

Monochromators for XRF in the photon energy range of 900-1800 eV

Stefan Braun*, Reiner Dietsch#, Thomas Foltyn, and Andreas Leson

IWS Dresden, Fraunhofer Institute for Material and Beam Technology, Winterbergstr. 28, D-01277 Dresden, Germany

AXO DRESDEN GmbH, Siegfried-Rädel-Str. 31, D-01809 Heidenau, Germany

* e-mail: stefan.braun@iws.fraunhofer.de, phone: +49.351.2583.432, fax: +49.351.2583.314

Introduction

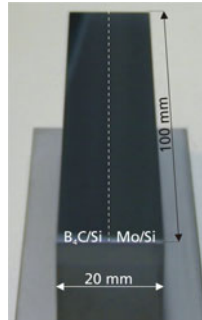
Problem

Wavelength dispersive X-ray fluorescence analysis requires X-ray monochromators with

- high reflectance => decrease of detection limits
- high resolving power => increase of selectivity

However: Best values for reflectance and resolving power can not be obtained with the same multilayer

=> Possible solution: Deposition of **two** multilayers onto one mirror!



Multilayer mirror for synchrotron applications.

Left hand side:

B₄C/Si multilayer with high resolving power

Right hand side:

Mo/Si multilayer with high reflectance

=> Depending on the application needs, the mirror can be switched between high resolution and high reflectance mode.

Theoretical and experimental results

Theory

Questions

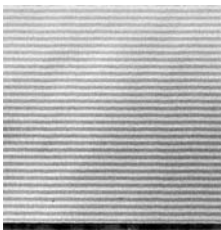
- Which multilayer combination results in the highest reflectance?
- Which multilayer combination results in the highest resolving power?

Answers

- Si and B₄C have the lowest absorption below E = 1800 eV
 - For high reflectance, absorber layer materials with the best compromise between high contrast to the refraction index of the spacer material and lowest possible absorption are needed => several candidates: Mo, W, Ru, ...
 - For high resolving powers, a high number of periods is necessary, which contribute to the total multilayer reflection
- => decrease of the period thickness and increase of the number of periods N
=> absorber layers with lowest possible absorption

Experimental results

B₄C/Si multilayers with high resolving powers



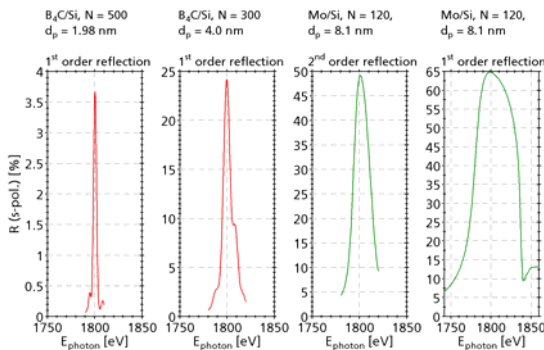
Theory predicts highest resolving powers for B₄C/Si multilayers.

Open question: Multilayer morphology (interface diffusion and roughness) of real multilayers?

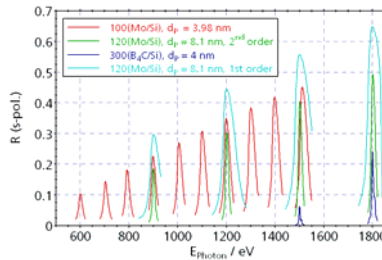
TEM investigation:

- atomically smooth interfaces
- no significant interdiffusion

Reflectance versus resolution



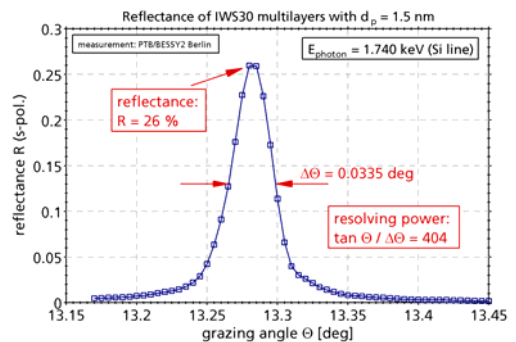
Reflectance versus photon energy



Reflectance steadily increases with photon energy up to absorption edges of the multilayer materials.
=> Tungsten based multilayers only useful for photon energies ≤ 1.5 keV (Al emission line).

Recent developments: TIAP replacement

IWS30 multilayers with higher resolving powers and better reflectances than W/B₄C multilayers and TIAP crystals!



Comparison with other multilayer types and the TIAP crystal:

type	Mo/Si	Mo/Si	B ₄ C/Si	B ₄ C/Si	W/B ₄ C	IWS30	TIAP
d _p [nm]	8.1	8.1	4.0	2.0	1.51	1.55	TIAP
Order	1st	2nd	1st	1st	1st	1st	1st
E [keV]	1.8	1.8	1.8	1.8	1.74	1.74	1.74
R [%]	65	49	24	3.7	21	26	~ 25
E/ΔE	31	89	203	492	309	404	~ 400

=> Replacement of the TIAP crystal by IWS30 multilayers possible!
=> High performance of IWS30 for emission lines up to sulfur.

Acknowledgments

We would like to thank F. Scholz, C. Laubis and B. Beckhoff (PTB/BESSY2 Berlin) for the reflectance measurements.