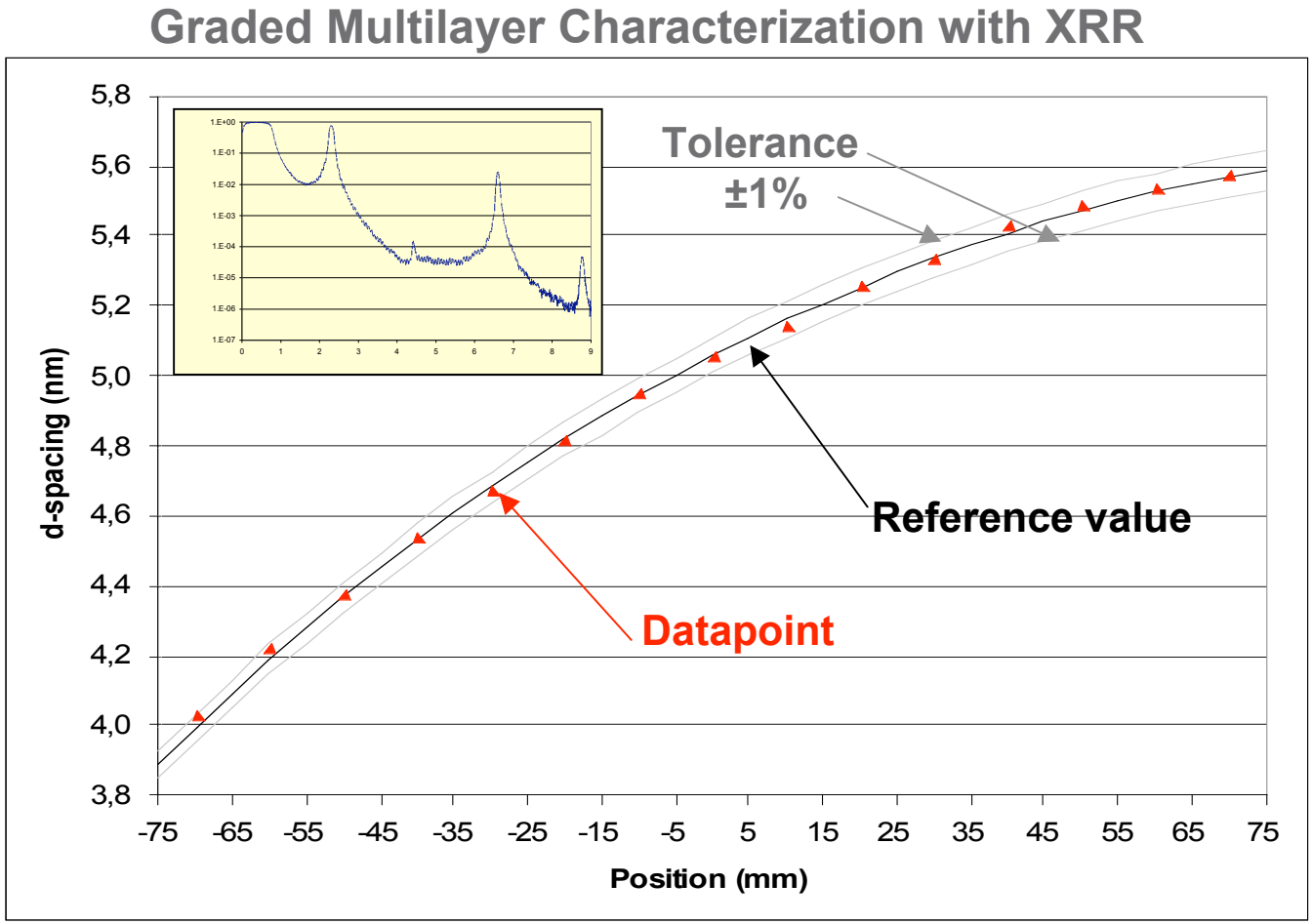


Perfect correspondence of the layer-thickness over 500 pairs

Characterization with XRR



Characterization with XRR



d-spacing accuracy better 1% !

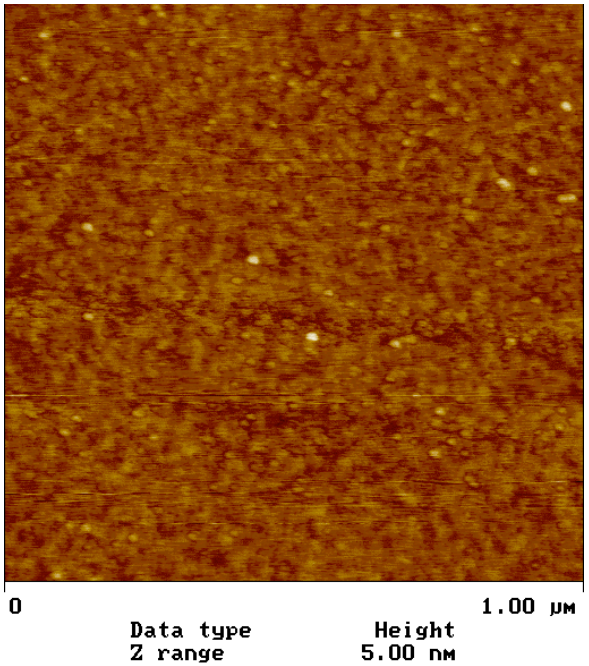
Characterization with SFM / AFM

Research & Development:

SFM
Scanning Force Microscope

AFM
Atomic Force Microscope

C-Film (38 nm) on Silicon



Scanning Force Microscopy
(F. Felten, TUHH)

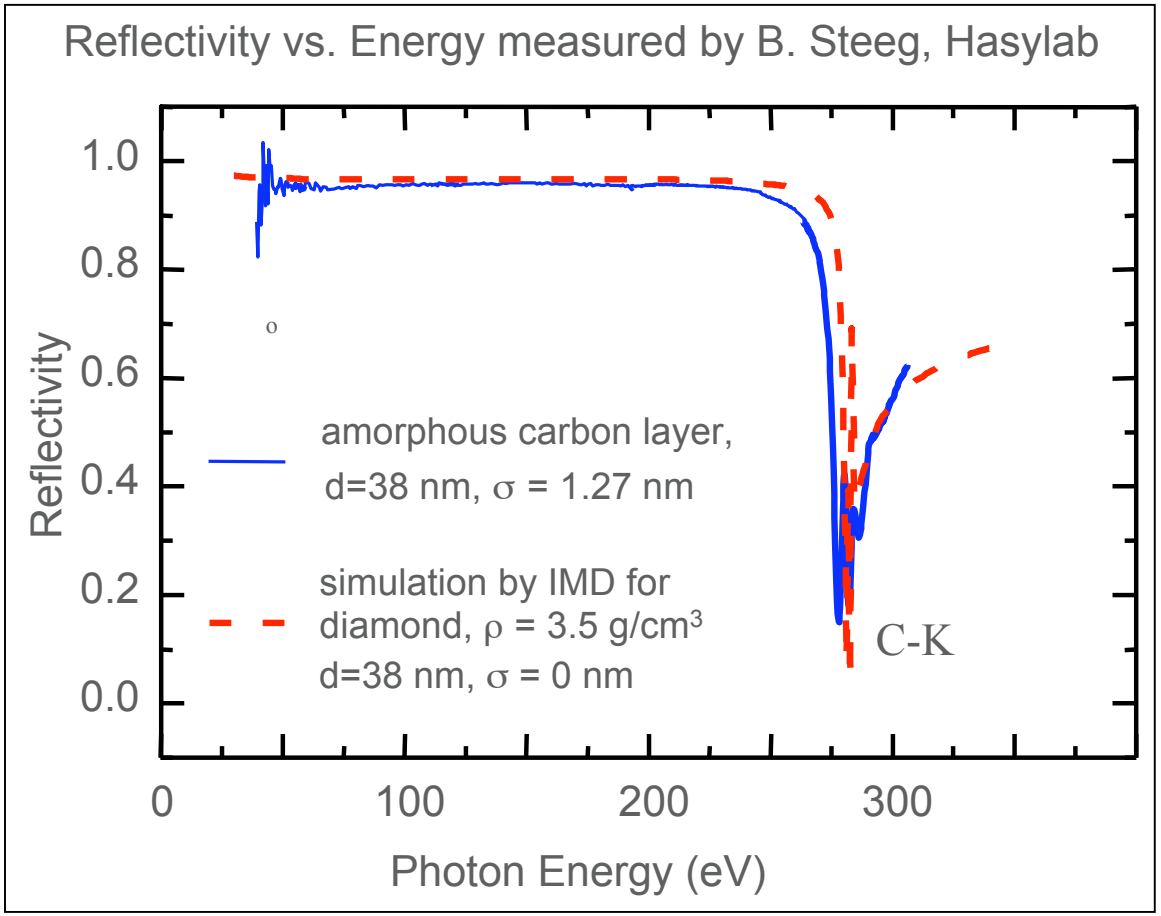
Rq,rms = 0.24±0.02 nm

Application I:
Total reflection optics of carbon for FEL

Optics for FEL at Desy

Substrate made by:

Coating made by:



R(E) ~ 95-96 % at 50 - 250 eV at grazing incidence of 2 deg

Characterization of Total Reflection Optics

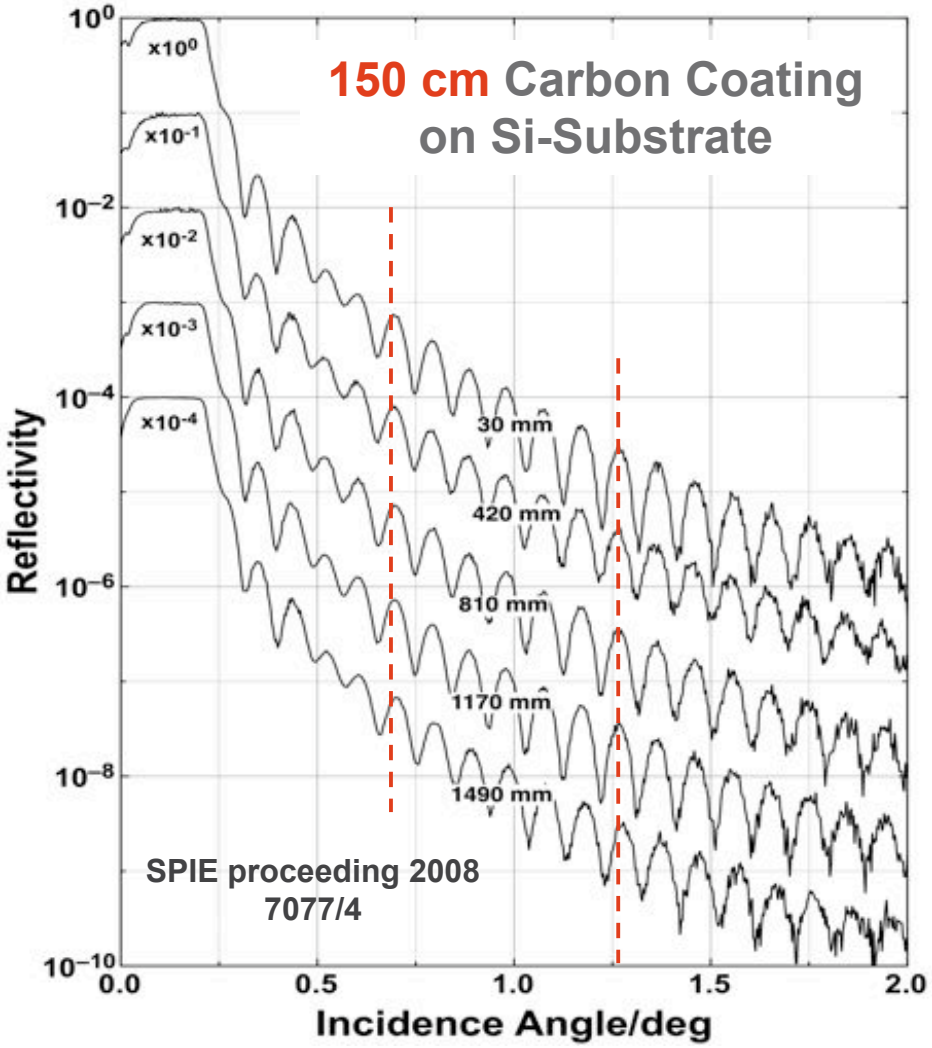
XRR measurement with
Cu-K_α (8 keV) at different positions

density: 2.2 g/cm^3

roughness: 0.5 nm

thickness: 44.2 nm

Measured by M. Störmer, GKSS



Characterization of Total Reflection Optics

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Mean film thickness
44.2 nm

Standard deviation
0.2 nm rms

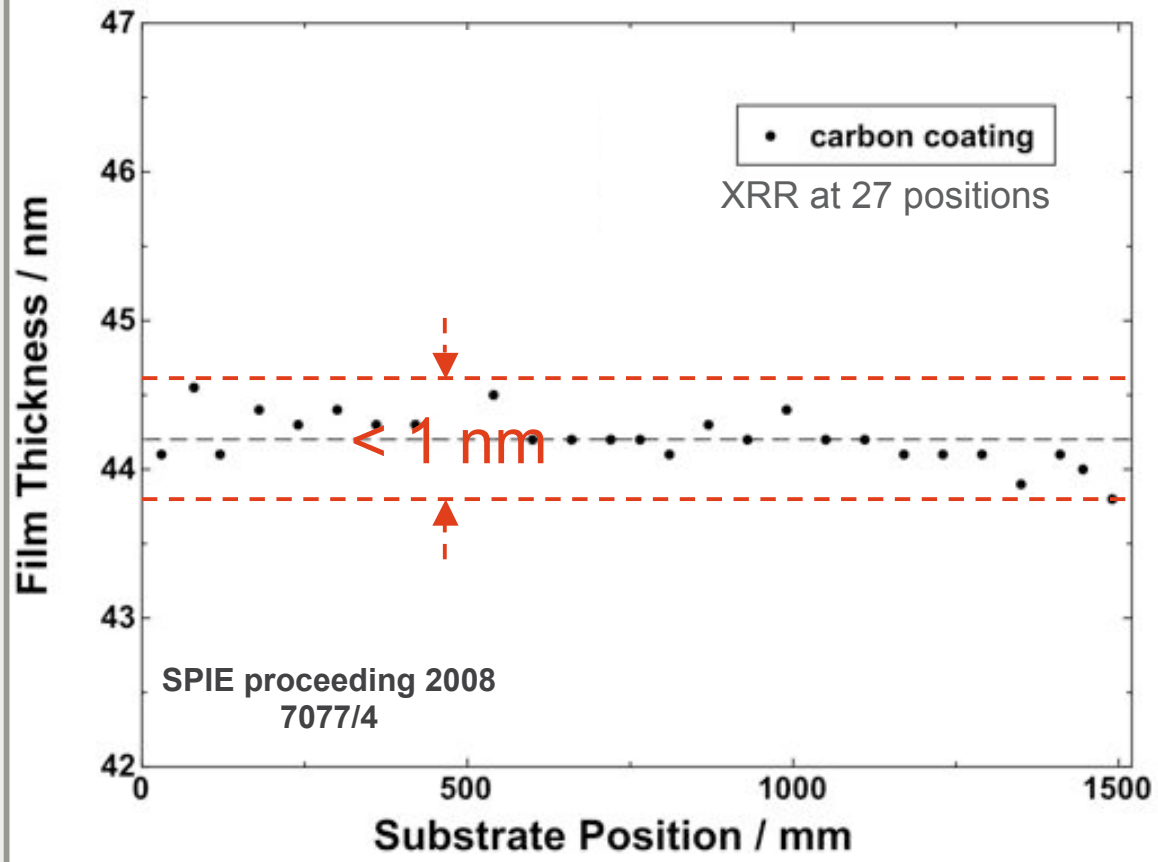
Peak-to-Valley
~1 nm

Homogeneity
better 2 %

Measured by M. Störmer,

GKSS FORSCHUNGSZENTRUM

150 cm Carbon Coating on Si-Substrate



Application II:
Multi-stripe X-ray Optics

Tomography Beamline
(M. Stampanoni, PSI-SLS)

PAUL SCHERRER INSTITUT
PSI

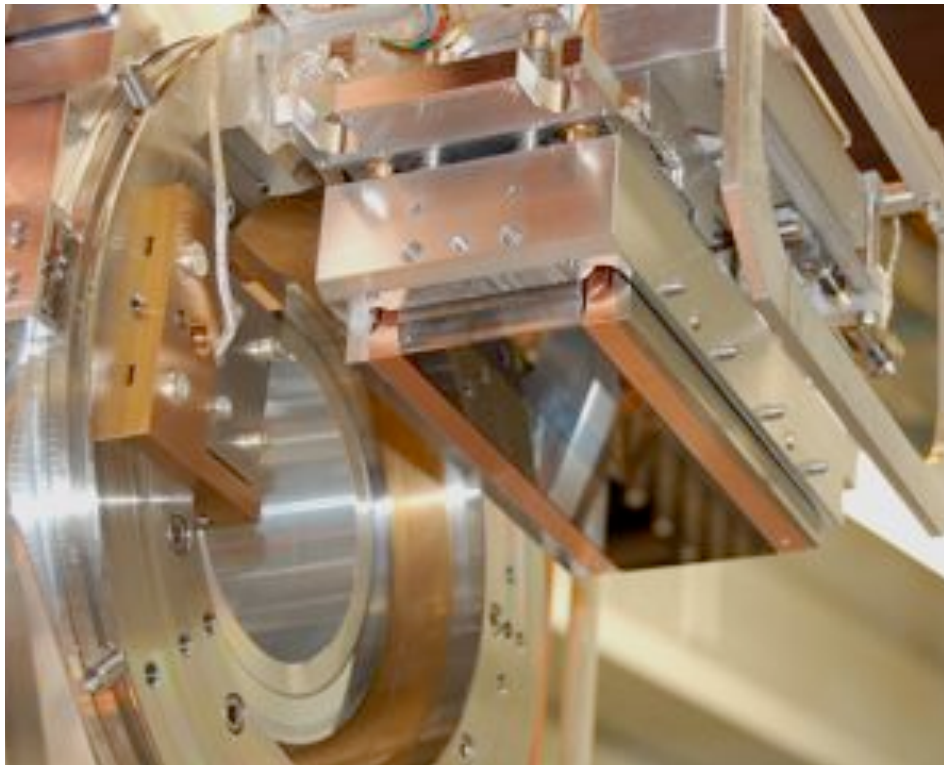
Substrate made by:

ZEISS

Coating made by:

INCOATEC
innovative coating technologies gmbh

GKSS
FORSCHUNGSZENTRUM



Picture courtesy of M. Stampanoni, PSI-SLS

Stripe A : $[Ru/C]_{100}$, d = 40 Å, γ = 0.5, R > 80% for 10 < E < 22 keV

Midspace: Si111, $D_{orientation}$< 0.01°, σ = 0.1 nm, slope error 0.04''

Stripe B : $[W/Si]_{100}$, d = 30 Å, γ = 0.5, R > 80% for 22 < E < 45 keV

Conclusion - Our profile

- Simulation of layer and optics properties
  - Flexible, on customer request

- Physical Vapour Deposition (PVD) methods for coatings
  - extreme precise coatings
  - large area coatings
  - with gradients / stripes / monolayer / multilayer

- Characterization of thin films

We produce the optics as you like!

Flexible “in-house” manufacturing for various wavelengths and applications

Conclusion - Our costumers

- Zeiss
- JenOptik
- Desy / Hasylab
- Bessy
- University of Hamburg
- University Göttingen

- APS / ANL
- Swiss Light Source PSI
- SESO
- …

Thank you for your attention

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