New multi-element compositions for reference samples

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- AXO project 906214 –

Abstract

The commercially available AXO thin film multi-element XRF reference samples cover a wide energy range with 7 different reference elements. However, some energy regions do not feature any fluorescence lines in the present composition. Thus, new element collections shall be evaluated and – if there is demand – made available in the near future.

Wishlist

If you are a (potential) user of thin film reference samples, please let us know what you need or what you may be interested in so we can consider in the upcoming new series of reference samples.

Substrate	Silicon nitride membrane (d = 200 nm) • 5×5 mm² membrane in 10×10 mm² Si frame • 2×2 mm² membrane in 5×5 mm² Si frame • other membrane sizes Membranes as stated above fixed in PEEK holder • 5×5 mm² membrane with 30 mm Ø PEEK • 5×5 mm² membrane with 49 mm Ø PEEK Silicon wafer or wafer piece • 2" wafer • other wafer sizes • square/rectangular wafer pieces Foils: • 4 µm ultralene • Kapton • Mylar Other substrate types: • please define	 • available • available • • available • available • available • • • • • •
Coating elements	RF: 3 – 34 keV • Pb, La, Pd, Mo, Cu, Fe, Ca* (standard) * long term stability of Ca is critical RG: focus on 3 – 8 keV • e.g. Ti, Cr, Fe, Cu, Ag, V, Mn, Ni RH: focus on 10 - 20 keV • e.g. Zr, Mo, Pd, W, Ir, Au	
Mass deposition	standard deposition (1-30 ng/mm²) • c0 high mass deposition (10-300 ng/mm²) • c10 ultralow (sub-monolayers) • TX	 • available • available •

Standard element composition RF – In Stock

The standard element collection *RF* comprises: Ca, Fe, Cu, Mo, Pd, La, Pb. In addition to that, C, Si, and N are present due to production reasons. Ar will be visible when measuring in ambient air. *(Ca is not stable on a long timescale. Thus, it should not be included in future versions. If necessary, Ca can be substituted by L lines of a suitable element.)*

Element	Atomic	Emission lines [eV]								
	number Z	$K\alpha_1$	$K\alpha_2$	$K\beta_1$	$L\alpha_1$	$L\alpha_2$	$L\beta_1$	$L\beta_2$	$L\gamma_1$	$ML\alpha_1$
C	6	277.0								
N	7	392.4								
O	8	524.9								
Si	14	1740.0	1739.4	1835.9						
Ar	18	2957.7	2955.6	3190.5						
Ca	20	3691.7	3688.1	4012.7	341.3	341.3	344.9			
Fe	26	6403.8	6390.8	7058.0	705.0	705.0	718.5			
Cu	29	8047.8	8027.8	8905.3	929.7	929.7	949.8			
Mo	42	17479.3	17374.3	19608.3	2293.2	2289.9	2394.8	2518.3	2623.5	
Pd	46	21177.1	21020.1	23818.7	2838.6	2833.3	2990.2	3171.8	3328.7	
La	57	33441.8	33034.1	37801.0	4651.0	4634.2	5042.1	5383.5	5788.5	833.0
Pb	82	74969.4	72804.2	84936.0	10551.5	10449.5	12613.7	12622.6	14764.4	2345.5

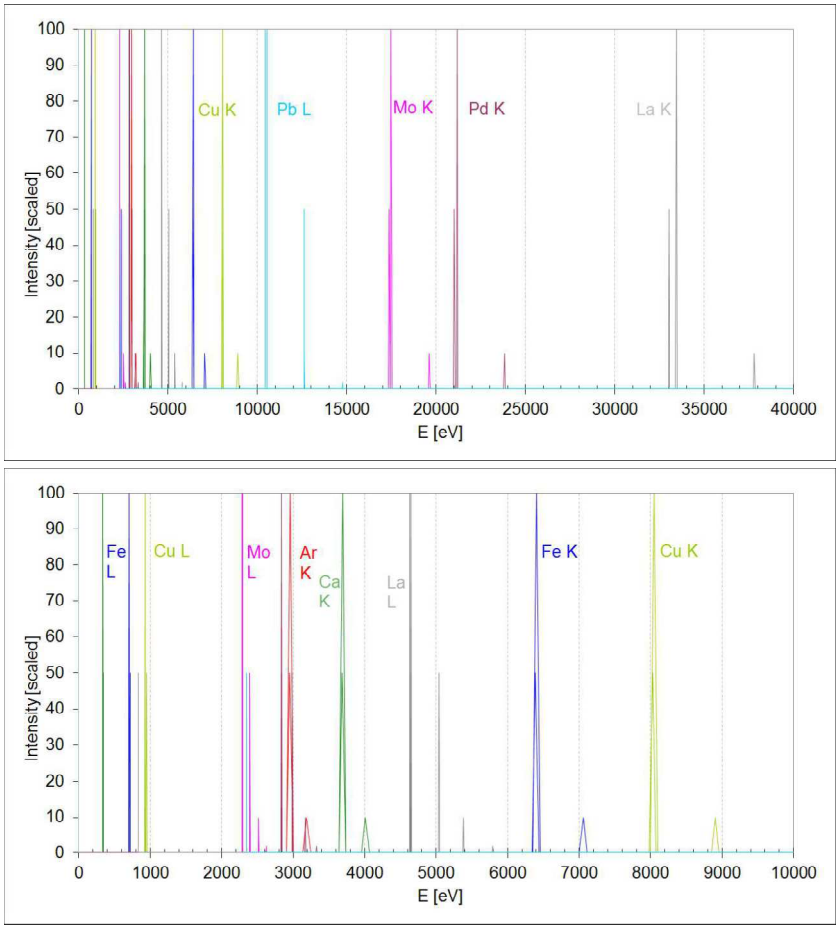


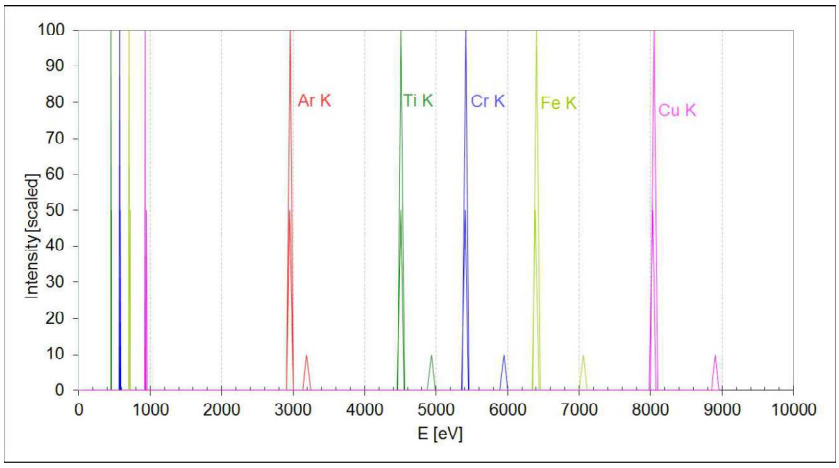
Figure 1: Fluorescence lines for the standard reference sample composition *RF* (plus Ar).

Element composition RG for 3 keV to 8 keV

Suggestion *RG* uses Ti, V, Cr, Mn, Fe, Ni (atomic numbers Z = 22 ... 29) providing more lines in the region between 3 keV (Ar) and 8.0 keV. The L line emission of Ag can be useful, too, although Ag L is very close to the Ar K lines. As Kα and Kβ lines of neighboring elements overlap here, it makes sense to use elements with ΔZ ≥ 2. Suggested compositions are:

RG1: Ti, Cr, Fe, Cu RG2: Ag, V, Mn, Ni

Element	Atomic	Emission lines [eV]								
	number Z	$K\alpha_1$	$K\alpha_2$	$K\beta_1$	$L\alpha_1$	$L\alpha_2$	$L\beta_1$	$L\beta_2$	$L\gamma_1$	$ML\alpha_1$
C	6	277.0								
N	7	392.4								
O	8	524.9								
Si	14	1740.0	1739.4	1835.9						
Ar	18	2957.7	2955.6	3190.5						
Ti	22	4510.8	4504.9	4931.8	452.2	452.2	458.4			
V	23	4952.2	4944.6	5427.3	511.3	511.3	519.2			
Cr	24	5414.7	5405.5	5946.7	572.8	572.8	582.8			
Mn	25	5898.8	5887.7	6490.5	637.4	637.4	648.8			
Fe	26	6403.8	6390.8	7058.0	705.0	705.0	718.5			
Ni	28	7478.2	7460.9	8264.7	851.5	851.5	868.8			
Cu	29	8047.8	8027.8	8905.3	929.7	929.7	949.8			
Ag	47	22162.9	21990.3	24942.4	2984.3	2978.2	3150.9	3347.8	3519.6	



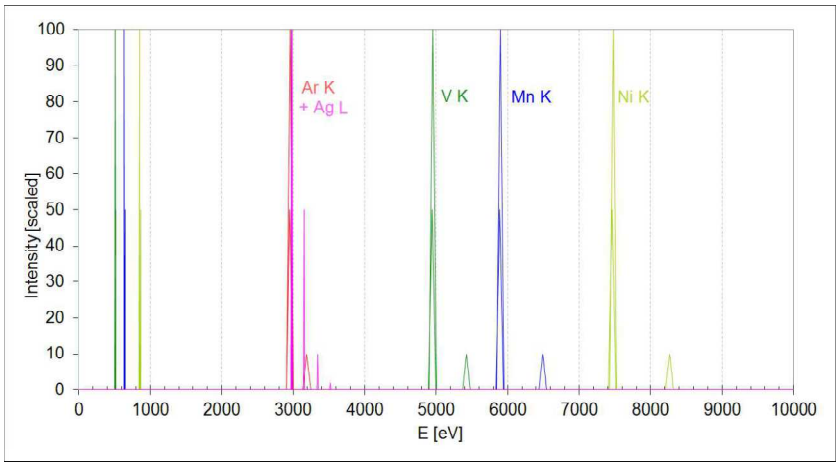


Figure 2: Fluorescence lines for a composition *RG1* (top) and *RG2* (bottom).

Element composition RH for 10 keV to 20 keV

Version *RH* tries to cover the region between ~10 keV and ~20 keV with Kα,β and Lα,β lines in a better way. Suggestions are: Zr, Mo, Pd (K lines) plus W, Ir, Au (L lines).

Element	Atomic	Emission lines [eV]								
	number Z	$K\alpha_1$	$K\alpha_2$	$K\beta_1$	$L\alpha_1$	$L\alpha_2$	$L\beta_1$	$L\beta_2$	$L\gamma_1$	$ML\alpha_1$
C	6	277.0								
N	7	392.4								
O	8	524.9								
Si	14	1740.0	1739.4	1835.9						
Ar	18	2957.7	2955.6	3190.5						
Zr	40	15775.1	15690.9	17667.8	2042.4	2039.9	2124.4	2219.4	2302.7	
Mo	42	17479.3	17374.3	19608.3	2293.2	2289.9	2394.8	2518.3	2623.5	
Pd	46	21177.1	21020.1	23818.7	2838.6	2833.3	2990.2	3171.8	3328.7	
W	74	59318.2	57981.7	67244.3	8397.6	8335.2	9672.4	9961.5	11285.9	1775.4
Ir	77	64895.6	63286.7	73560.8	9175.1	9099.5	10708.3	10920.3	12512.6	1979.9
Au	79	68803.7	66989.5	77984.0	9713.3	9628.0	11442.3	11584.7	13381.7	2122.9

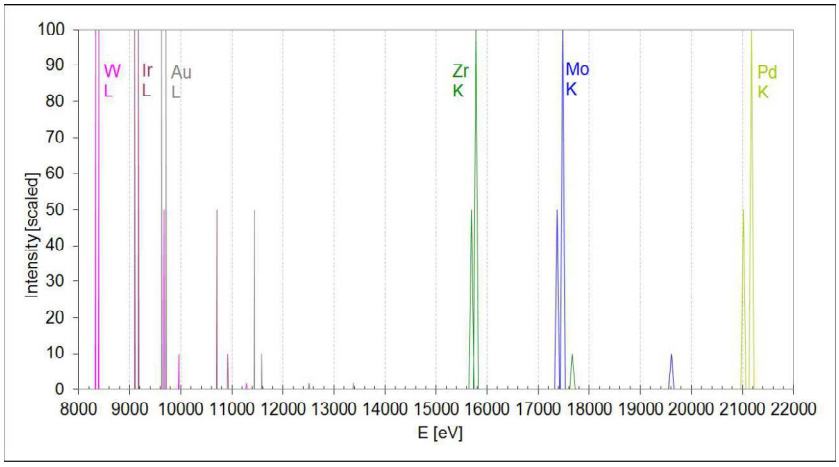


Figure 3: Fluorescence lines for composition *RH*.

Fabrication remarks

It is possible to combine several elemenents in one multi-element reference sample to cover a wider energy range. A set of 3 or 6-7 is a reasonable number of elements. When combining several elements is has to be taken into account that lines of different elements do not overlap and fluorescence yields (detected intensity of X-ray fluoresnce emission) of all elements are in the same order of magnitude.