Re-check of Sn foils, self-supporting and mounted over Ni

(ser. nos 16401, 16403, 19336, and 19339)

The secondary "master" reference standards tested in this report have been produced in 2005 and 2011. The mass per unit area has been determined acc. to the accredited gravimetric procedure (Reg. No. D-K-15076-01-00. Two new primary reference foils have been produced recently and they were used to confirm the existing secondary reference standards. Their mass per unit area has been determined according to the same accredited procedure.

Experiment

a) XUV-S 50 kV Ni-Filter (samples of tab. 1)
b) XDAL 50 kV Ni-Filter (samples of tab. 2)

For all secondary "master" standards (no. 1-13 in tabs 1 and 2) a central area of 2 mm*2mm has been covered by 9 measurements with a 3*3 grid. For the primary reference standards a grind of 30 * 30 measuring positions covered the entire area 5 cm * 5 cm of the foil. The measuring sport size was 1.2 mm diameter, approximately.

Measuring results

The stated and measured no-standard thickness results are given in tabs. 1-2. Also the estimated true values are depicted. The Figs. 1-2 display the relative deviation of the standard free theoretical result from the stated values.

Tab. 1 List of the self-supporting Sn foil samples under investigation. The thickness values (stated and experimental) are calculated from masses per unit area using the density ρ=7.30 g/cm^3. The samples 1-13 are secondary reference samples ("masters") and nos. 14-15 are primary reference samples acc. to the DAkkS Qualitätsmanagement-HandbuchD-K-15076-01-00). The expected "true" values have been estimated from the ensemble of all standards (grey line in fig. 1)

No.	Sample code	Date of production	Stated thickness (µm)	No-std. exp. thickness (µm)	Rel. deviation (%)	Expected true value (µm)
1	ADHGL	2010 (19339)	2,84	2,92	-2,8	2,87
2	ADHFW		4,93	5,11	-3,7	5,01
3	ADHFO		9,34	9,72	-4,1	9,46
4	ADHGG		13,15	13,58	-3,3	13,13
5	ADHGA		25,67	27,03	-5,3	25,84
6	ADHFS		50,7	52,2	-3,0	50,10
7	ADIZL		94,7	94,7	0,0	94,32
8	ABSEQ	2004 (16401)	3,15	3,2	-1,6	3,15
9	ABSBX		5,21	5,23	-0,4	5,12
10	ABSFU		8,91	9,1	-2,1	8,86
11	ABTFS		26,05	27,28	-4,7	26,06
12	ABTEO		55,7	57,26	-2,8	55,16
13	ABTFF		71	73,9	-4,1	72,03
14	BAH Sn2510-02-12	2012	25,35	26,8	-5,0	
15	BAG Sn1510-02-12		14,69	15,4	-4,7	

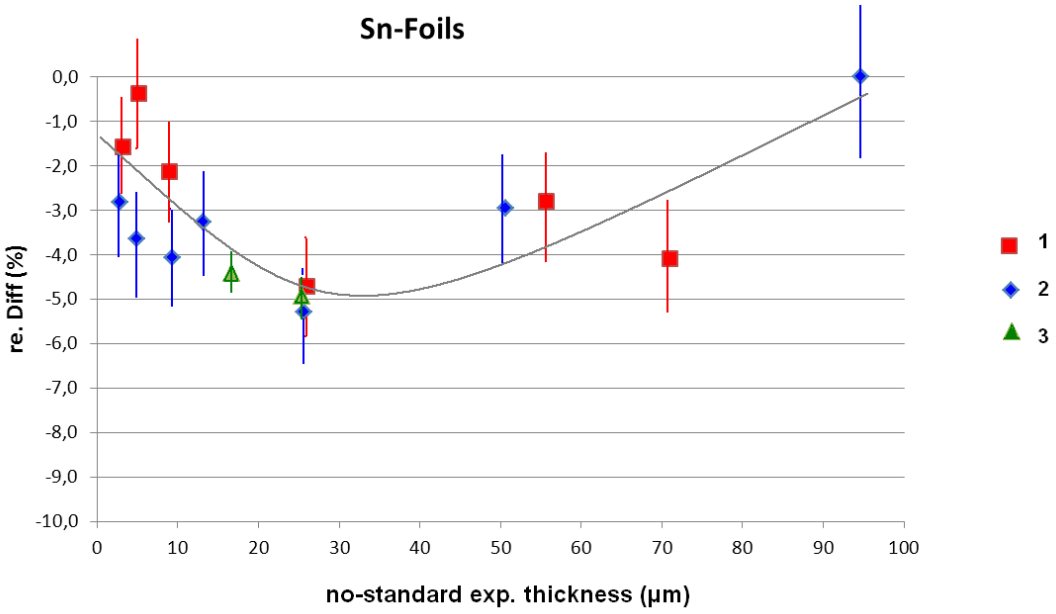

Fig. 1 The relative deviation (in %) between the stated and the theoretical results for self-supporting Sn foils. (1= secondary standards 8-13, 2 = secondary standards 1-7, 3 = primary standards 14-15, cf. Tab. 1).

Tab. 2 List of the Sn Foils mounted on a massive Ni base. The thickness values (stated and experimental = no-standard) are calculated from masses per unit area using the density ρ=7.30 g/cm^3. The samples are secondary reference samples. The expected "true" values have been estimated from the ensemble of all standards (grey line in fig. 2)

No.	Sample code	Date of production	Stated thickness (µm)	No-std. exp. thickness (µm)	Rel. deviation (%)	Expected true value (µm)
1	ADHGJ	2010 (19336)	2,82	2,83	-0,4	2,86
2	ADHFZ		5,22	5,28	-1,1	5,32
3	ADHFR		9,23	9,06	1,8	9,06
4	ADHGH		13,1	13,25	-1,1	13,18
5	ADHGD		26,44	26,9	-1,7	26,37
6	ADHFV		50	51,3	-2,6	50,39
7	ADHQI		95,5	93,6	2,0	95,51
8	ABSFA	2004 (16403)	3,05	3,01	1,3	3,04
9	ABSCJ		5,44	5,44	0,0	5,47
10	ABHGF		8,88	9	-1,4	9,00
11	ABTFU		26,84	27,54	-2,6	27,00
12	ABTER		56	56,7	-1,3	55,92
13	ABTEZ		71,4	71,7	-0,4	71,49

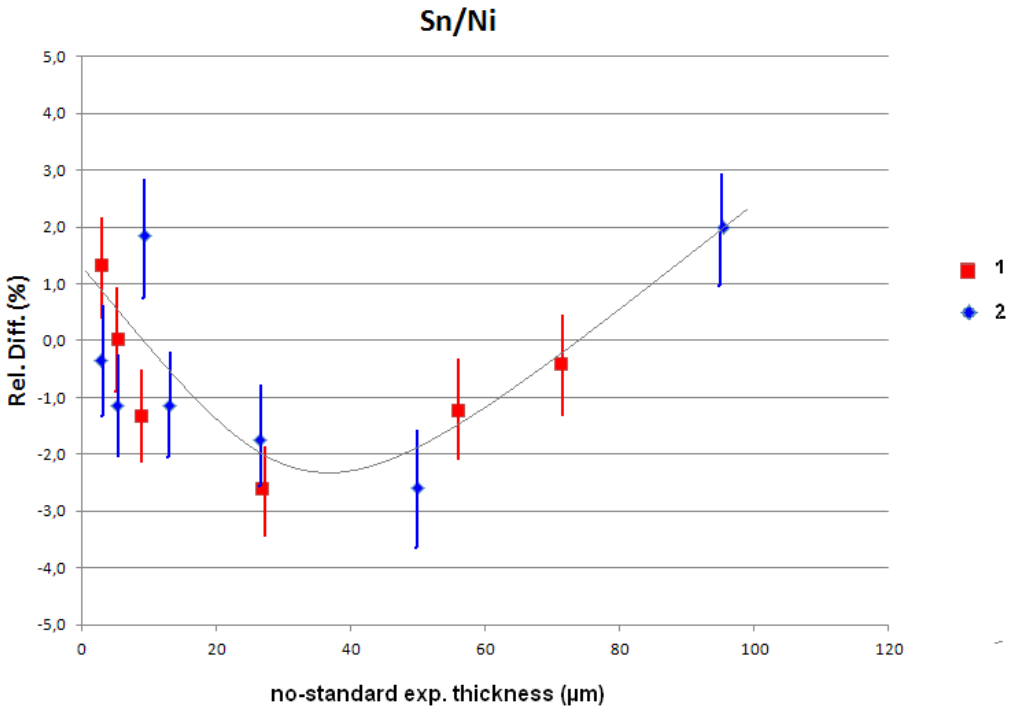

Fig. 2 The relative deviation (in %) between the stated and the theoretical results for Sn foils mounted over massive nickel. (1= secondary standards 8-13, 2 = secondary standards 1-7, cf. Tab. 2).

Discussion

The Sn foils, both self-supporting and mounted on Ni, are consistent within a range of 1%. An influence of the up to 8 years difference in age is not visible. The 2 new primary reference samples BAG Sn1510-02-12 and BAH Sn2510-02-12 are in good agreement with the two batches of old secondary standards. Both instruments (XUV-S and XDAL) which have been used here are suitable for testing Sn layers in the range up to 100 µm.
There is no influence of aging for these Sn foils.
The standard uncertainty of the expected values (last column of tabs. 1-2) is estimated with 0.7 % relative.

These measurements are also a good validation for the standard free FP based technique as applied by the Fischer WinFTM© software.

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Appendix 1
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3 Sn foils are to be measured where the calibration is performed by 4 of the above described samples.

Experimental: XUV-S, 50 kV, evaluation of SnK.

Tab. A1 Results, cf. text.

No.	Sample code	Stated thick-ness (µm)	No-std. exp. thickness (µm)	deviation (µm)	Expected true value (µm)	estimated u (k=1)
1	(mylar foil)[1]	0	0.003	0.003		
2	ADHGL	2.87	2.86	-0.01		
3	ADHFW	5.01	5.02	0.01		
4	ABSEQ	3.15	3.16	0.01		
5	ABSBX	5.12	5.26	0.14		
6	ACMZV	-	0.913	-	0.913	0.007
7	ACMFO	-	1.15	-	1.15	0.01
8	ACMFS	-	0.491	-	0.491	0.006

The calibration samples (items 1-5) are in excellent agreement with the stated thickness[2] values. A correction is not necessary. The estimated uncertainties reflect the uncertainties of the standards from Tab. 1 and the statistical scattering of these measurements.

Conclusion:

- The 3 new foils ACMZV, ACMFO, and ACMFS are added to the GN set 19339.
- Due to the good agreement with the new foils BAH Sn2510-02-12 and BAG Sn1510-02-12 (which are stored in their original size) the respective GN sets 19339 and 19336 with the minor changes given in Tabs. 1 and 2 are confirmed as “DAkkS conform” with the actual date 2012..

[1] Mylar foils are used as substrate fort thin metallic layers. For the measurement a suitable sample holder is used to avoid radiation components from the measuring chamber

[2] Thickness means mass per unit area given in thickness units using the Sn density ρ=7.30 g/cm^3