Supplementary Information to 'Reference-free X-ray fluorescence analysis using well-known polychromatic synchrotron radiation'

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A. Purity of absorber

To verify the purity of the absorber material (Si), SRXRF measurements were conducted on individual parts of the absorber stack consisting of three wafer parts. A resulting spectrum is shown in figure A1. The spectrum is dominated by the Si K lines, as is expected. While minor signals from the sample holder (steel) are visible in the form of XRF radiation of Cr, Fe, and Ni, no signals of contaminations were detected. The information depth for Si is in the order of about 20 µm, lighter elements generally have less information depth and heavier elements generally more. Nevertheless, the information about the purity from this SRXRF analysis can be considered representative of the whole absorber material because of the very high homogeneity of the wafers. The photon energy of the monochromatic excitation radiation ($E_0 = 9.7\,\mathrm{keV}$) was enough to excite K radiation for elements up to and including Zn ($Z = 30$) and L radiation for elements up to and including Hf ($Z = 72$).

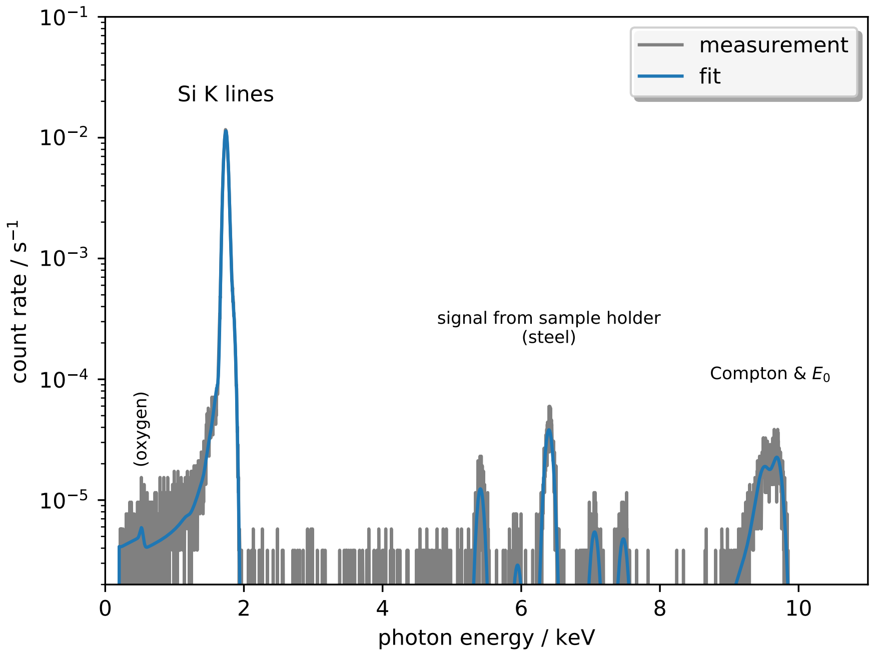

Figure A1: SRXRF spectrum of Si absorber based on monochromatic excitation ($E_0 = 9.7\,\mathrm{keV}$). Some stray light from the sample holder can be seen (Cr, Fe, Ni). The oxygen signal, which is below the limit of detection, is indicated for ease of reference.

B. Lateral homogeneity of samples

The lateral homogeneity of both foils was analysed by means of laboratory-based μXRF. The results of the μXRF experiments were achieved with a commercial μXRF device (tube voltage 50 kV and current 1 mA) and are shown in figure A2. Here, both foils were placed on top of each other to reduce measurement time. The dwell time for each position was 25 s, while the step width in both lateral directions was about 30 µm, and the beam width was about 15 µm. Differences in the lateral homogeneity with this µm-resolution is in the range of a few percent over the whole measured area. All measurements presented in the main text were conducted in the centre of the samples.

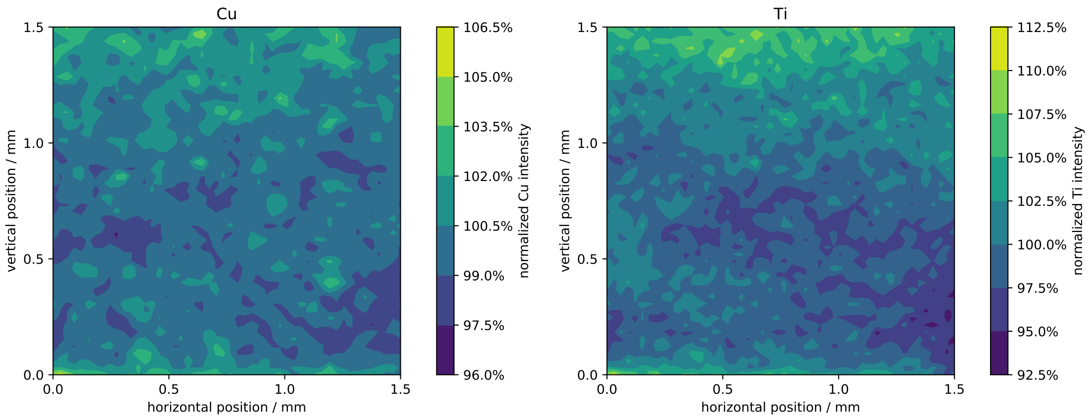

Figure A2: Normalized μXRF maps for the determination of the lateral homogeneity of titanium and copper foils. Recorded with a commercial μXRF device.

C. Contributions to the uncertainty budget

Contributions to the uncertainty budget of the titanium quantification based on (undispersed) polychromatic SR. These numbers were used to produce figure 6 of the main text.

Table A1: This table lists the relative standard uncertainties of individual parameters involved in determining the mass thickness based on equation 2 of the manuscript.

Parameter	Rel. standard uncertainty / 10^{-2}	Comments
effective solid angle of detection $\frac{\Omega}{4\pi}$	6	distance of detector to sample
incident photon flux after aperture $\Phi_0^{\mathrm{Schwinger}}$	1	see [1] & aperture diameter
fluorescence intensity Φ_i	1	deconvolution & counting statistics
thickness Be window d_{Be}	10	estimated
density Be window ρ_{Be}	0.6	estimated
mass attenuation coefficient Be window $\mu_{\mathrm{Be},E}$	3	estimated
thickness Si absorber d_{Si}	3	digital calliper
density Si absorber ρ_{Be}	0.5	estimated
mass attenuation coefficient Si absorber $\mu_{\mathrm{Si},E}$	3	estimated
fluorescence yield of Ti K	4	see [2]
transition probability of Ti Kα_1, Kα_2	3	estimated based on [3, 4]
mass attenuation coefficient of Ti $\mu_{\mathrm{Ti},E}$	3	unpublished PTB values
photoionization coefficient of Ti $\tau_{\mathrm{Ti},E}$	5	estimated based on [5]
angle of incidence and angle of detection θ_{in}, θ_{out}	negligible	motor resolution and alignment
SDD efficiency $\varepsilon_{\text{Ti-K}\alpha}$	negligible	efficiency is known, see [6]
absorber composition	negligible	confirmed by SRXRF

References

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