SEM Results for Witness Sample SN C21094_80mm (SN1009-LMA005)

80 mm optic coated with a Ti:Ta2O5/SiO2 HR stack
Optic mount, shutter, nearby panels were ALL covered in clean room foil.

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Originated 03 October 2021
E2100394

Table of Contents

Table of Contents

Overview of SEM results

“Top 10” compositions:
- 5x Aluminum (!!!)
- Remaining are coating

“Top 10” sizes:
- > 20 µm = 1x
- 20 µm ≥ size ≥ 10 µm = 3x
- < 10 µm = 6x

Interesting composition features:
- 1x Titanium, sub-10 micron (11)
- 2x Aluminum, tiny and sub-10 micron (14, 45)
- 2x Sodium (35, 36)

60 features measured in total (>600 ppm).
- 9 of 60 are larger than 10 microns.

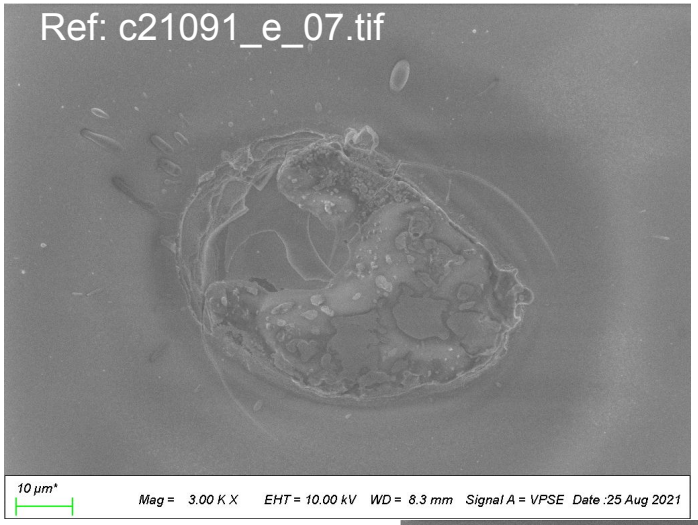
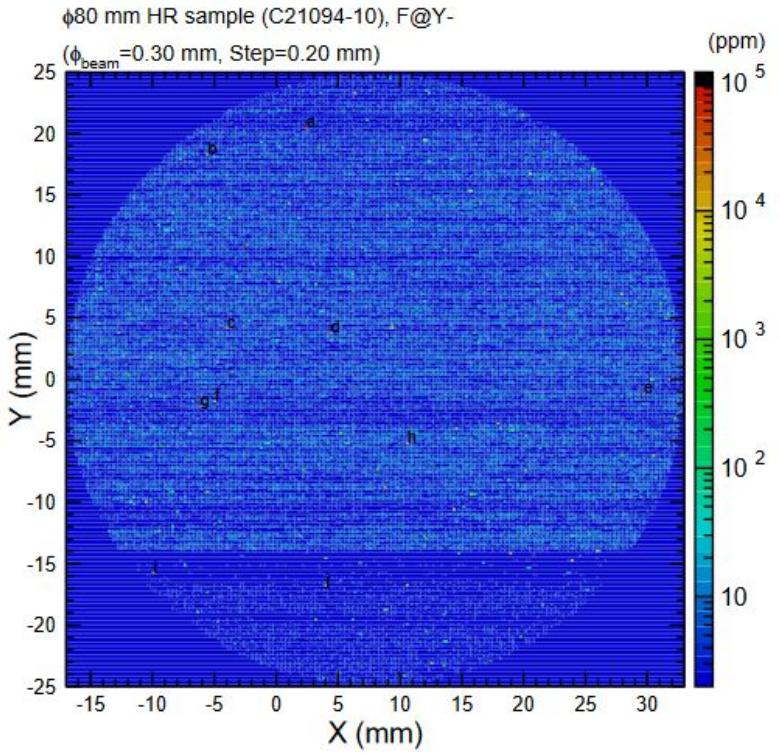
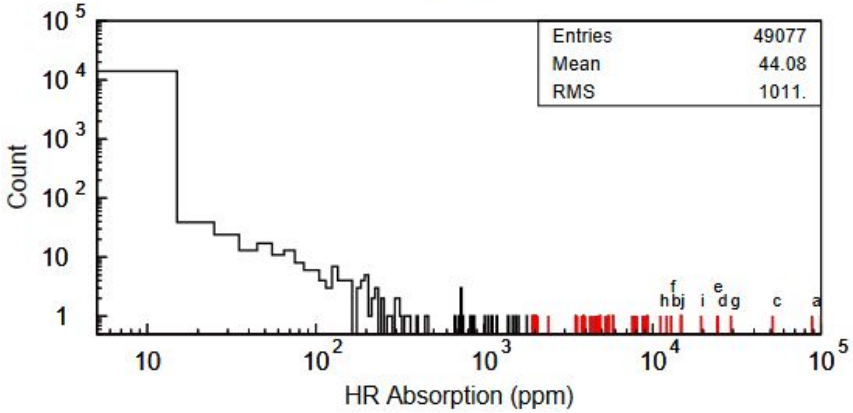


Table of Contents

RTS Map

	A	B	C	D	E
1	No	ID	X_{optic} (mm)	Y_{optic} (mm	Absorption (ppm
4	3	a	2.338	20.613	88127
7	6	b	-5.363	18.413	12921
23	22	c	-4.094	4.212	51664
26	25	d	4.239	3.810	24500
30	29	e	29.826	-1.186	24118
31	30	f	-5.102	-1.795	12888
32	31	g	-6.292	-2.190	29136
38	37	h	10.759	-5.187	12149
54	53	i	-10.015	-15.790	19348
56	55	j	4.177	-16.792	14747
62		M1 (next to "F")	0.000	-30.000	
63		M2	0.000	30.000	





Reminder that all images are posted to Catalog

Table of Contents

Catalog and References

All images referenced are posted to T2000733

Raw Aztec project files:

- All features = “c21094 80mm 20211001.oip”

Note that composition data and images exist for all features; the top 10 absorbers are presented in these slides, along with the “interesting composition” lower absorbing features.

Mounting

Carbon tape on back surface

Best effort centering

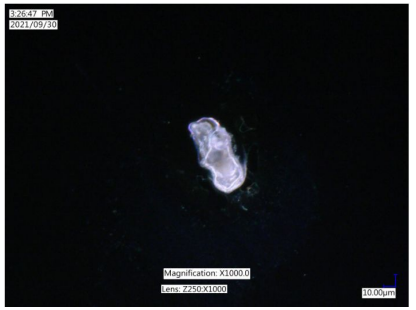
M1 and M2 used to align

Note: When no RTS photo was available, “calibrated” to typical offset using known features, and attempted to make ID based on feature size. Felt comfortable in all IDs - no confusing scenarios with more than 2 possibilities.

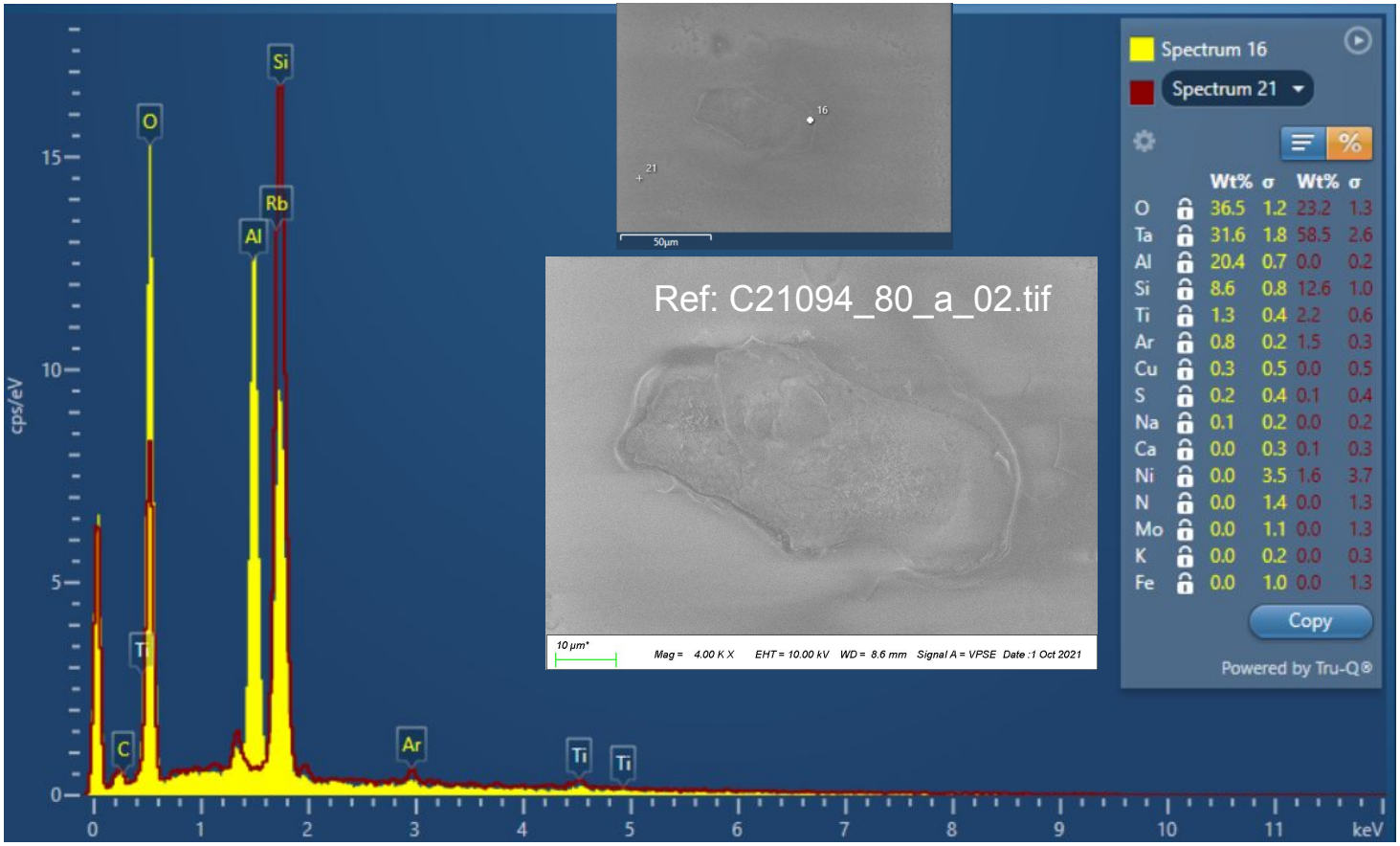
Table of Contents

Point A - 88127 ppm

Aluminum (oxide?)



Element	Spectrum 16 Weight %	σ	Spectrum 21 Weight %	σ
O	36.5	1.2	23.2	1.3
Ta	31.6	1.8	58.5	2.6
Al	20.4	0.7	0.0	0.2
Si	8.6	0.8	12.6	1.0
Ti	1.3	0.4	2.2	0.6
Ar	0.8	0.2	1.5	0.3
Cu	0.3	0.5	0.0	0.5
S	0.2	0.4	0.1	0.4
Na	0.1	0.2	0.0	0.2
Ca	0.0	0.3	0.1	0.3
Ni	0.0	3.5	1.6	3.7
N	0.0	1.4	0.0	1.3
Mo	0.0	1.1	0.0	1.3
K	0.0	0.2	0.0	0.3
Fe	0.0	1.0	0.0	1.3



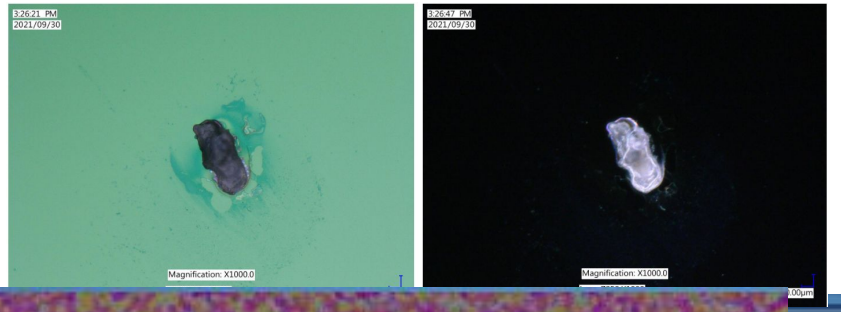
(X-axis is zoomed for visibility of peaks)

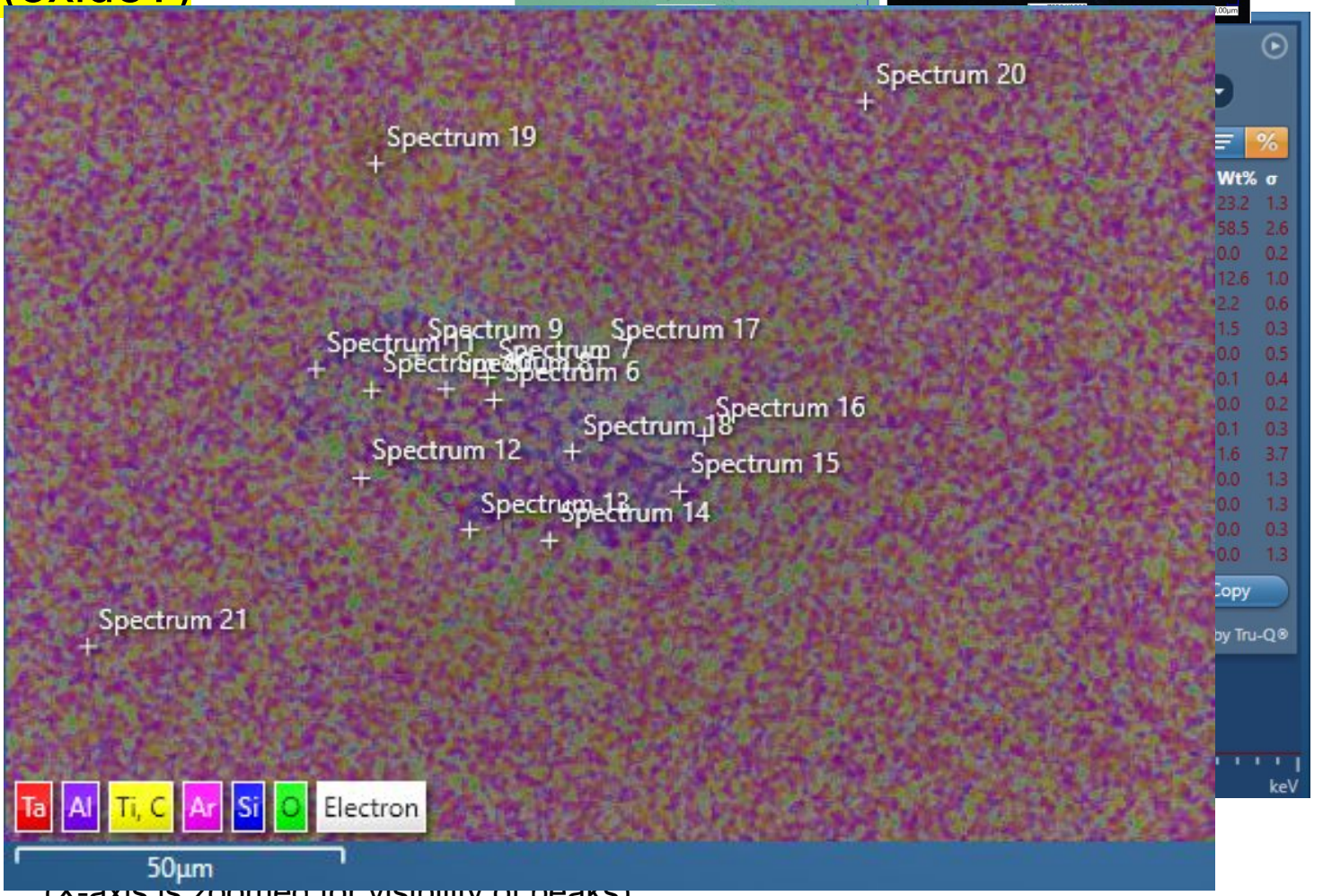
Table of Contents

Point A - 88127 ppm

Aluminum (oxide?)

Element	Spectrum 16 Weight %	σ	Spectrum 21 Weight %	σ
O	36.5	1.2	23.2	1.3
Ta	31.6	1.8	58.5	2.6
Al	20.4	0.7	0.0	0.2
Si	8.6	0.8	12.6	1.0
Ti	1.3	0.4	2.2	0.6
Ar	0.8	0.2	1.5	0.3
Cu	0.3	0.5	0.0	0.5
S	0.2	0.4	0.1	0.4
Na	0.1	0.2	0.0	0.2
Ca	0.0	0.3	0.1	0.3
Ni	0.0	3.5	1.6	3.7
N	0.0	1.4	0.0	1.3
Mo	0.0	1.1	0.0	1.3
K	0.0	0.2	0.0	0.3
Fe	0.0	1.0	0.0	1.3



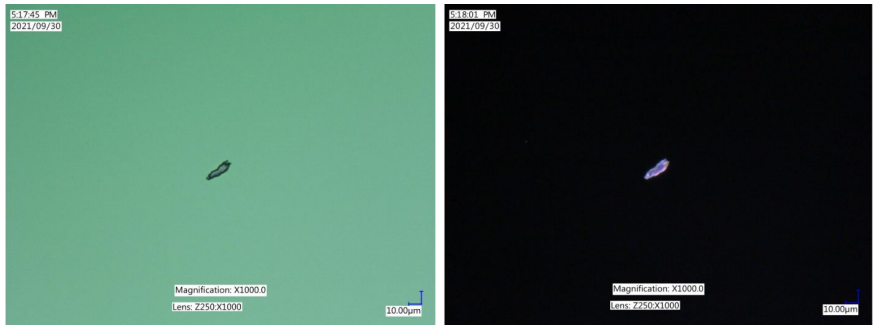


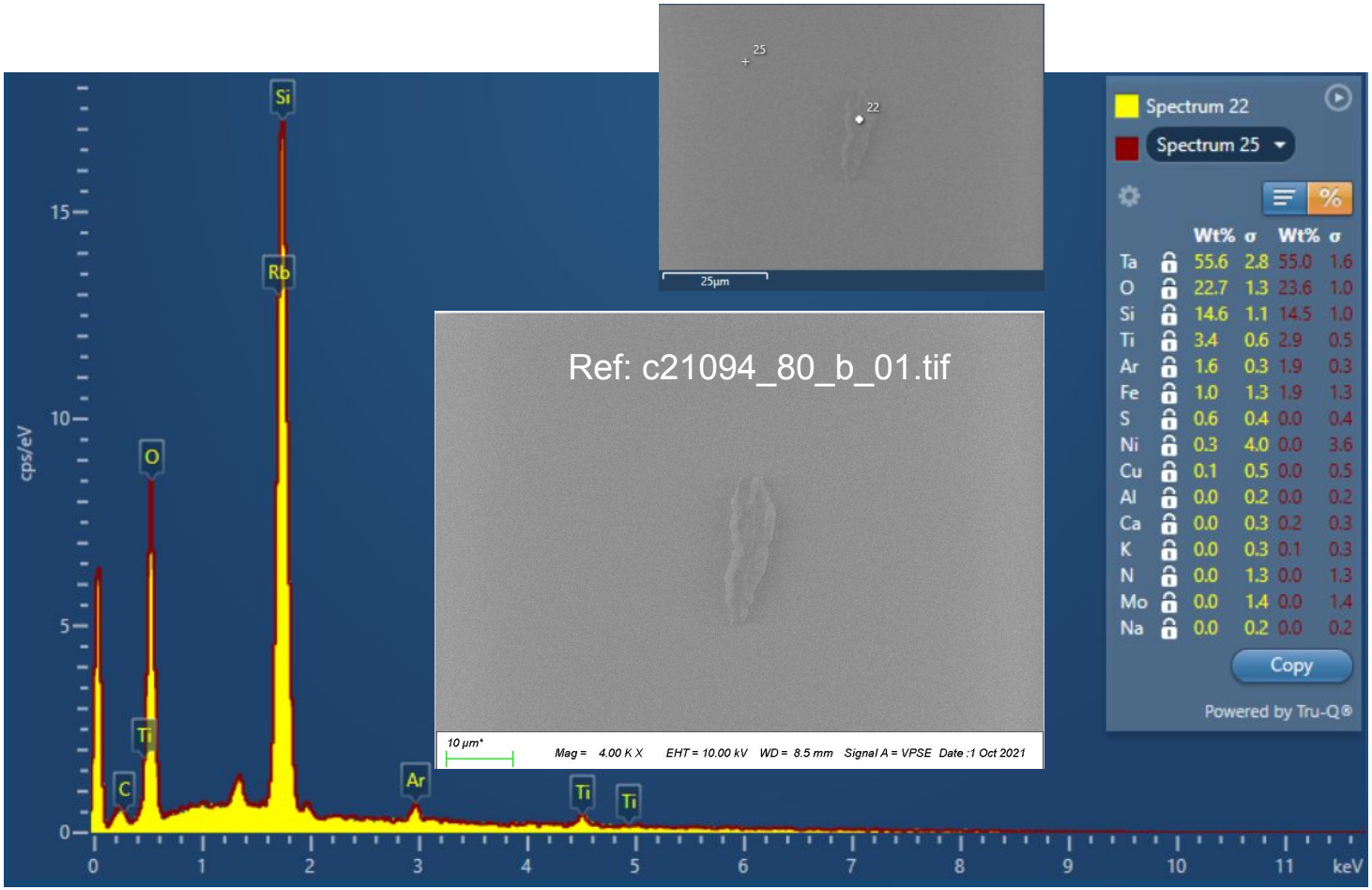
(X-axis is zoomed for visibility of peaks)

Table of Contents

Point B - 12921 ppm Coating

Element	Spectrum 22 Weight %	σ	Spectrum 25 Weight %	σ
Ta	55.6	2.8	55.0	1.6
O	22.7	1.3	23.6	1.0
Si	14.6	1.1	14.5	1.0
Ti	3.4	0.6	2.9	0.5
Ar	1.6	0.3	1.9	0.3
Fe	1.0	1.3	1.9	1.3
S	0.6	0.4	0.0	0.4
Ni	0.3	4.0	0.0	3.6
Cu	0.1	0.5	0.0	0.5
Al	0.0	0.2	0.0	0.2
Ca	0.0	0.3	0.2	0.3
K	0.0	0.3	0.1	0.3
N	0.0	1.3	0.0	1.3
Mo	0.0	1.4	0.0	1.4
Na	0.0	0.2	0.0	0.2





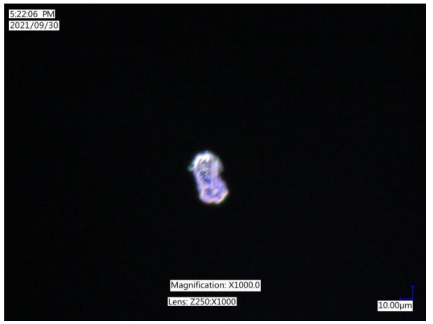
(X-axis is zoomed for visibility of peaks)

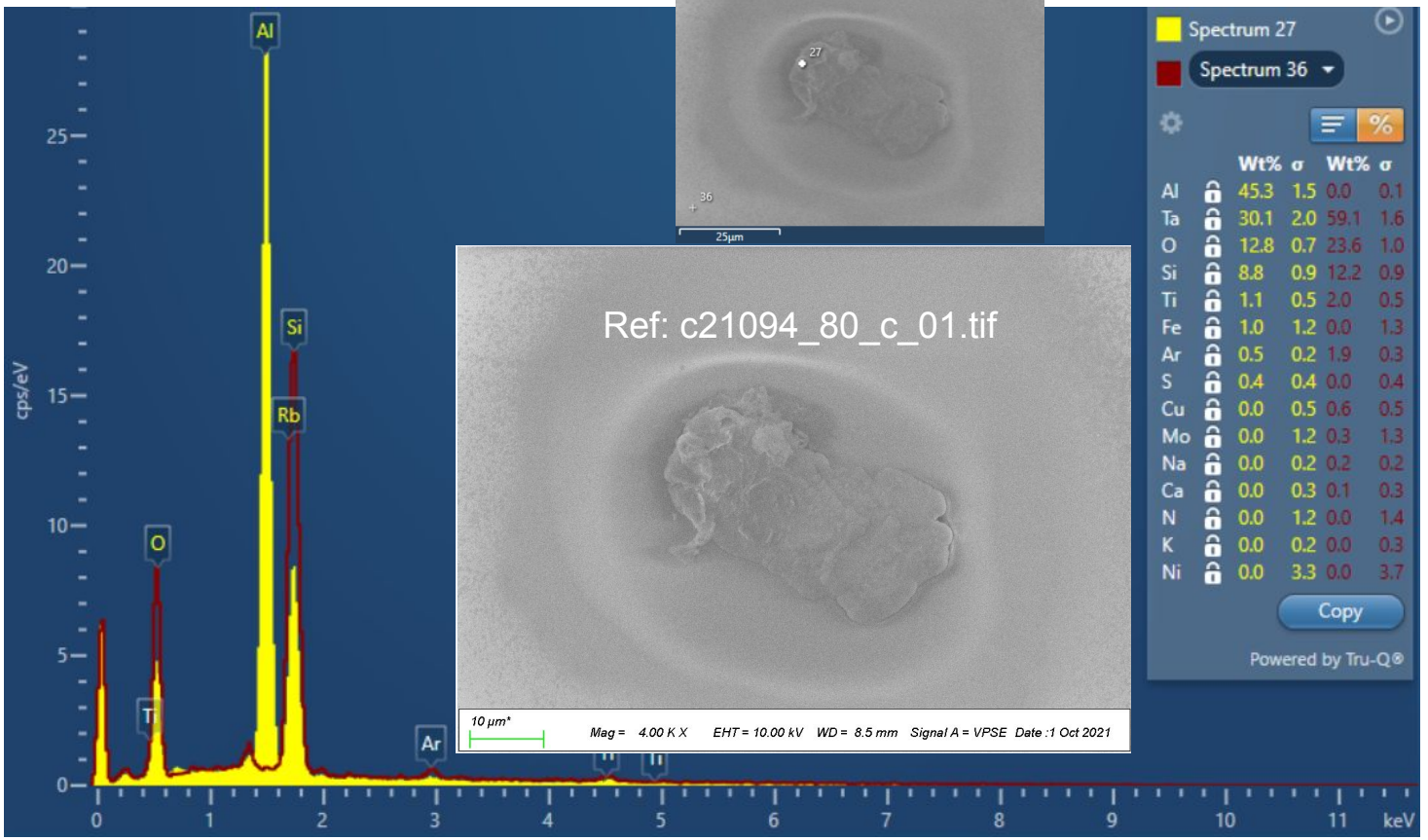
Table of Contents

Point C - 51644ppm

Aluminum

Element	Spectrum 158 Weight %	σ	Spectrum 162 Weight %	σ
Ta	57.8	3.1	57.5	2.1
O	20.9	1.5	22.4	1.2
Si	12.8	1.3	13.6	1.2
Ti	2.6	0.7	2.5	0.7
Ar	2.3	0.4	2.0	0.4
Ni	2.2	4.1	0.0	4.3
Mo	0.6	1.8	0.4	1.8
K	0.3	0.3	0.4	0.3
Cu	0.3	0.7	1.0	0.7
Na	0.1	0.2	0.2	0.2
Al	0.0	0.2	0.0	0.2
N	0.0	2.2	0.0	2.2
Ca	0.0	0.3	0.0	0.4
S	0.0	0.6	0.0	0.6
Fe	0.0	1.6	0.0	1.6





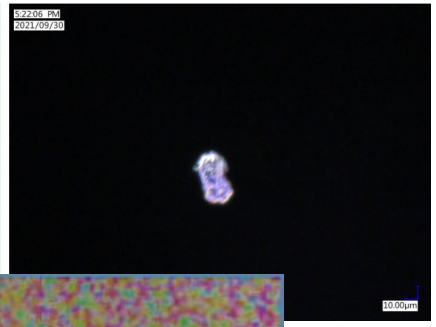
(X-axis is zoomed for visibility of peaks)

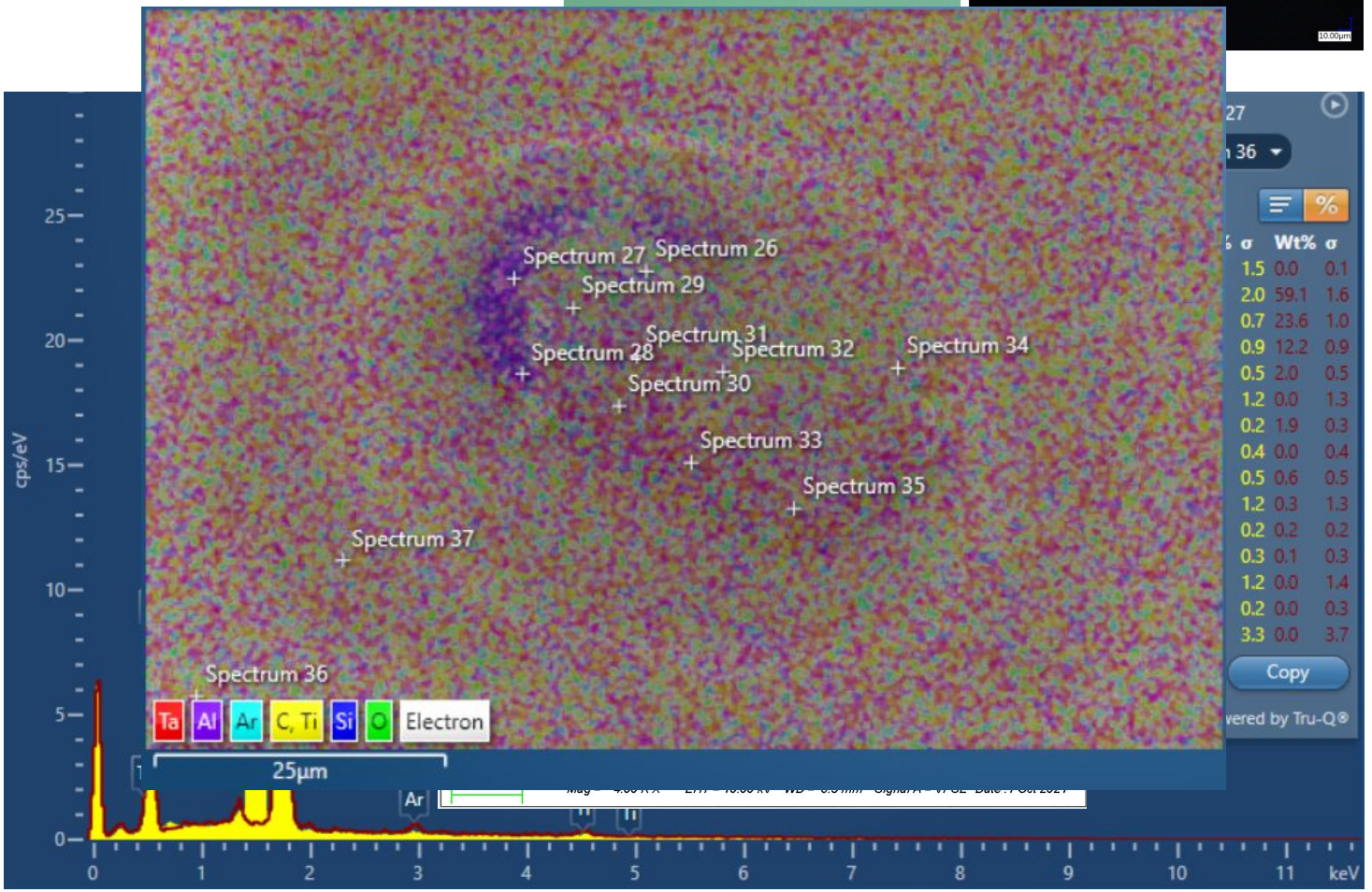
Table of Contents

Point C - 51644ppm

Aluminum

Element	Spectrum 158 Weight %	σ	Spectrum 162 Weight %	σ
Ta	57.8	3.1	57.5	2.1
O	20.9	1.5	22.4	1.2
Si	12.8	1.3	13.6	1.2
Ti	2.6	0.7	2.5	0.7
Ar	2.3	0.4	2.0	0.4
Ni	2.2	4.1	0.0	4.3
Mo	0.6	1.8	0.4	1.8
K	0.3	0.3	0.4	0.3
Cu	0.3	0.7	1.0	0.7
Na	0.1	0.2	0.2	0.2
Al	0.0	0.2	0.0	0.2
N	0.0	2.2	0.0	2.2
Ca	0.0	0.3	0.0	0.4
S	0.0	0.6	0.0	0.6
Fe	0.0	1.6	0.0	1.6





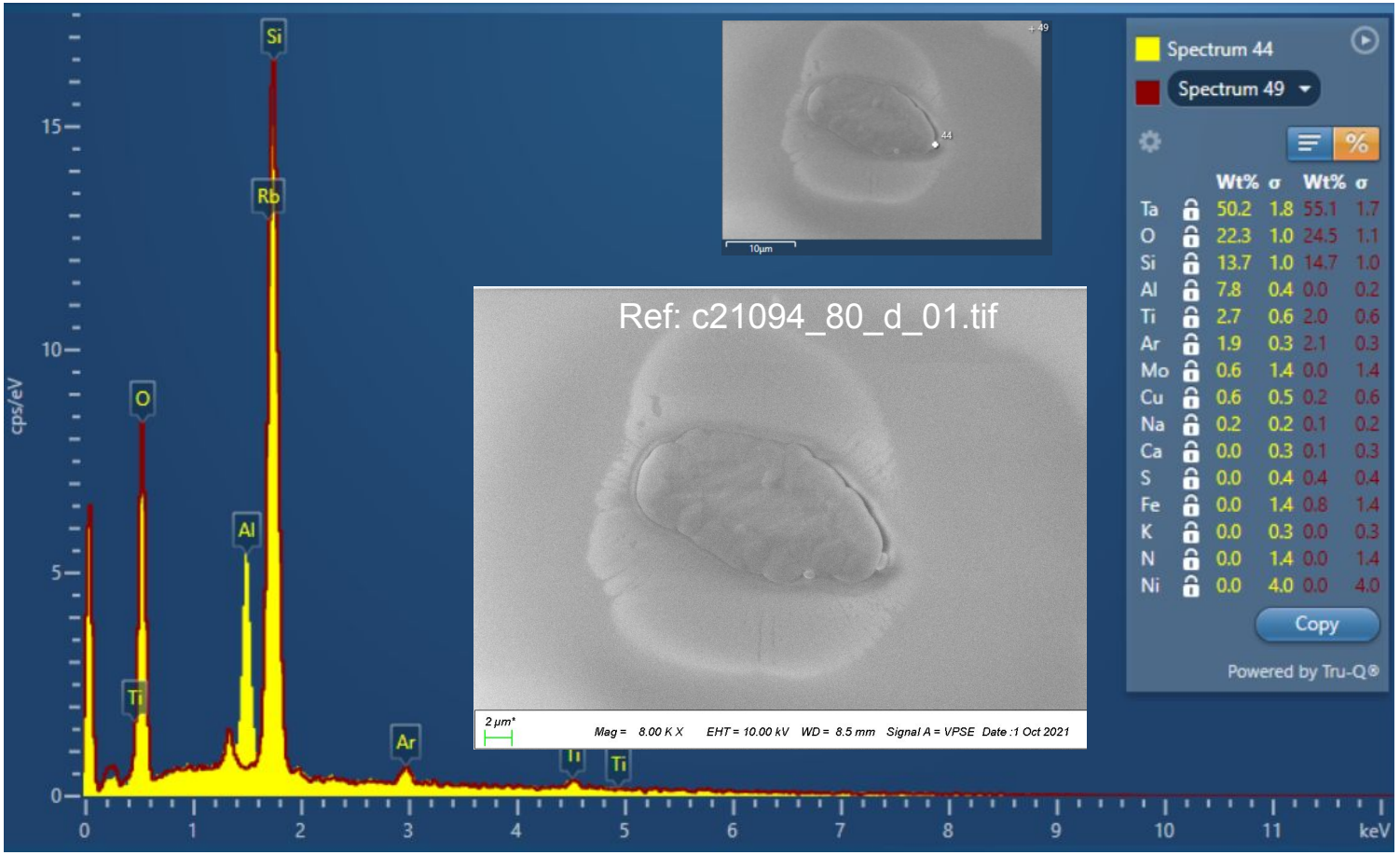
(X-axis is zoomed for visibility of peaks)

Table of Contents

Point D - 24500 ppm

Aluminum (local only, 2 micron)

Element	Spectrum 44 Weight %	σ	Spectrum 49 Weight %	σ
Ta	50.2	1.8	55.1	1.7
O	22.3	1.0	24.5	1.1
Si	13.7	1.0	14.7	1.0
Al	7.8	0.4	0.0	0.2
Ti	2.7	0.6	2.0	0.6
Ar	1.9	0.3	2.1	0.3
Mo	0.6	1.4	0.0	1.4
Cu	0.6	0.5	0.2	0.6
Na	0.2	0.2	0.1	0.2
Ca	0.0	0.3	0.1	0.3
S	0.0	0.4	0.4	0.4
Fe	0.0	1.4	0.8	1.4
K	0.0	0.3	0.0	0.3
N	0.0	1.4	0.0	1.4
Ni	0.0	4.0	0.0	4.0

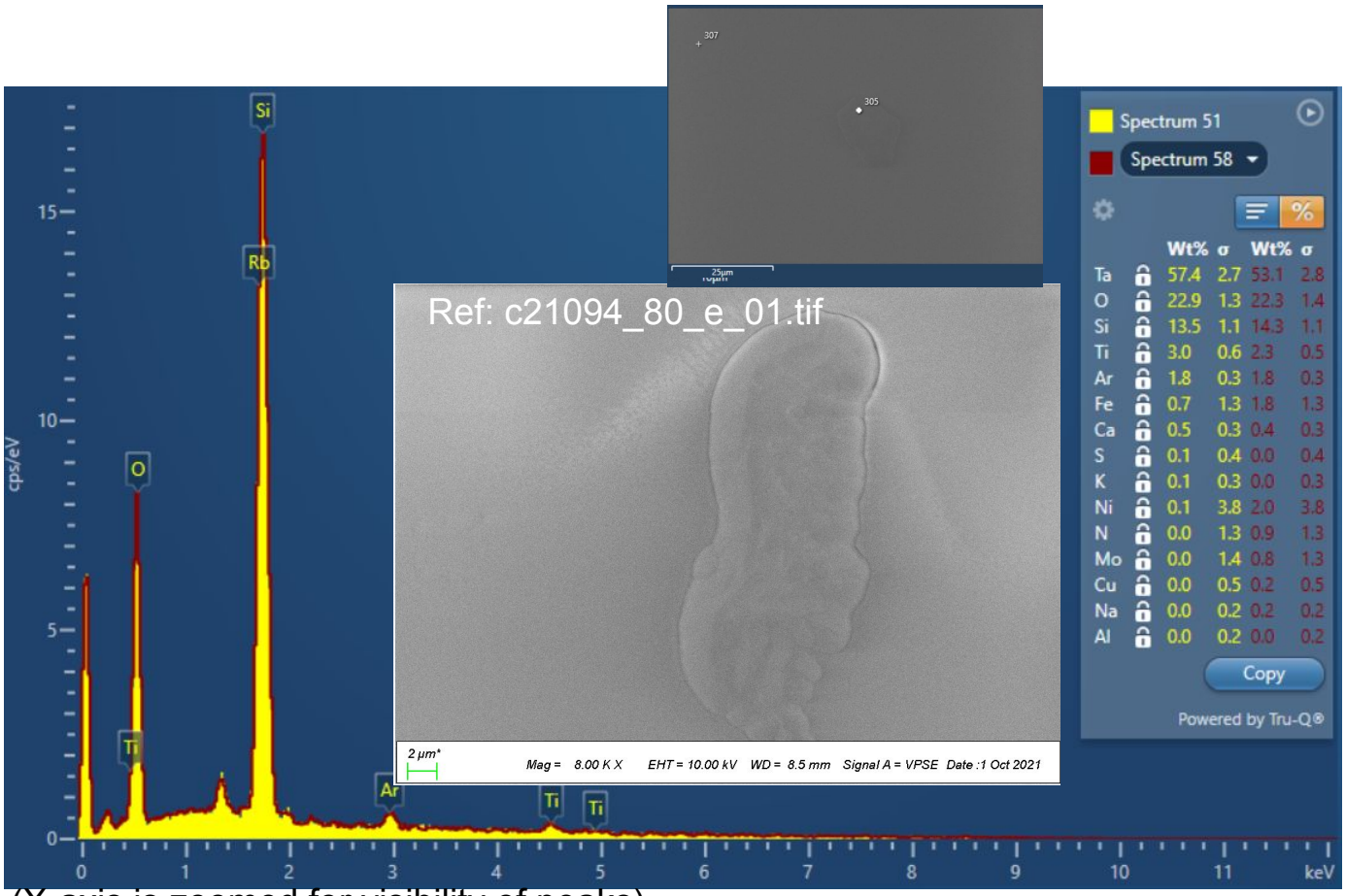


(X-axis is zoomed for visibility of peaks)

Table of Contents

Point E - 24188 ppm Coating

	Spectrum 51		Spectrum 58	
Element	Weight %	σ	Weight %	σ
Ta	57.4	2.7	53.1	2.8
O	22.9	1.3	22.3	1.4
Si	13.5	1.1	14.3	1.1
Ti	3.0	0.6	2.3	0.5
Ar	1.8	0.3	1.8	0.3
Fe	0.7	1.3	1.8	1.3
Ca	0.5	0.3	0.4	0.3
S	0.1	0.4	0.0	0.4
K	0.1	0.3	0.0	0.3
Ni	0.1	3.8	2.0	3.8
N	0.0	1.3	0.9	1.3
Mo	0.0	1.4	0.8	1.3
Cu	0.0	0.5	0.2	0.5
Na	0.0	0.2	0.2	0.2
Al	0.0	0.2	0.0	0.2

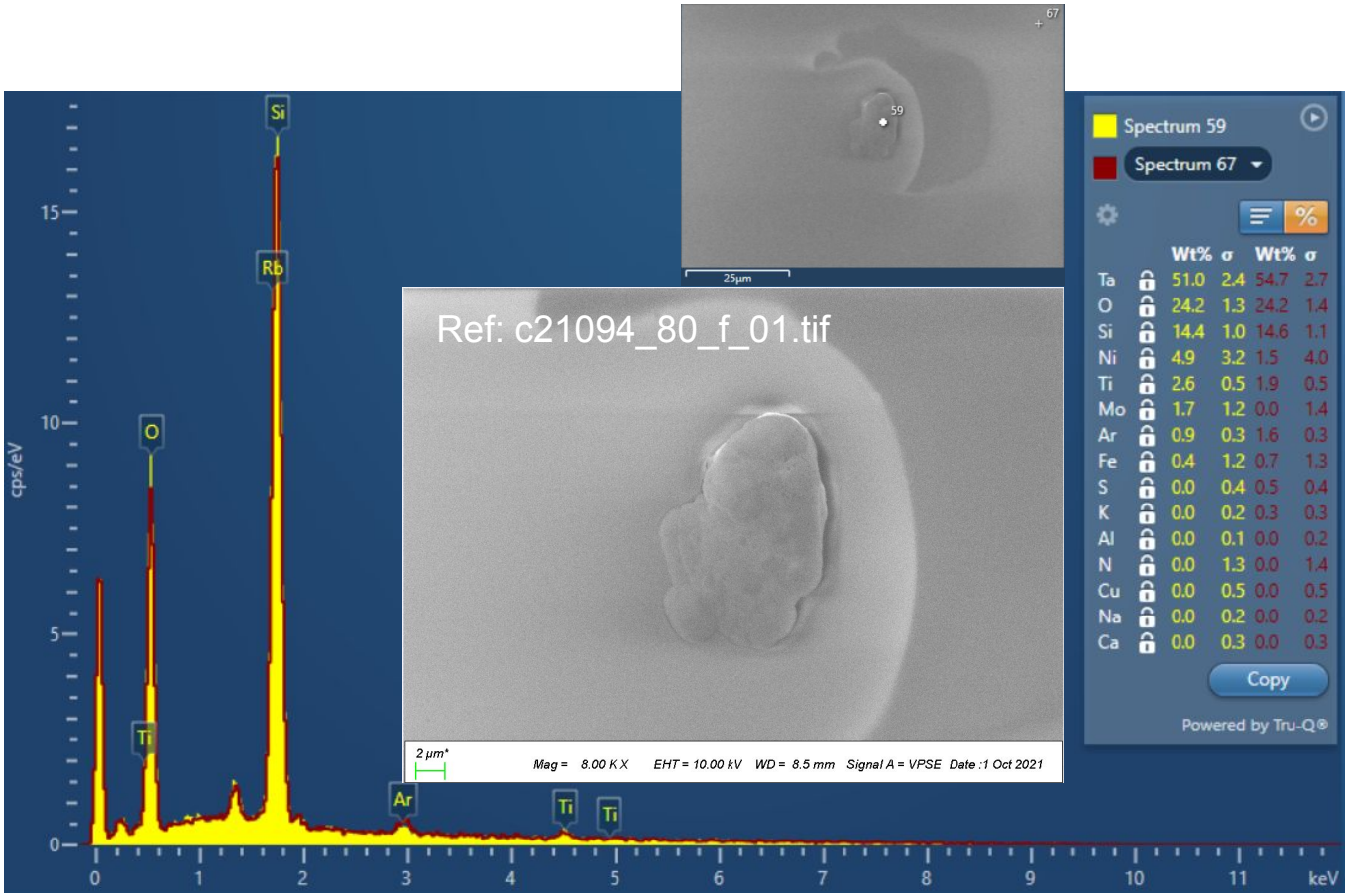


(X-axis is zoomed for visibility of peaks)

Table of Contents

Point F - 12888 ppm Coating

	Spectrum 59		Spectrum 67	
Element	Weight %	σ	Weight %	σ
Ta	51.0	2.4	54.7	2.7
O	24.2	1.3	24.2	1.4
Si	14.4	1.0	14.6	1.1
Ni	4.9	3.2	1.5	4.0
Ti	2.6	0.5	1.9	0.5
Mo	1.7	1.2	0.0	1.4
Ar	0.9	0.3	1.6	0.3
Fe	0.4	1.2	0.7	1.3
S	0.0	0.4	0.5	0.4
K	0.0	0.2	0.3	0.3
Al	0.0	0.1	0.0	0.2
N	0.0	1.3	0.0	1.4
Cu	0.0	0.5	0.0	0.5
Na	0.0	0.2	0.0	0.2
Ca	0.0	0.3	0.0	0.3



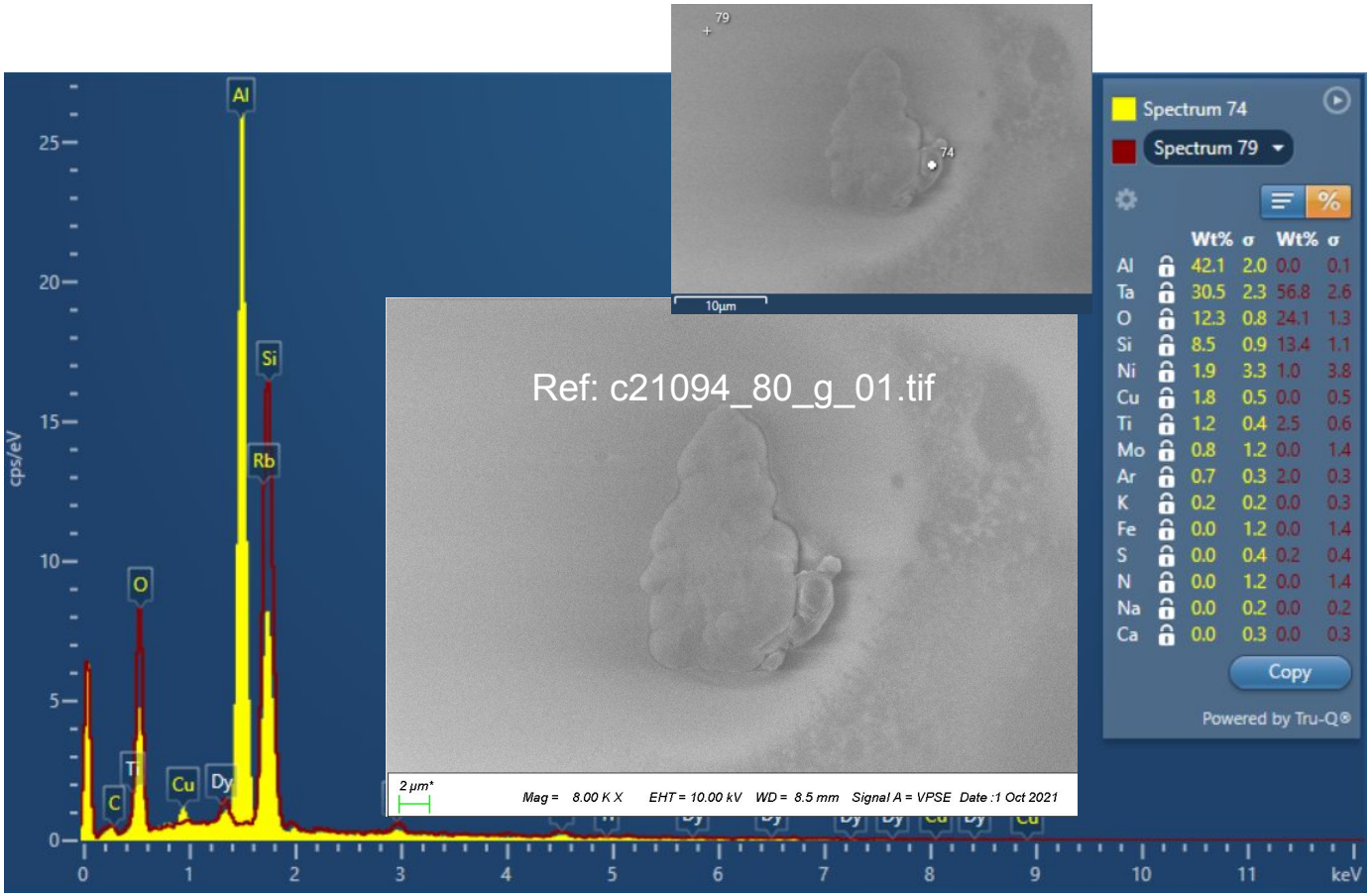
(X-axis is zoomed for visibility of peaks)

Table of Contents

Point G - 29136 ppm

Aluminum (alloyed with Cu - if wrought, 2000 series; local only)

Element	Spectrum 74 Weight %	σ	Spectrum 79 Weight %	σ
Al	42.1	2.0	0.0	0.1
Ta	30.5	2.3	56.8	2.6
O	12.3	0.8	24.1	1.3
Si	8.5	0.9	13.4	1.1
Ni	1.9	3.3	1.0	3.8
Cu	1.8	0.5	0.0	0.5
Ti	1.2	0.4	2.5	0.6
Mo	0.8	1.2	0.0	1.4
Ar	0.7	0.3	2.0	0.3
K	0.2	0.2	0.0	0.3
Fe	0.0	1.2	0.0	1.4
S	0.0	0.4	0.2	0.4
N	0.0	1.2	0.0	1.4
Na	0.0	0.2	0.0	0.2
Ca	0.0	0.3	0.0	0.3

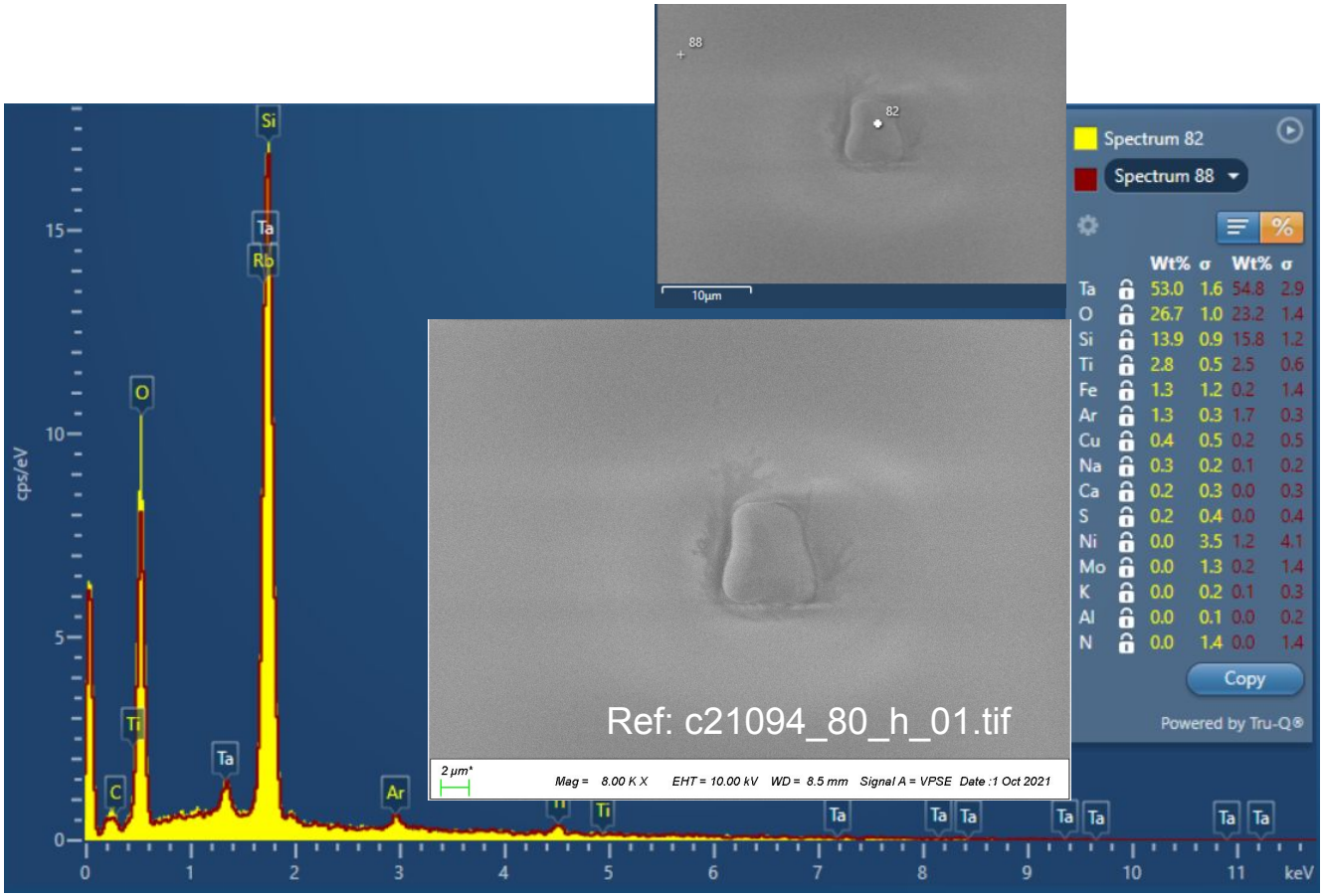


(X-axis is zoomed for visibility of peaks)

Table of Contents

Point H - 12149 ppm Coating

Element	Spectrum 82 Weight %	σ	Spectrum 88 Weight %	σ
Ta	53.0	1.6	54.8	2.9
O	26.7	1.0	23.2	1.4
Si	13.9	0.9	15.8	1.2
Ti	2.8	0.5	2.5	0.6
Fe	1.3	1.2	0.2	1.4
Ar	1.3	0.3	1.7	0.3
Cu	0.4	0.5	0.2	0.5
Na	0.3	0.2	0.1	0.2
Ca	0.2	0.3	0.0	0.3
S	0.2	0.4	0.0	0.4
Ni	0.0	3.5	1.2	4.1
Mo	0.0	1.3	0.2	1.4
K	0.0	0.2	0.1	0.3
Al	0.0	0.1	0.0	0.2
N	0.0	1.4	0.0	1.4



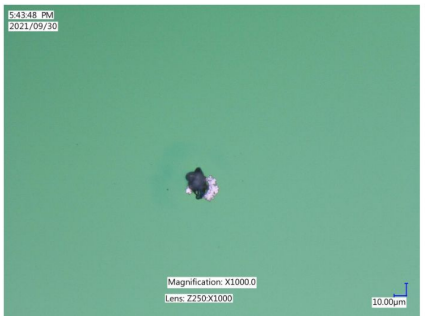
(X-axis is zoomed for visibility of peaks)

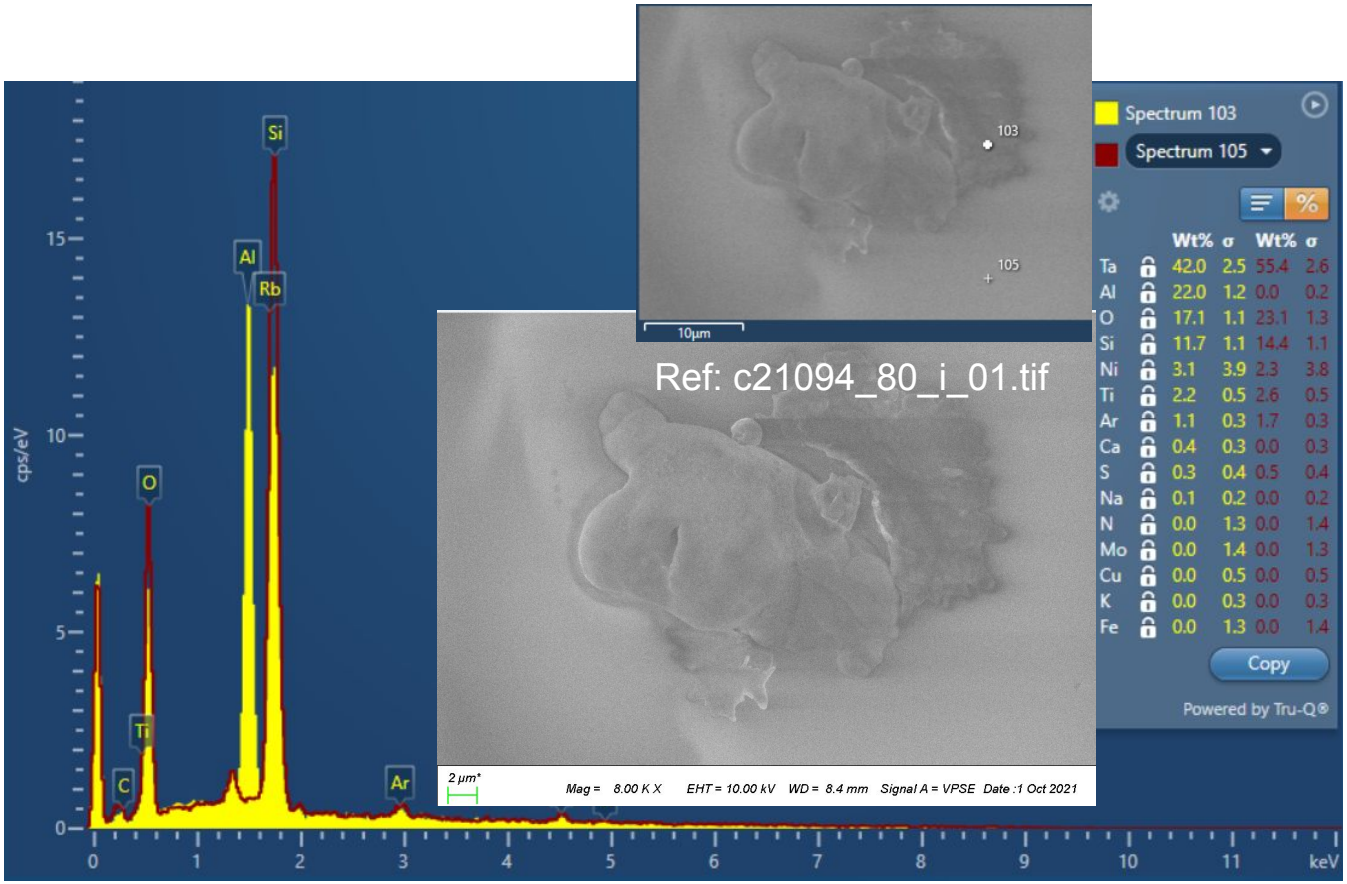
Table of Contents

Point I - 19348 ppm

Aluminum

Element	Spectrum 103 Weight %	σ	Spectrum 105 Weight %	σ
Ta	42.0	2.5	55.4	2.6
Al	22.0	1.2	0.0	0.2
O	17.1	1.1	23.1	1.3
Si	11.7	1.1	14.4	1.1
Ni	3.1	3.9	2.3	3.8
Ti	2.2	0.5	2.6	0.5
Ar	1.1	0.3	1.7	0.3
Ca	0.4	0.3	0.0	0.3
S	0.3	0.4	0.5	0.4
Na	0.1	0.2	0.0	0.2
N	0.0	1.3	0.0	1.4
Mo	0.0	1.4	0.0	1.3
Cu	0.0	0.5	0.0	0.5
K	0.0	0.3	0.0	0.3
Fe	0.0	1.3	0.0	1.4



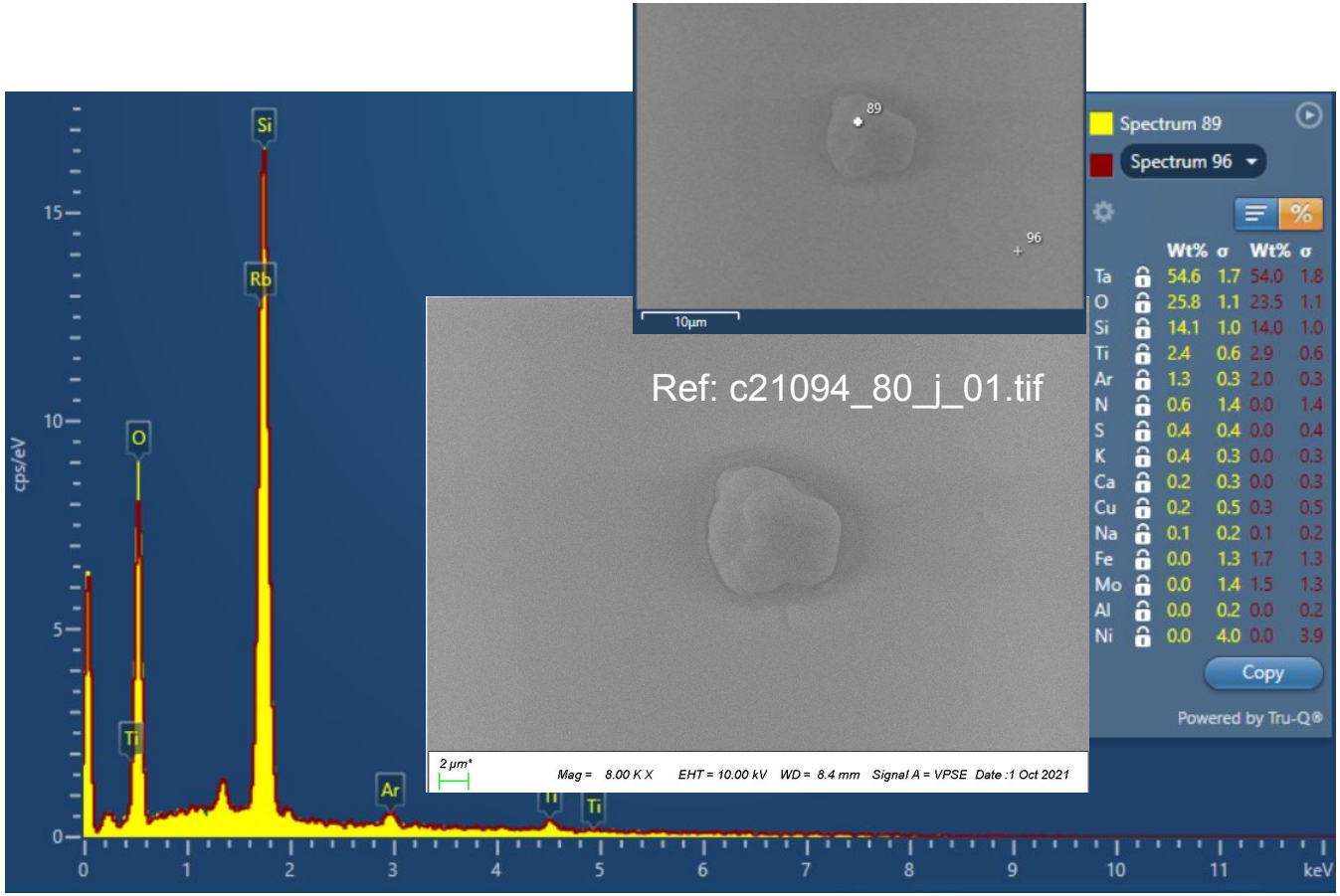


(X-axis is zoomed for visibility of peaks)

Table of Contents

Point J - 14747 ppm Coating

Element	Spectrum 89 Weight %	σ	Spectrum 96 Weight %	σ
Ta	54.6	1.7	54.0	1.8
O	25.8	1.1	23.5	1.1
Si	14.1	1.0	14.0	1.0
Ti	2.4	0.6	2.9	0.6
Ar	1.3	0.3	2.0	0.3
N	0.6	1.4	0.0	1.4
S	0.4	0.4	0.0	0.4
K	0.4	0.3	0.0	0.3
Ca	0.2	0.3	0.0	0.3
Cu	0.2	0.5	0.3	0.5
Na	0.1	0.2	0.1	0.2
Fe	0.0	1.3	1.7	1.3
Mo	0.0	1.4	1.5	1.3
Al	0.0	0.2	0.0	0.2
Ni	0.0	4.0	0.0	3.9



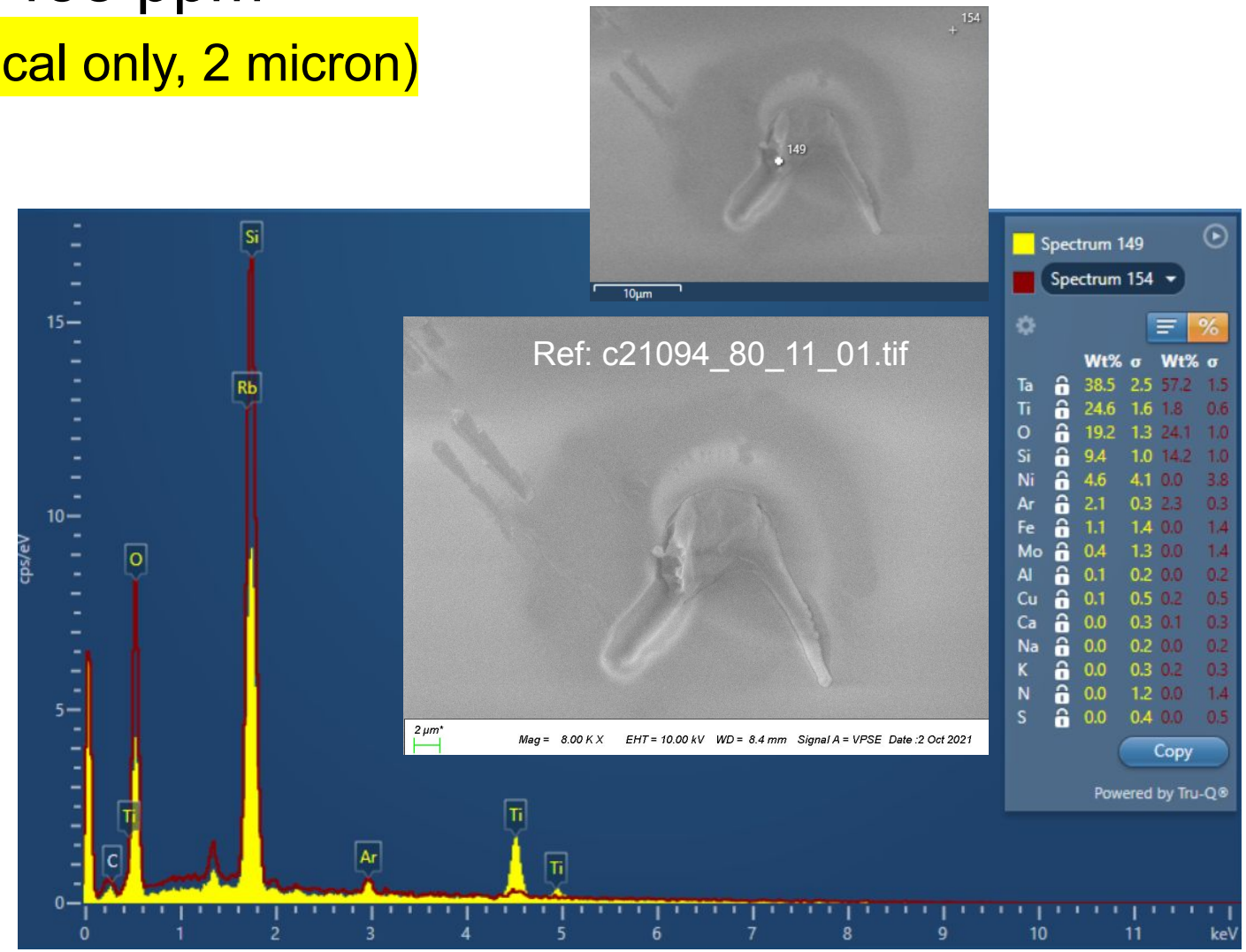
(X-axis is zoomed for visibility of peaks)

Table of Contents

Point 11 - 5458 ppm

Titanium (local only, 2 micron)

	Spectrum 149		Spectrum 154	
Element	Weight %	σ	Weight %	σ
Ta	38.5	2.5	57.2	1.5
Ti	24.6	1.6	1.8	0.6
O	19.2	1.3	24.1	1.0
Si	9.4	1.0	14.2	1.0
Ni	4.6	4.1	0.0	3.8
Ar	2.1	0.3	2.3	0.3
Fe	1.1	1.4	0.0	1.4
Mo	0.4	1.3	0.0	1.4
Al	0.1	0.2	0.0	0.2
Cu	0.1	0.5	0.2	0.5
Ca	0.0	0.3	0.1	0.3
Na	0.0	0.2	0.0	0.2
K	0.0	0.3	0.2	0.3
N	0.0	1.2	0.0	1.4
S	0.0	0.4	0.0	0.5



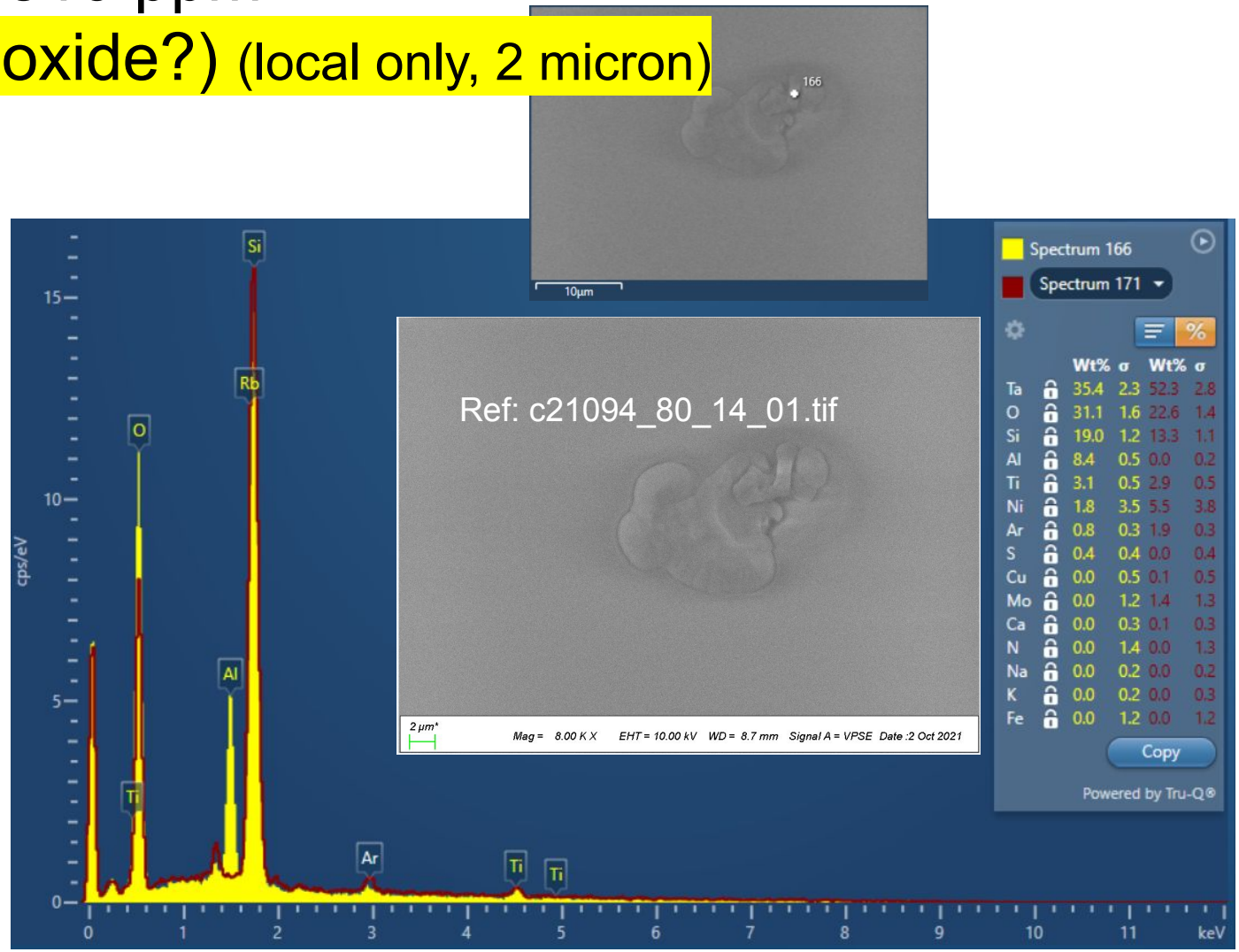
(X-axis is zoomed for visibility of peaks)

Table of Contents

Point 14 - 3810 ppm

Aluminum (oxide?) (local only, 2 micron)

Element	Spectrum 166 Weight %	σ	Spectrum 171 Weight %	σ
Ta	35.4	2.3	52.3	2.8
O	31.1	1.6	22.6	1.4
Si	19.0	1.2	13.3	1.1
Al	8.4	0.5	0.0	0.2
Ti	3.1	0.5	2.9	0.5
Ni	1.8	3.5	5.5	3.8
Ar	0.8	0.3	1.9	0.3
S	0.4	0.4	0.0	0.4
Cu	0.0	0.5	0.1	0.5
Mo	0.0	1.2	1.4	1.3
Ca	0.0	0.3	0.1	0.3
N	0.0	1.4	0.0	1.3
Na	0.0	0.2	0.0	0.2
K	0.0	0.2	0.0	0.3
Fe	0.0	1.2	0.0	1.2



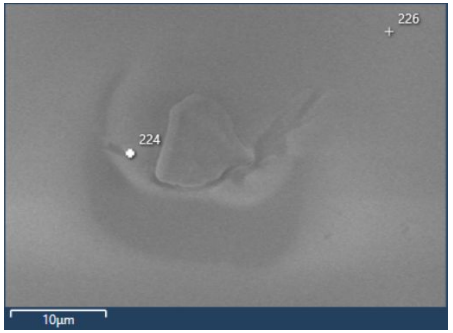
(X-axis is zoomed for visibility of peaks)

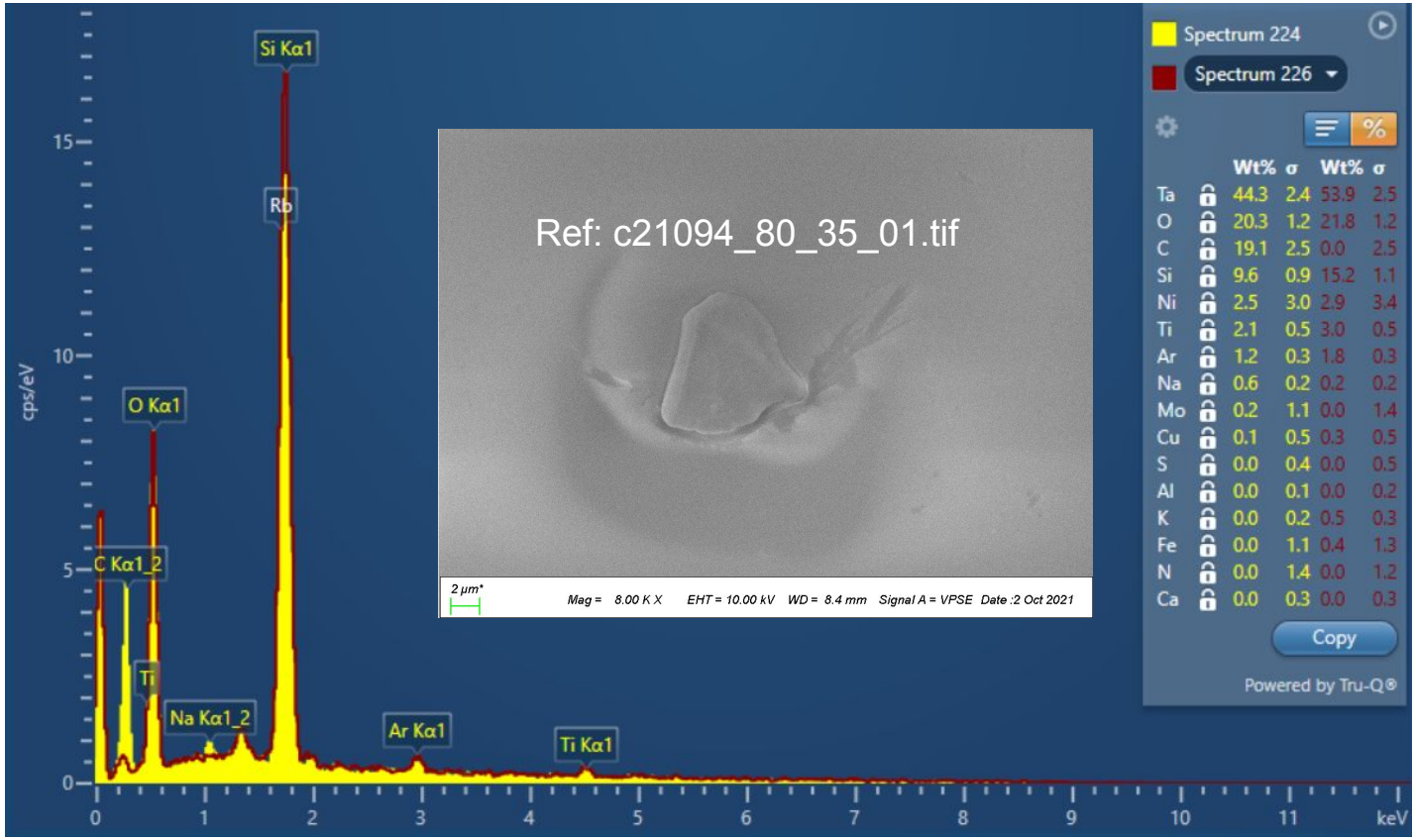
Table of Contents

Point 35 - 9048 ppm

Carbon, Sodium (local only, 2 micron)

Element	Spectrum 224 Weight %	σ	Spectrum 226 Weight %	σ
Ta	44.3	2.4	53.9	2.5
O	20.3	1.2	21.8	1.2
C	19.1	2.5	0.0	2.5
Si	9.6	0.9	15.2	1.1
Ni	2.5	3.0	2.9	3.4
Ti	2.1	0.5	3.0	0.5
Ar	1.2	0.3	1.8	0.3
Na	0.6	0.2	0.2	0.2
Mo	0.2	1.1	0.0	1.4
Cu	0.1	0.5	0.3	0.5
S	0.0	0.4	0.0	0.5
Al	0.0	0.1	0.0	0.2
K	0.0	0.2	0.5	0.3
Fe	0.0	1.1	0.4	1.3
N	0.0	1.4	0.0	1.2
Ca	0.0	0.3	0.0	0.3





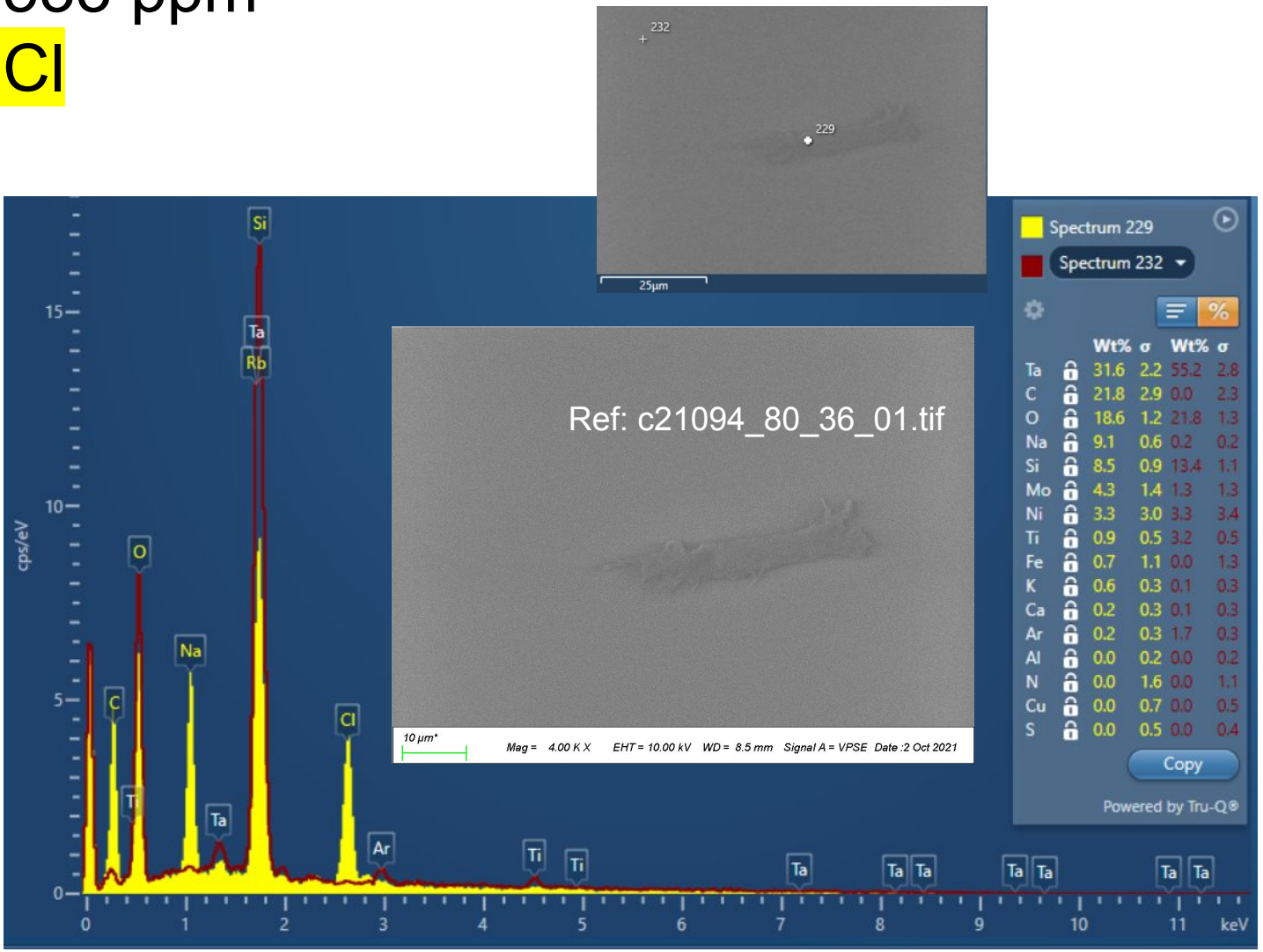
(X-axis is zoomed for visibility of peaks)

Table of Contents

Point 36 - 1533 ppm

Carbon, NaCl

Element	Spectrum 229 Weight %	σ	Spectrum 232 Weight %	σ
Ta	31.6	2.2	55.2	2.8
C	21.8	2.9	0.0	2.3
O	18.6	1.2	21.8	1.3
Na	9.1	0.6	0.2	0.2
Si	8.5	0.9	13.4	1.1
Mo	4.3	1.4	1.3	1.3
Ni	3.3	3.0	3.3	3.4
Ti	0.9	0.5	3.2	0.5
Fe	0.7	1.1	0.0	1.3
K	0.6	0.3	0.1	0.3
Ca	0.2	0.3	0.1	0.3
Ar	0.2	0.3	1.7	0.3
Al	0.0	0.2	0.0	0.2
N	0.0	1.6	0.0	1.1
Cu	0.0	0.7	0.0	0.5
S	0.0	0.5	0.0	0.4

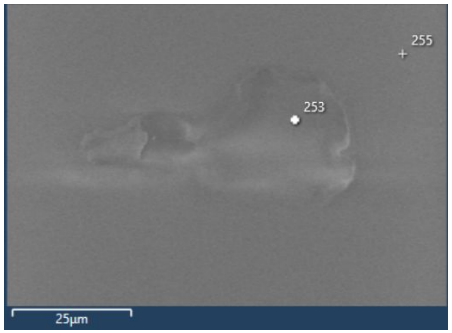


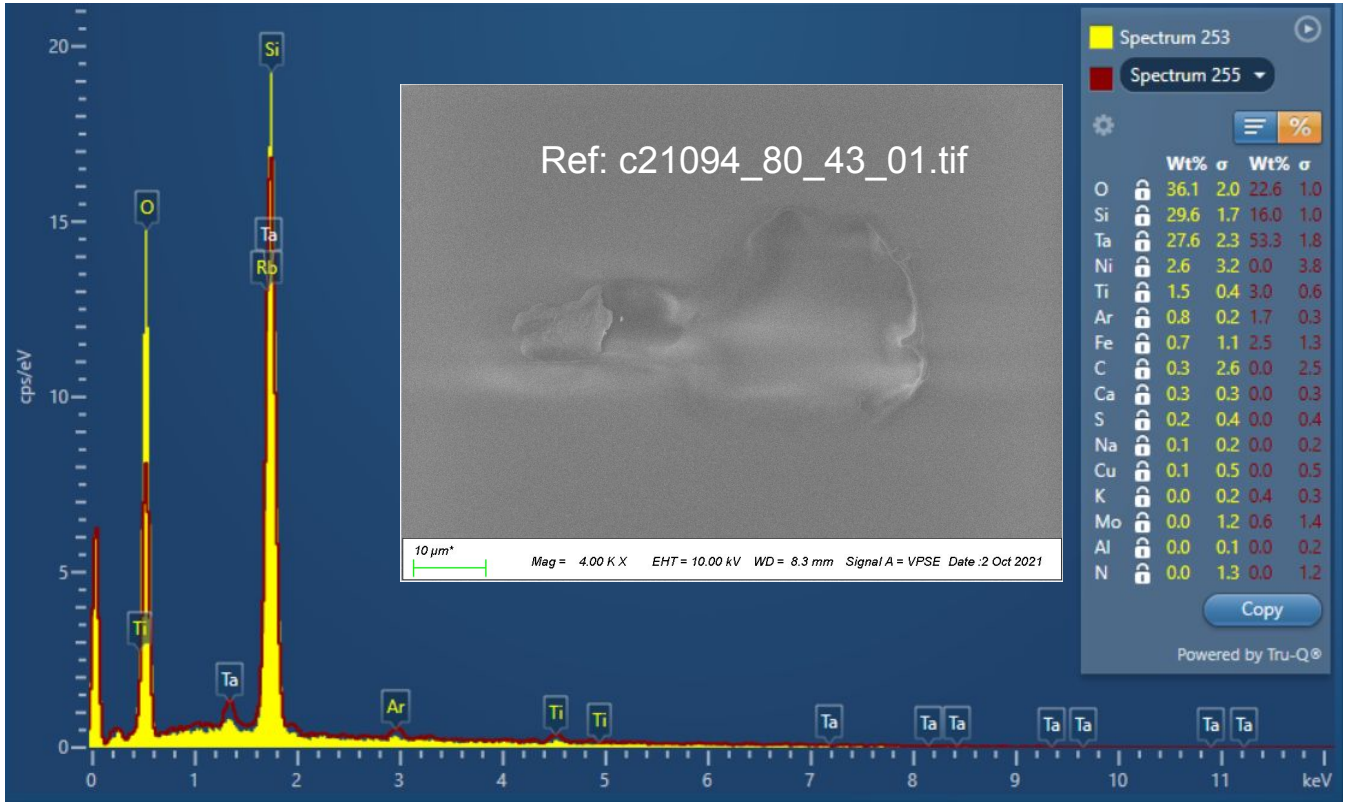
(X-axis is zoomed for visibility of peaks)

Table of Contents

Point 43 - 1944 ppm
Coating (specifically Silica, apparently)

	Spectrum 253		Spectrum 255	
Element	Weight %	σ	Weight %	σ
O	36.1	2.0	22.6	1.0
Si	29.6	1.7	16.0	1.0
Ta	27.6	2.3	53.3	1.8
Ni	2.6	3.2	0.0	3.8
Ti	1.5	0.4	3.0	0.6
Ar	0.8	0.2	1.7	0.3
Fe	0.7	1.1	2.5	1.3
C	0.3	2.6	0.0	2.5
Ca	0.3	0.3	0.0	0.3
S	0.2	0.4	0.0	0.4
Na	0.1	0.2	0.0	0.2
Cu	0.1	0.5	0.0	0.5
K	0.0	0.2	0.4	0.3
Mo	0.0	1.2	0.6	1.4
Al	0.0	0.1	0.0	0.2
N	0.0	1.3	0.0	1.2





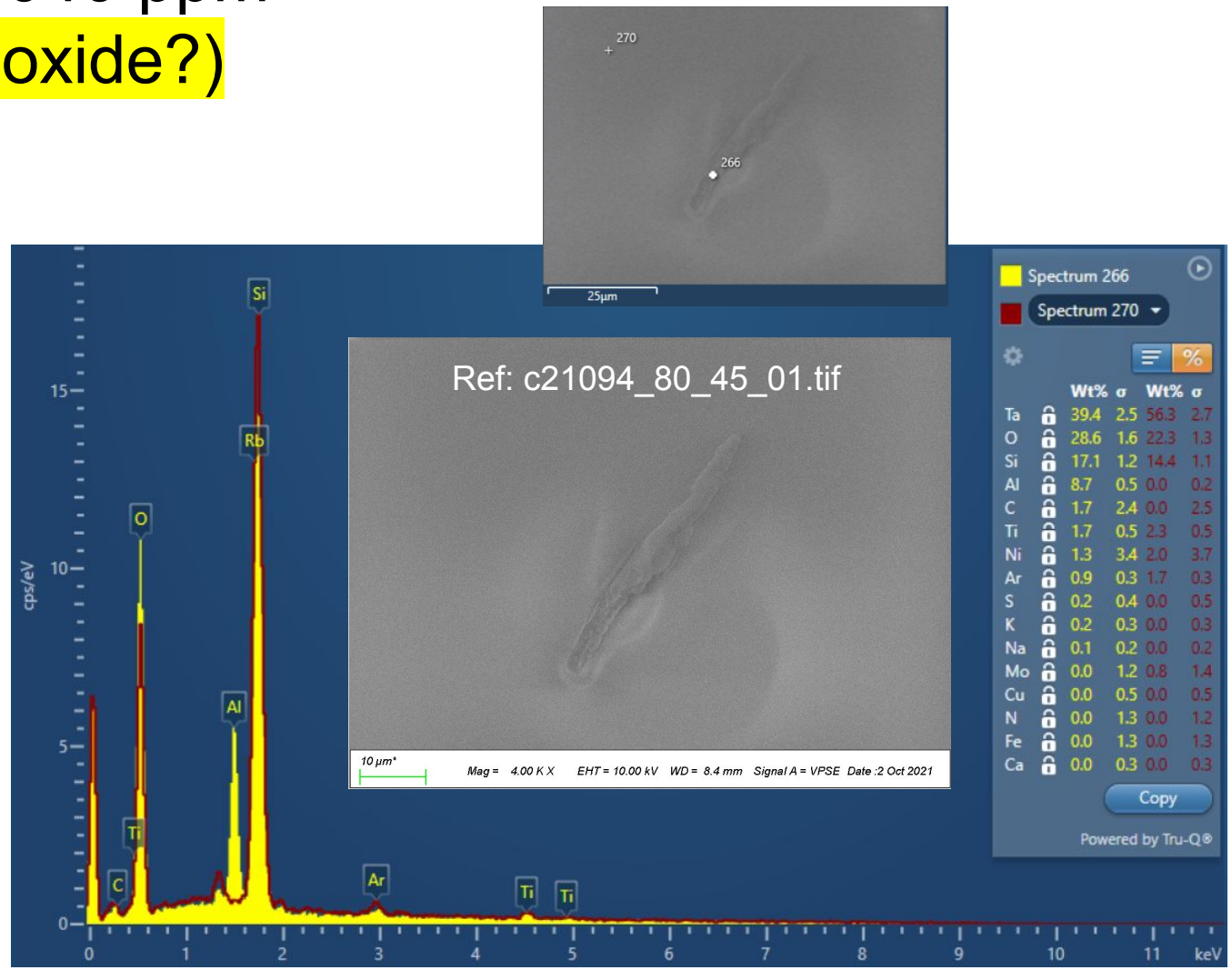
(X-axis is zoomed for visibility of peaks)

Table of Contents

Point 45 - 8040 ppm

Aluminum (oxide?)

Element	Spectrum 266 Weight %	σ	Spectrum 270 Weight %	σ
Ta	39.4	2.5	56.3	2.7
O	28.6	1.6	22.3	1.3
Si	17.1	1.2	14.4	1.1
Al	8.7	0.5	0.0	0.2
C	1.7	2.4	0.0	2.5
Ti	1.7	0.5	2.3	0.5
Ni	1.3	3.4	2.0	3.7
Ar	0.9	0.3	1.7	0.3
S	0.2	0.4	0.0	0.5
K	0.2	0.3	0.0	0.3
Na	0.1	0.2	0.0	0.2
Mo	0.0	1.2	0.8	1.4
Cu	0.0	0.5	0.0	0.5
N	0.0	1.3	0.0	1.2
Fe	0.0	1.3	0.0	1.3
Ca	0.0	0.3	0.0	0.3



(X-axis is zoomed for visibility of peaks)

Table of Contents