Recent Surface Studies in KEK-STF

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Studies on Nb surface contaminations in BCP, EP process

(1) Motivation of the study

(2) Newly identified contamination on BCP sample coupon.

(3) Newly identified contamination on Lab-EP sample coupon.

(4) Effort to remove the contamination

Motivation of study on BCP Nb surface

Why Pits are formed on EBW seam?

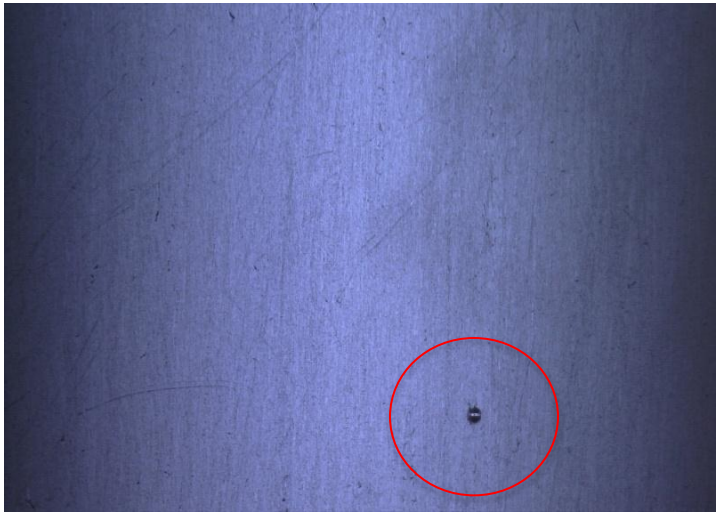
BCP treatment just before EBW is the established recipe.
Is it enough clean after BCP?
Why spark is happened during EBW, sometime?

MHI-010

Local grinding example on cell#1

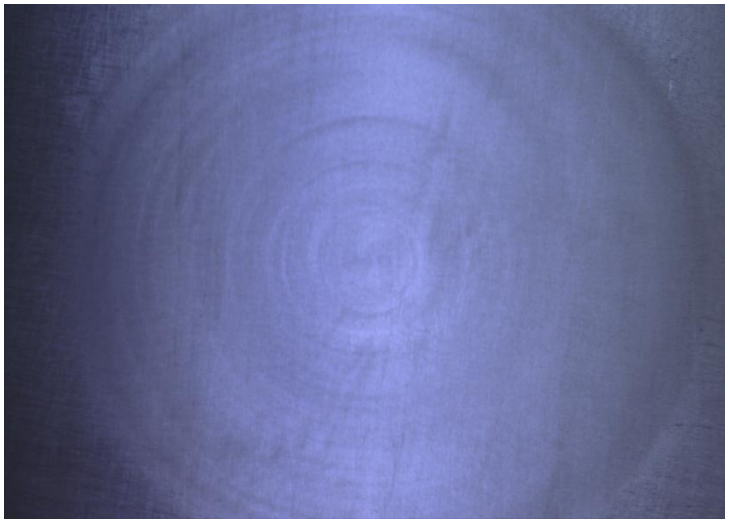
after 2nd V.T.

grinding by hand



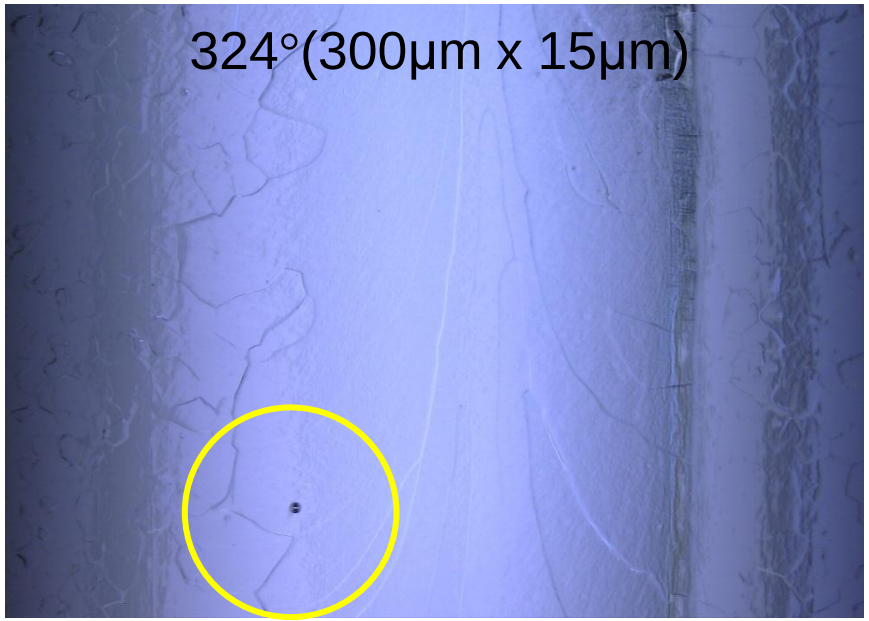
machine grinding

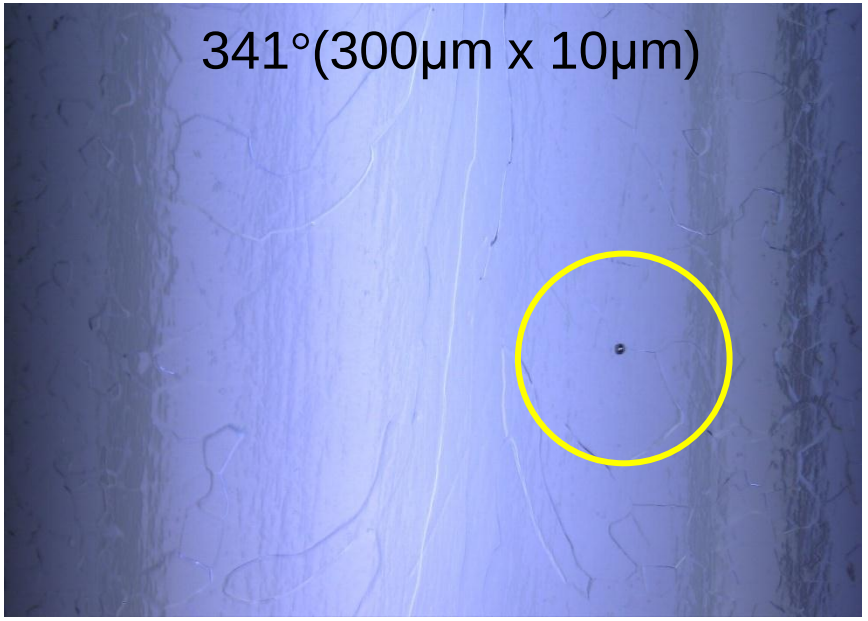
finish

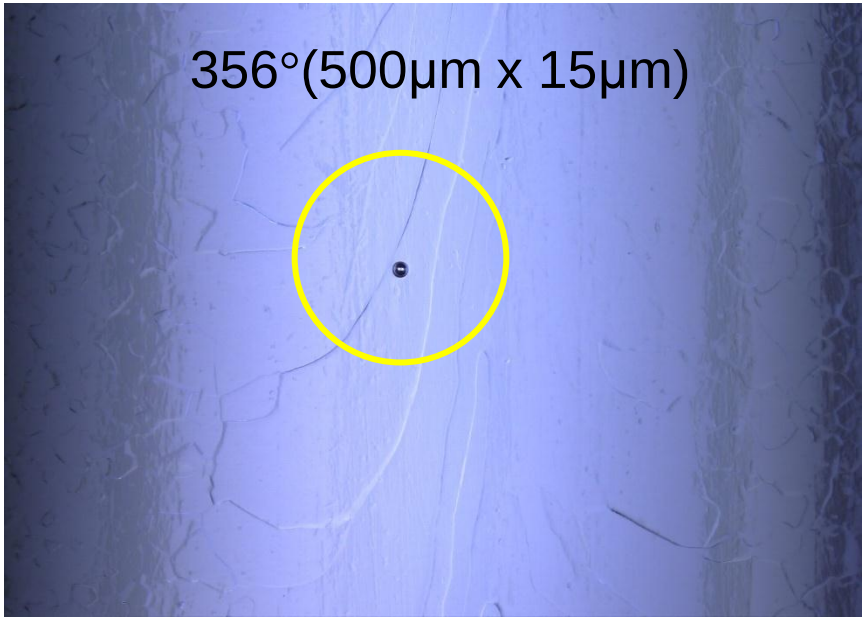


MHI-010

After local grinding and 100μm EP, new pits were appeared!







MHI-010:

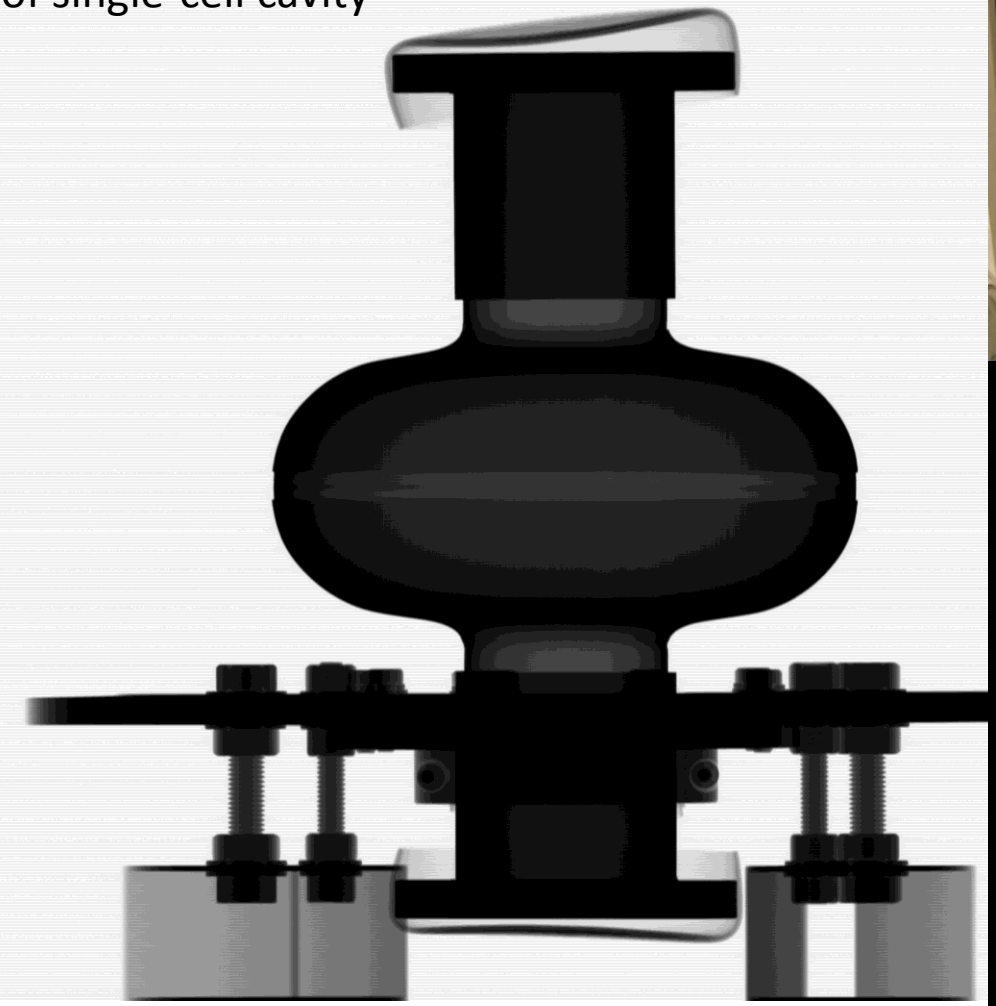
1st VT 23.8MV/m @ Q0=1.1E10 May 20,2010
2nd VT 25.7MV/m @Q0=8.1E9 June 17,2010

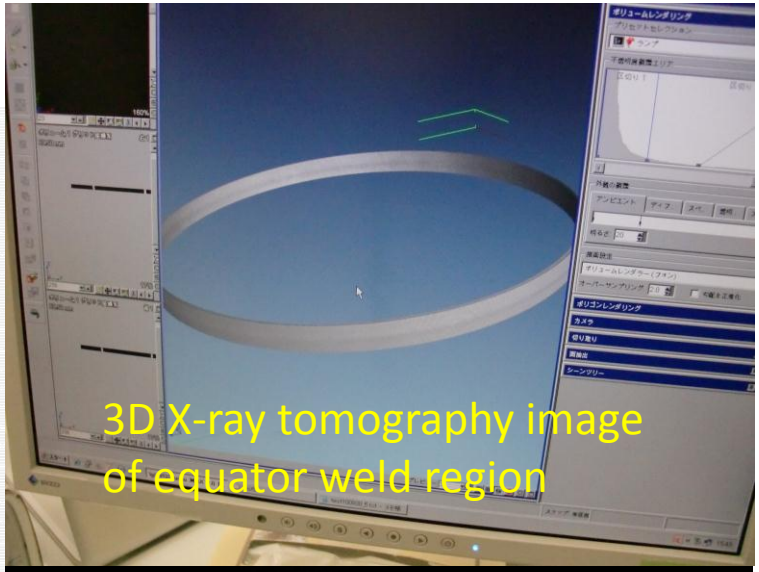
local grinding and 100μm EP

3rd VT 20MV/m @ Q0=1.1E10 Sep 02,2010

R&D Effort for EBW seam inspection: 3D X-ray tomography

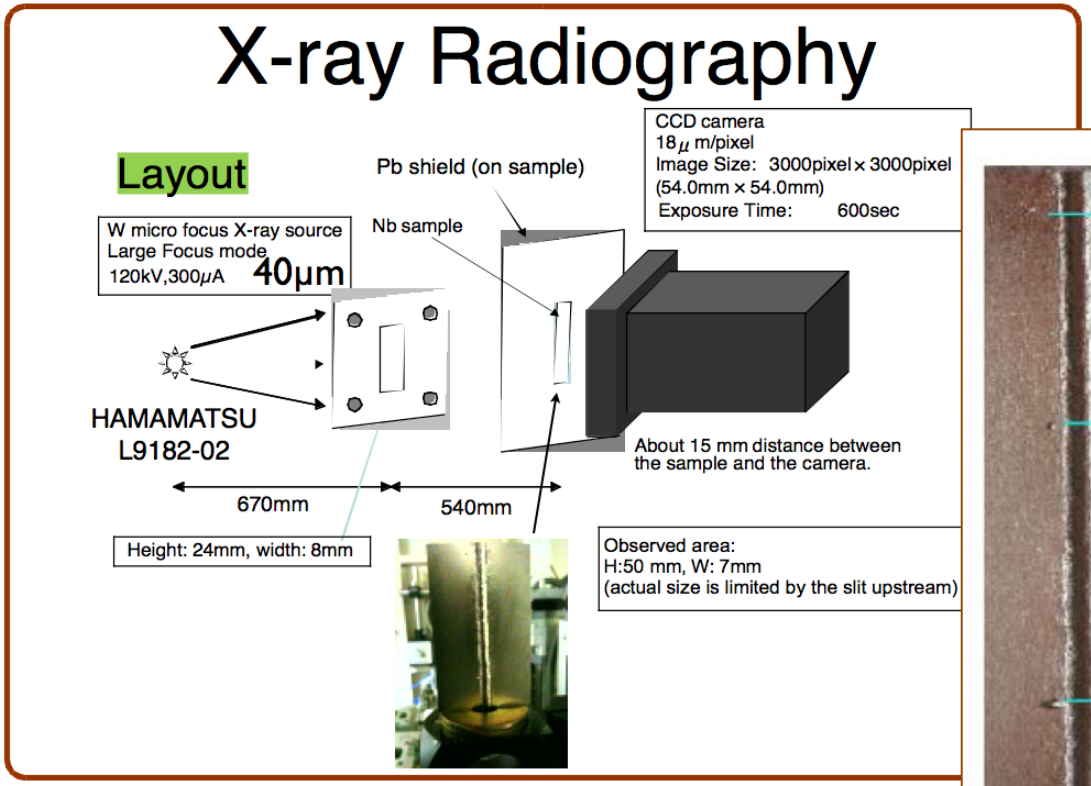
2D X-ray transparant image
of single-cell cavity



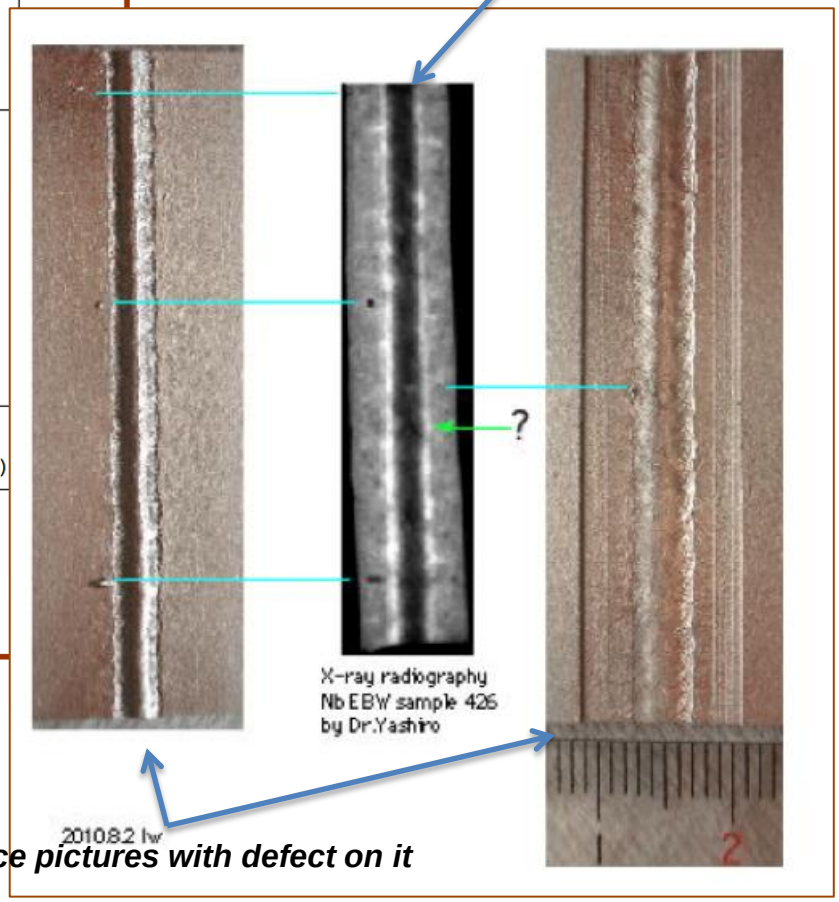


R&D Effort for EBW seam inspection: X-ray radiography

3D X-ray tomography image for equator weld region has not enough resolution. High resolution X-ray imaging is under development.



Transparent image by X-ray

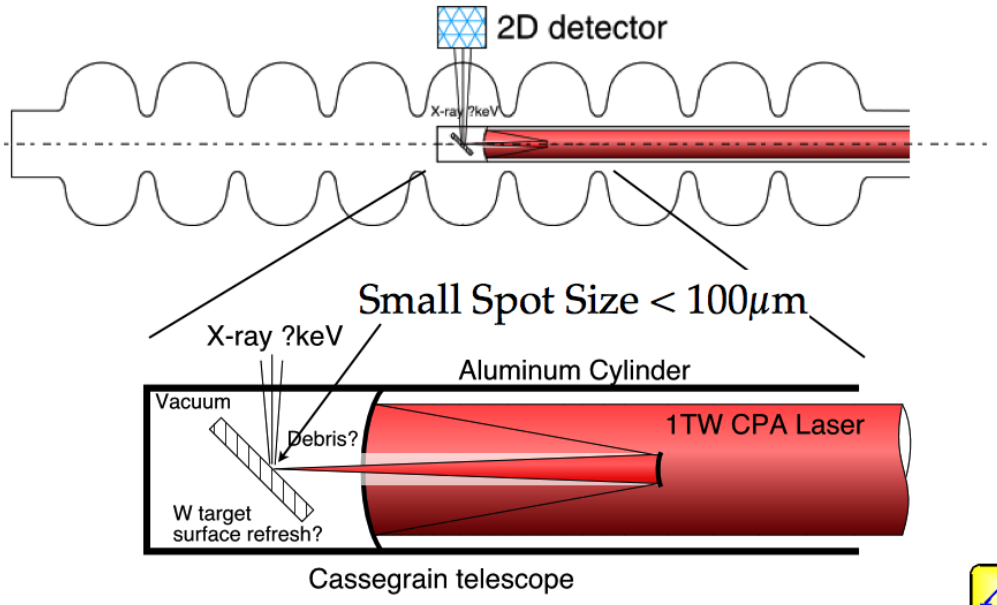


Combination of point-like X-ray source and high resolution CCD camera are one of candidate. Laser-induced X-ray is also another candidate.

Surface pictures with defect on it

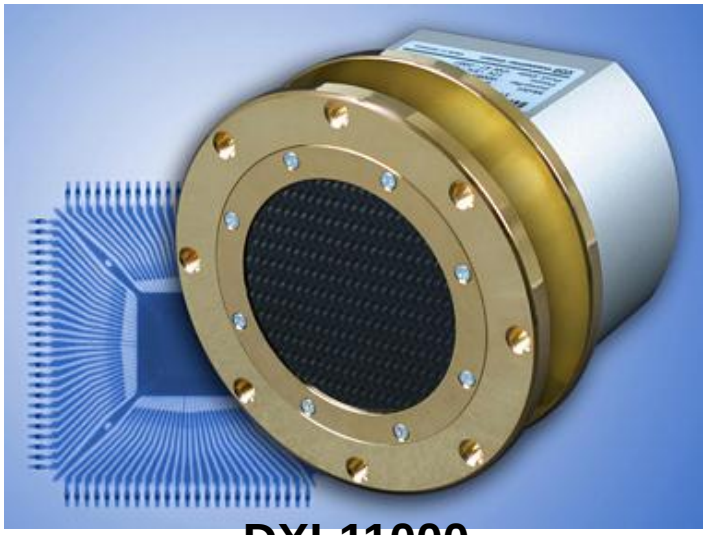
Possibility on X-ray imaging of EBW seam

Possible Configuration



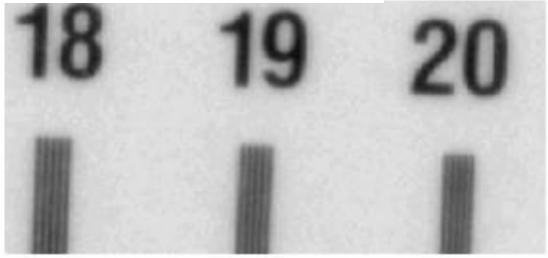
Using high power Laser and W target for small spot X-ray source

Candidate detector

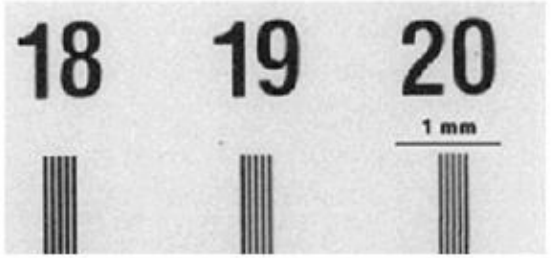


DXI-11000
High resolution X-ray camera

Candidates of Point-like X-ray source
(1) Laser induced source
(2) Small X-ray tube
are under development.



Ordinary scintillator detector



DXI-11000 scint-X scintillator

Contamination found on BCP treated Nb surface

Found contamination on BCP treated Nb surface

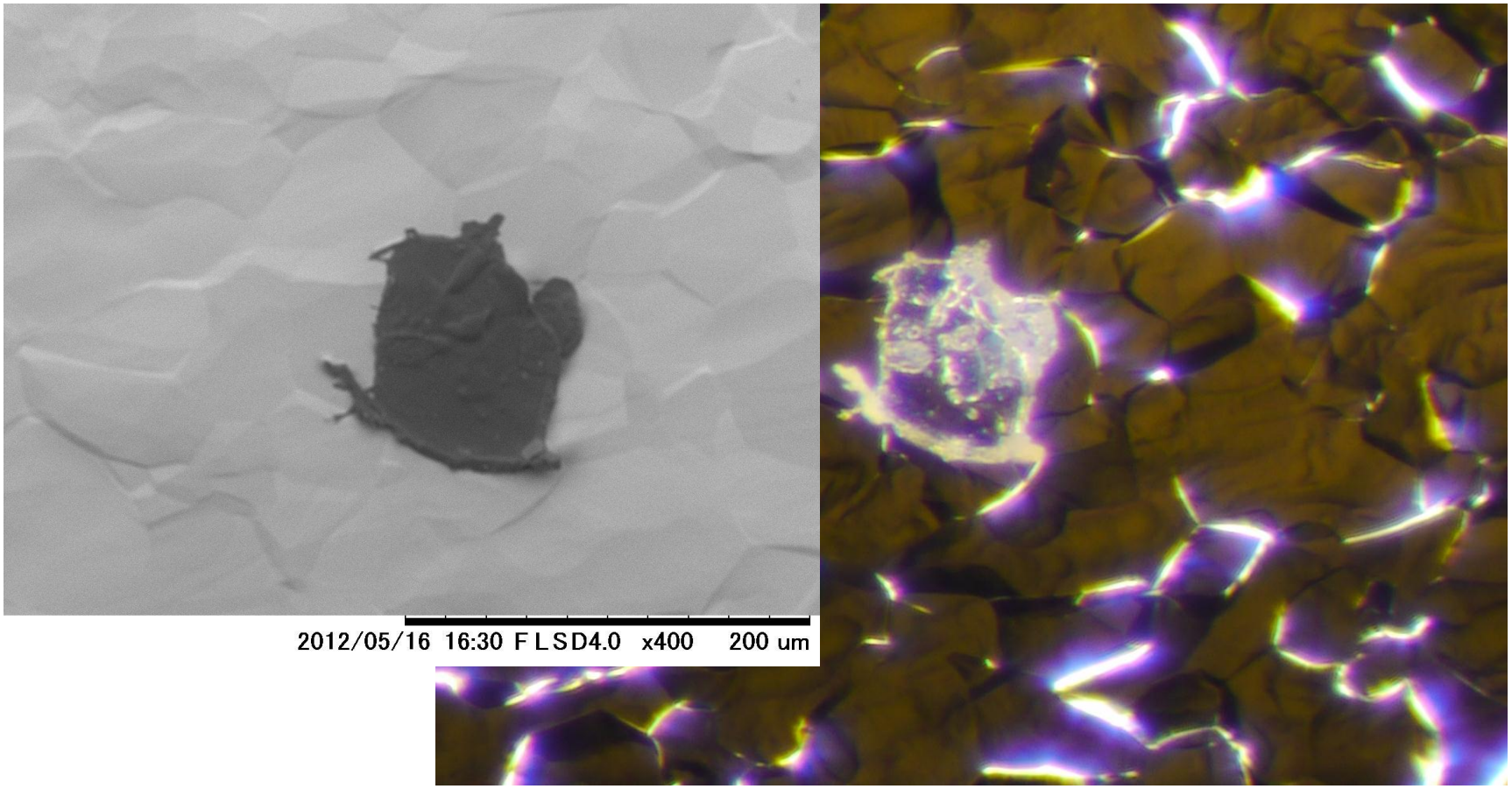
M. Sawabe

Contamination appeared different place in every BCP treatment

Found contamination on BCP treated Nb surface

SEM image
(black)

Optical Microscope image
(shiny)



M. Sawabe

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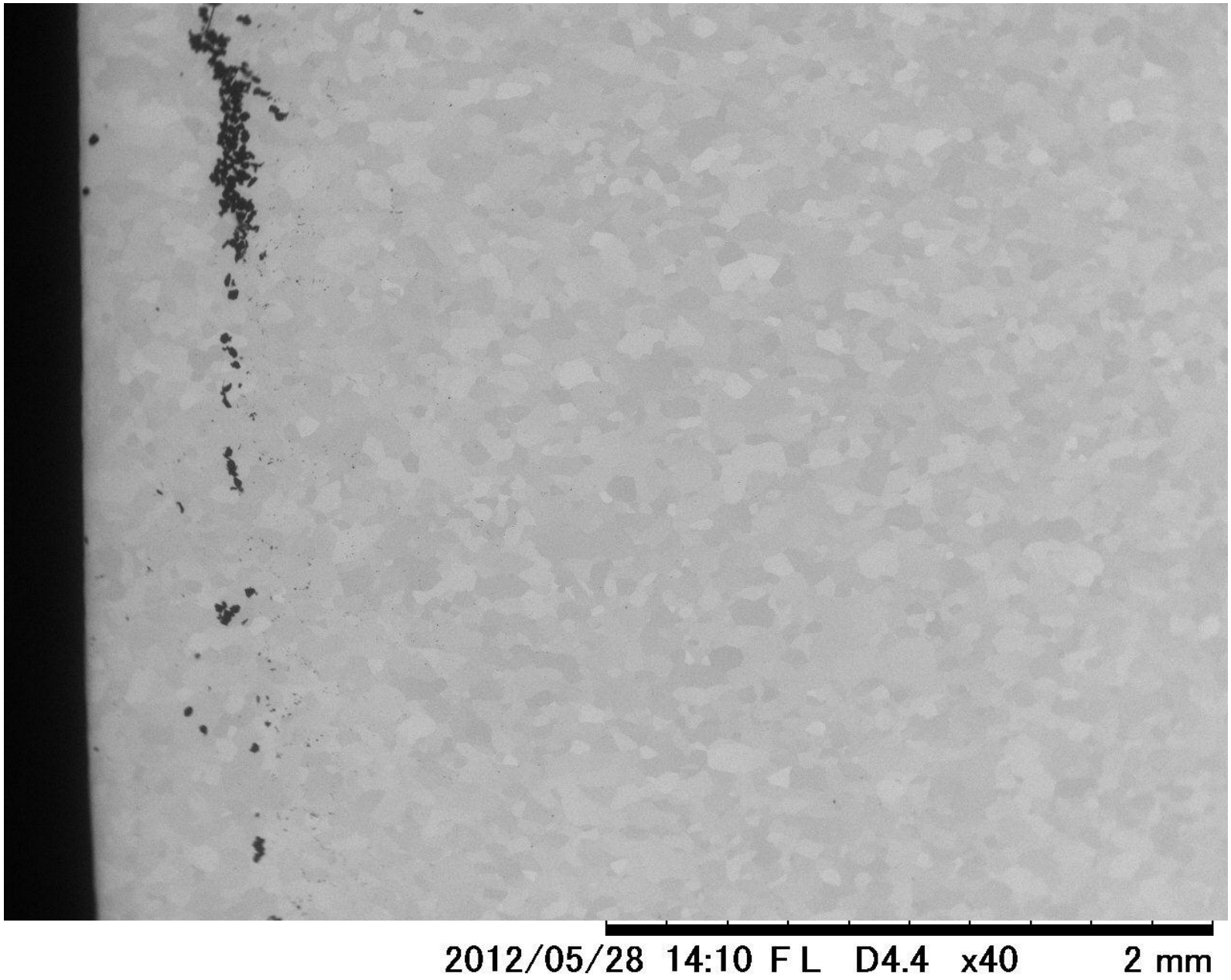

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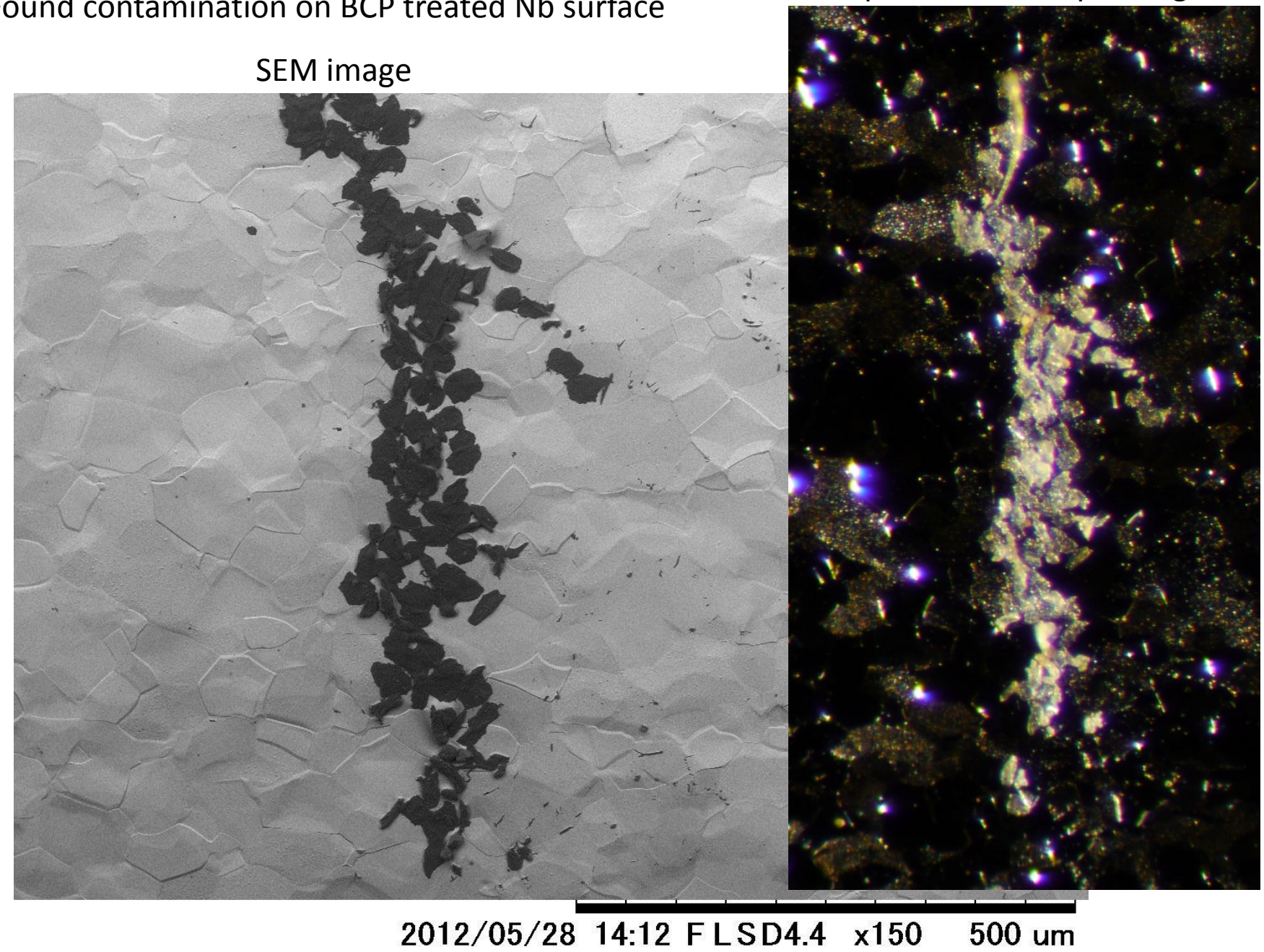
Found contamination on BCP treated Nb surface

SEM image

Optical Microscope image



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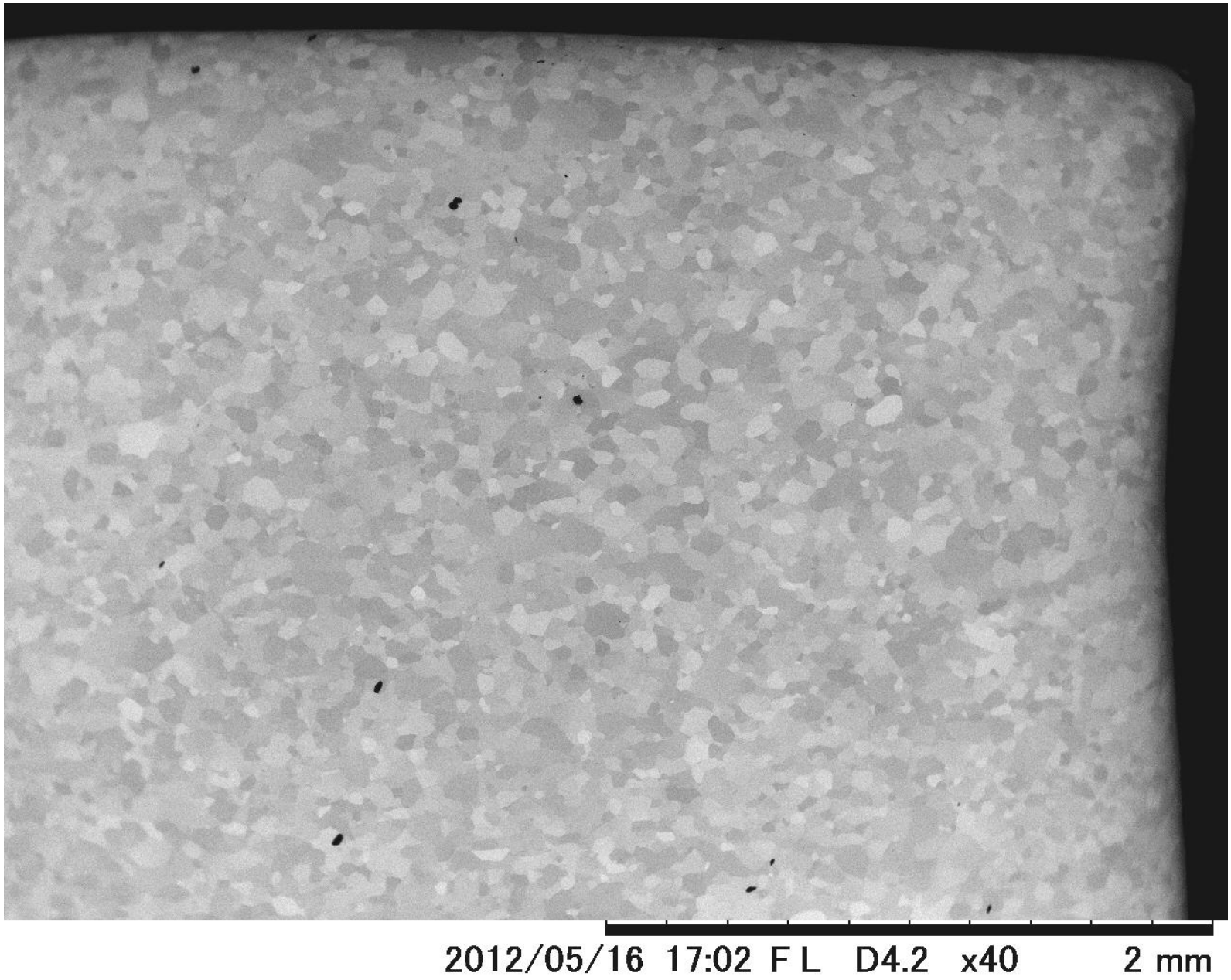
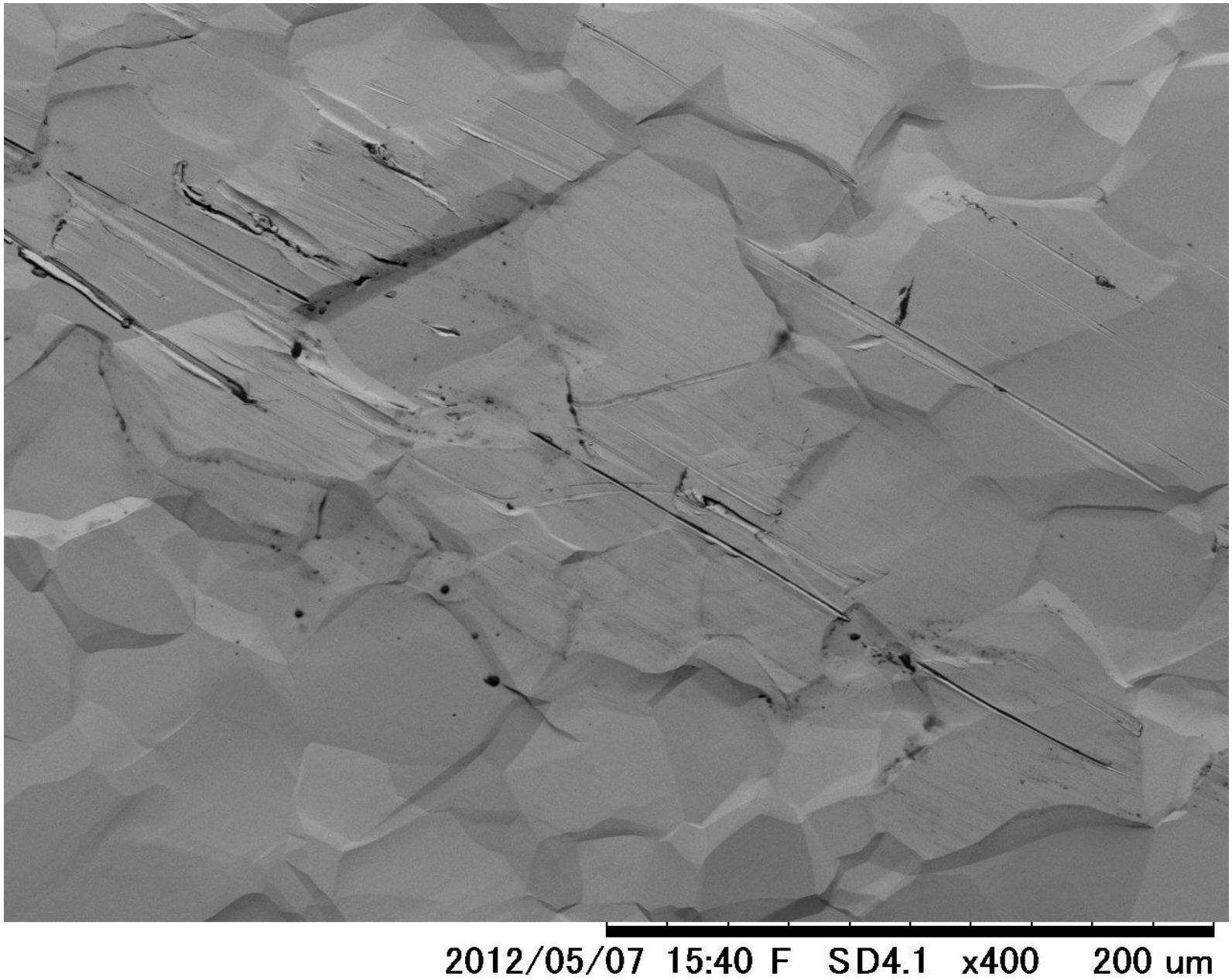


M. Sawabe

Found contamination on BCP treated Nb surface (easy to find on scratched place)



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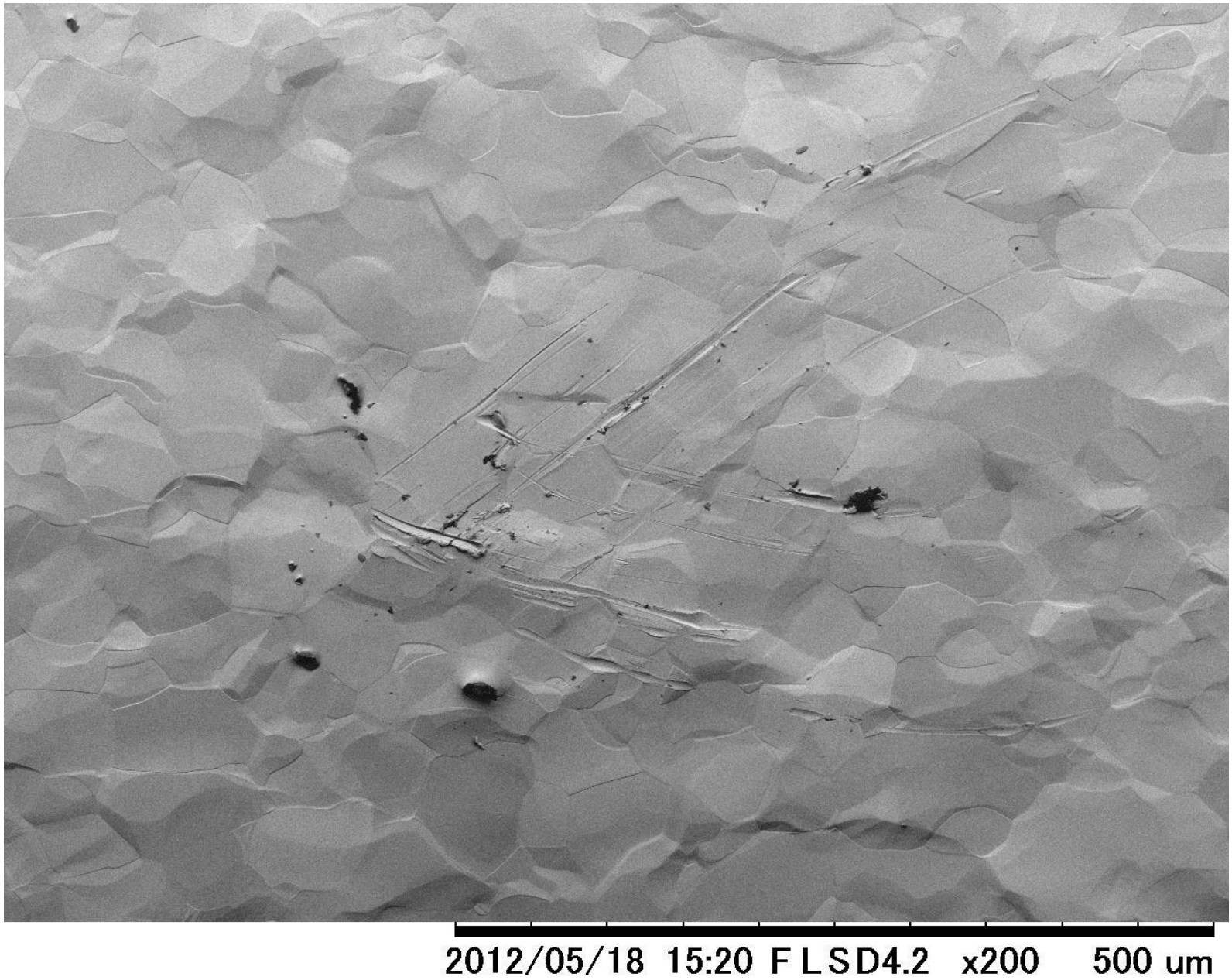

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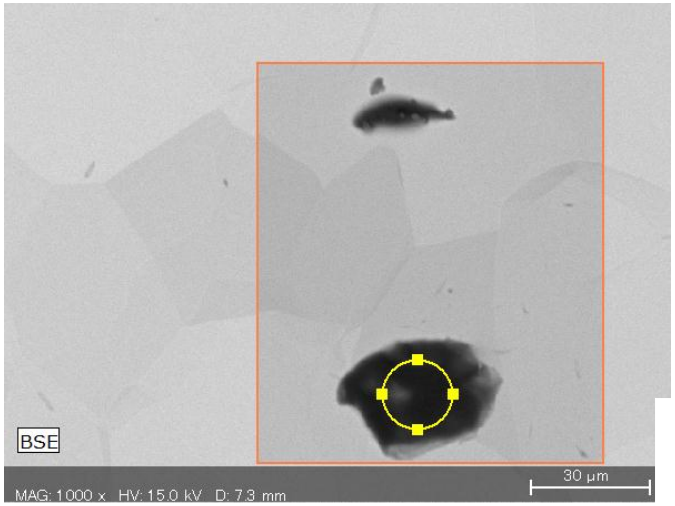
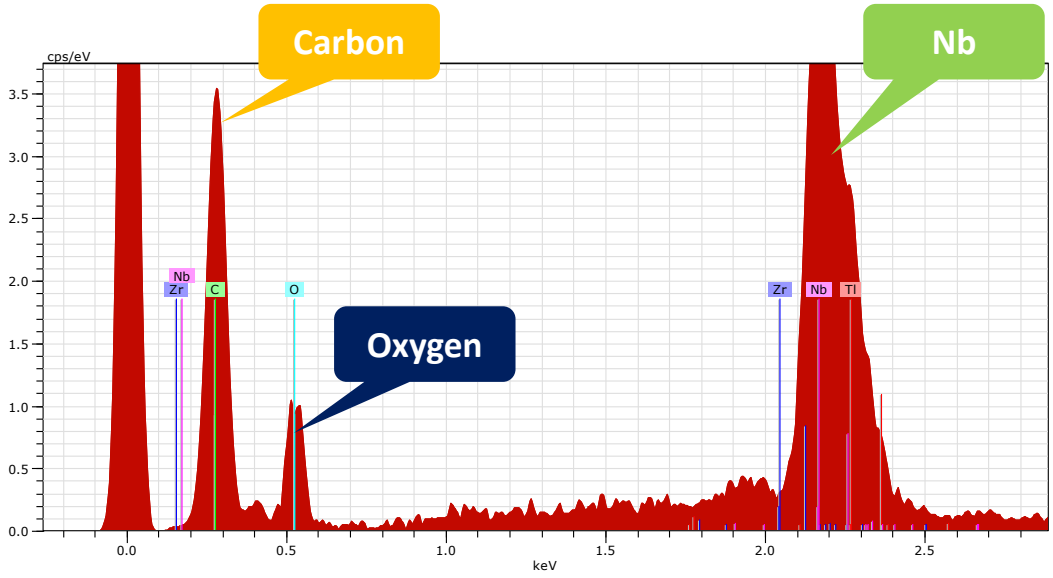
EDX Analysis of the contamination of BCP Nb surface



SEM image of the contamination

It’s Carbon with oxygen!

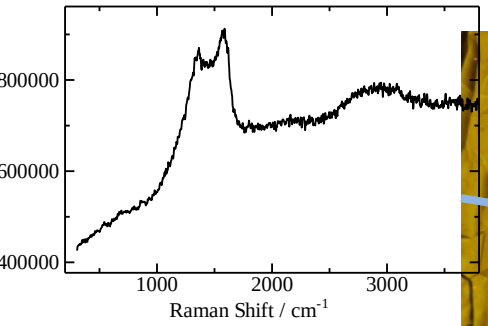


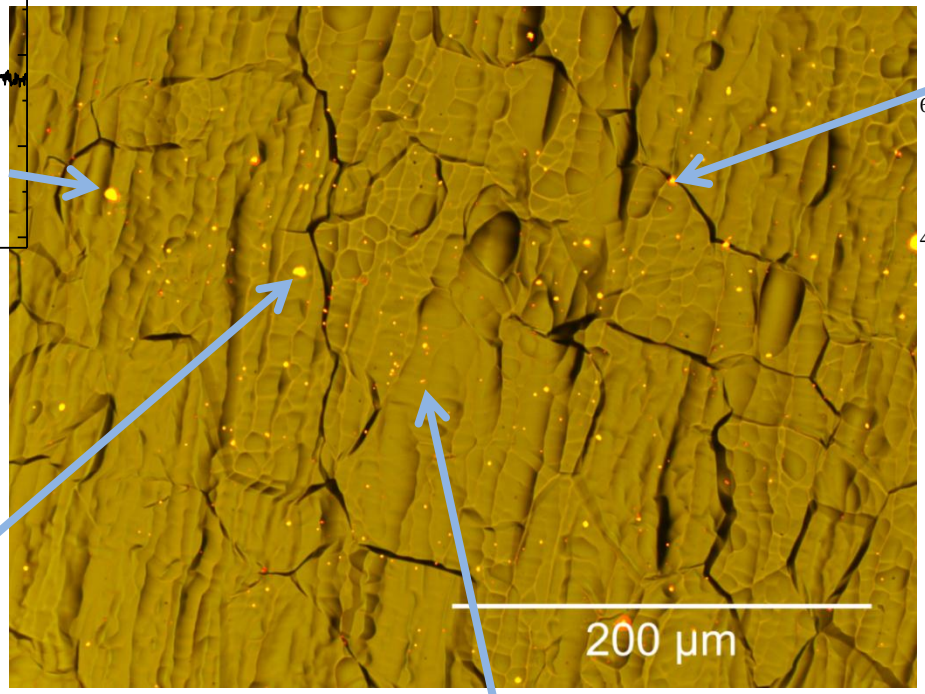
EDX spectrum of the contamination

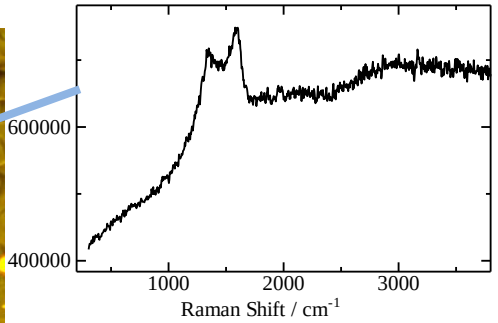
M. Sawabe

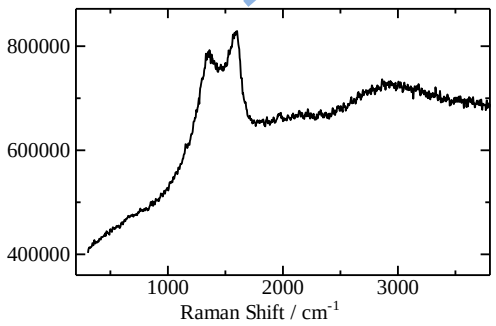
Raman image superimposed on SEM image of BCP Nb surface

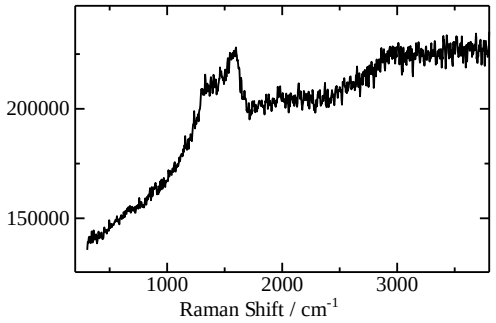
Observed Raman spectrum of bright spots







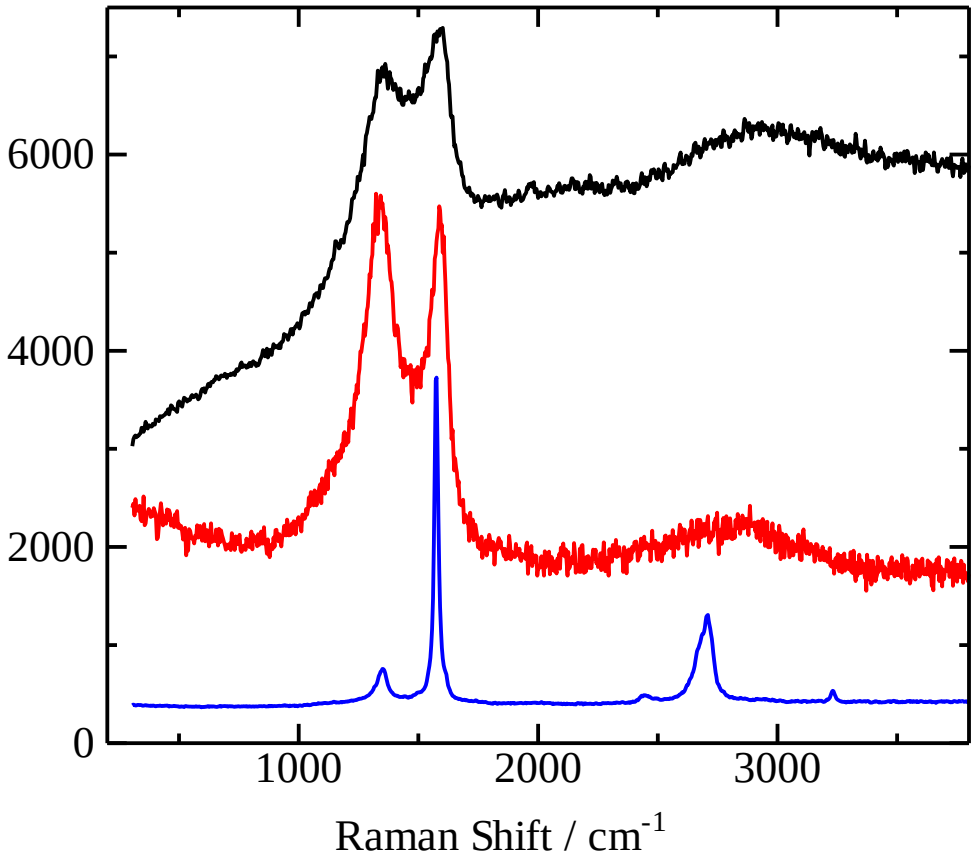




All spots are the same spectrum

H. Monjushiro

Comparison of Raman spectrum with Carbon



Contamination on BCP Nb surface

Activated Carbon (C, O, etc)

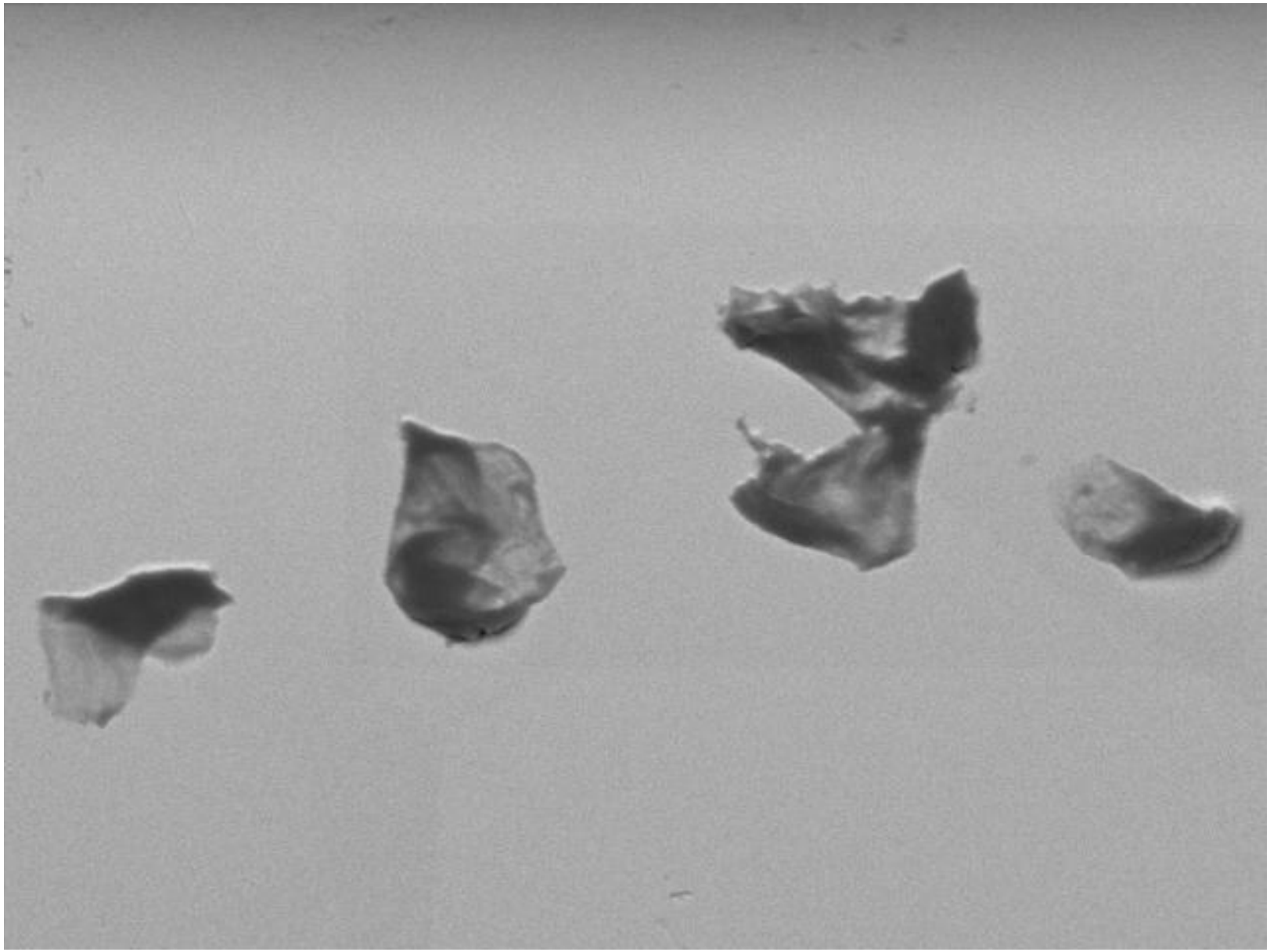
Graphite (C only)

The contamination on BCP Nb surface is similar to activated Carbon!

H. Monjushiro

Contamination found on EP treated Nb surface

Found contamination on 100μm EP treated Nb surface
SEM image



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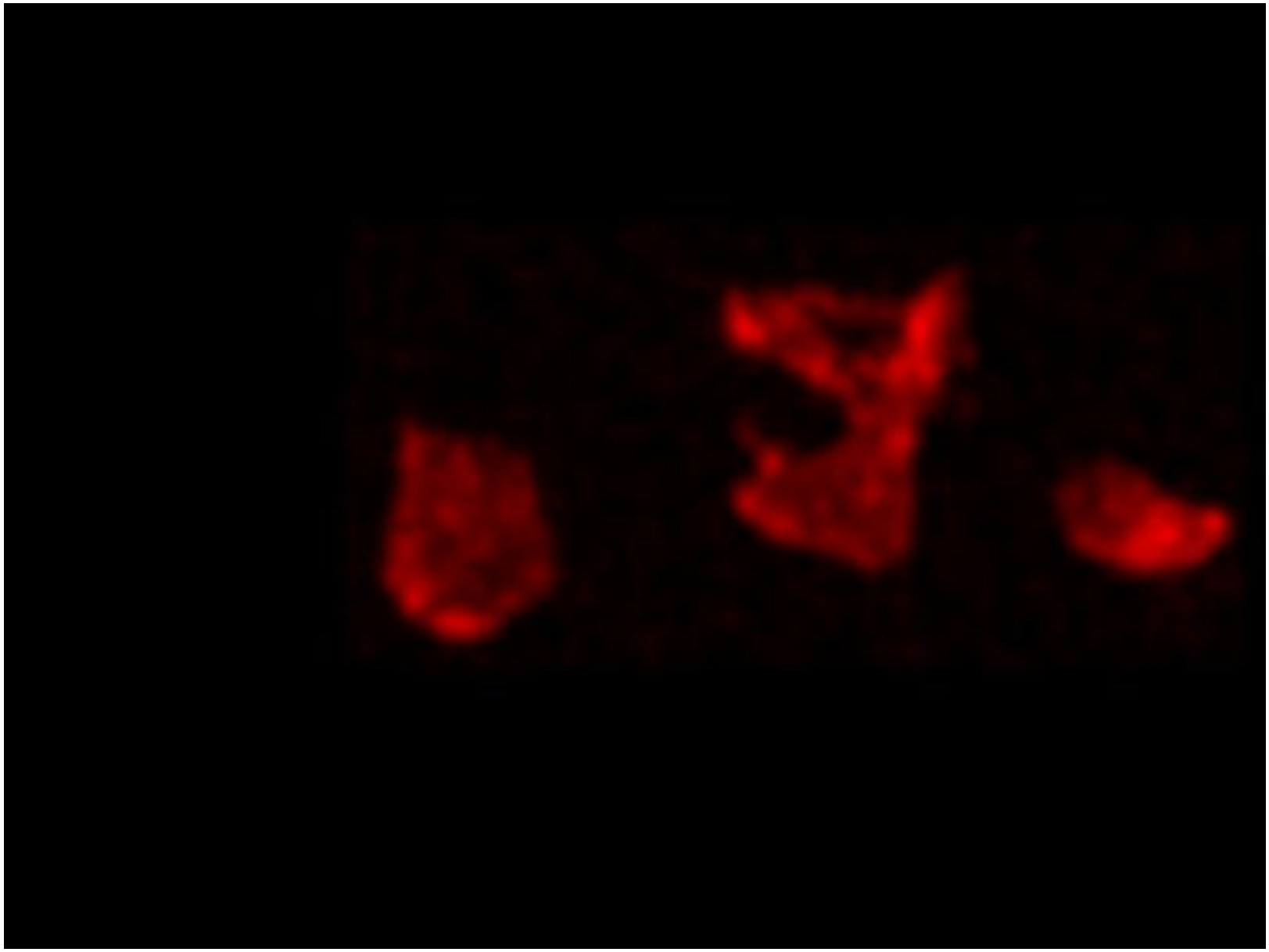
C-Kα mapping



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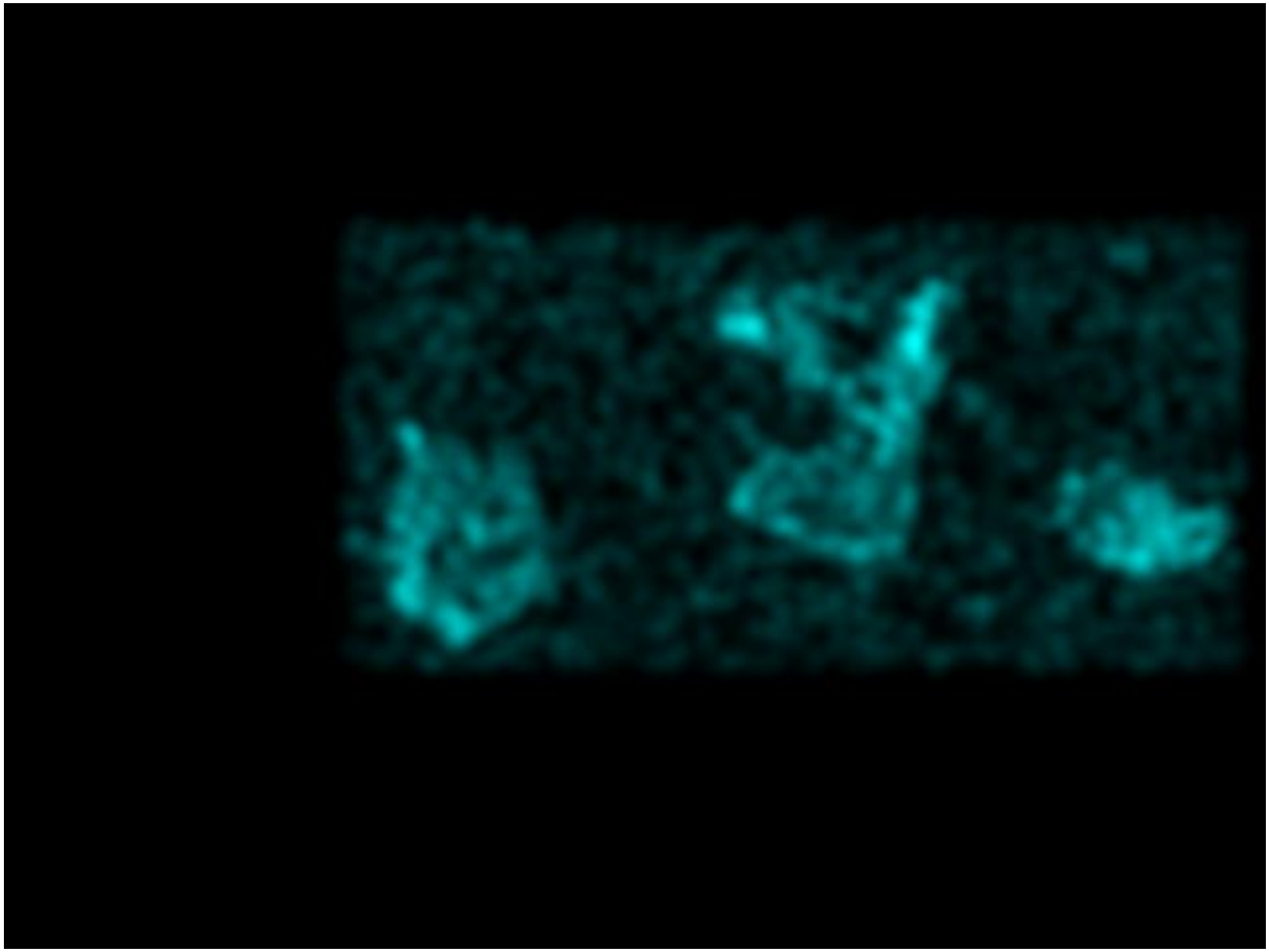
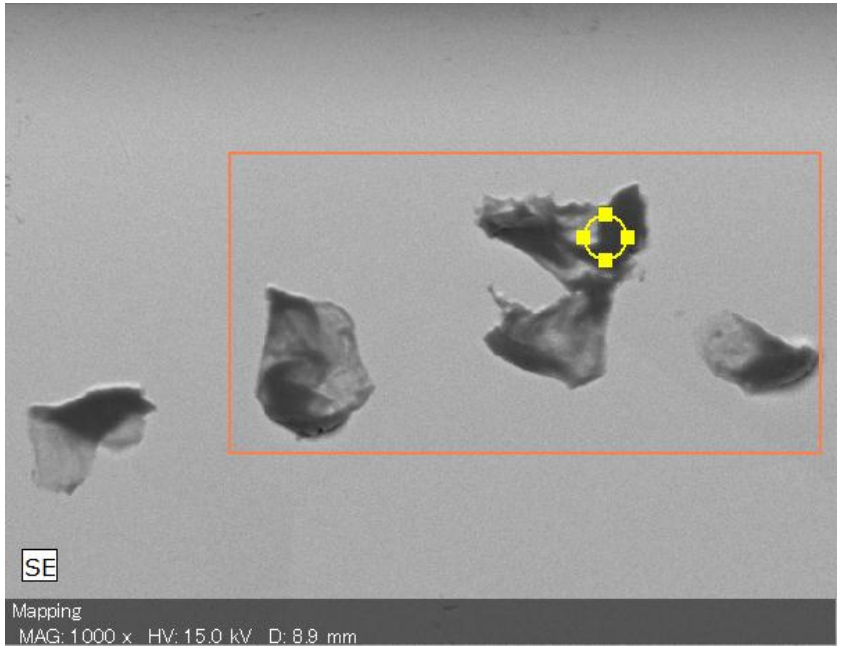
O-Kα mapping



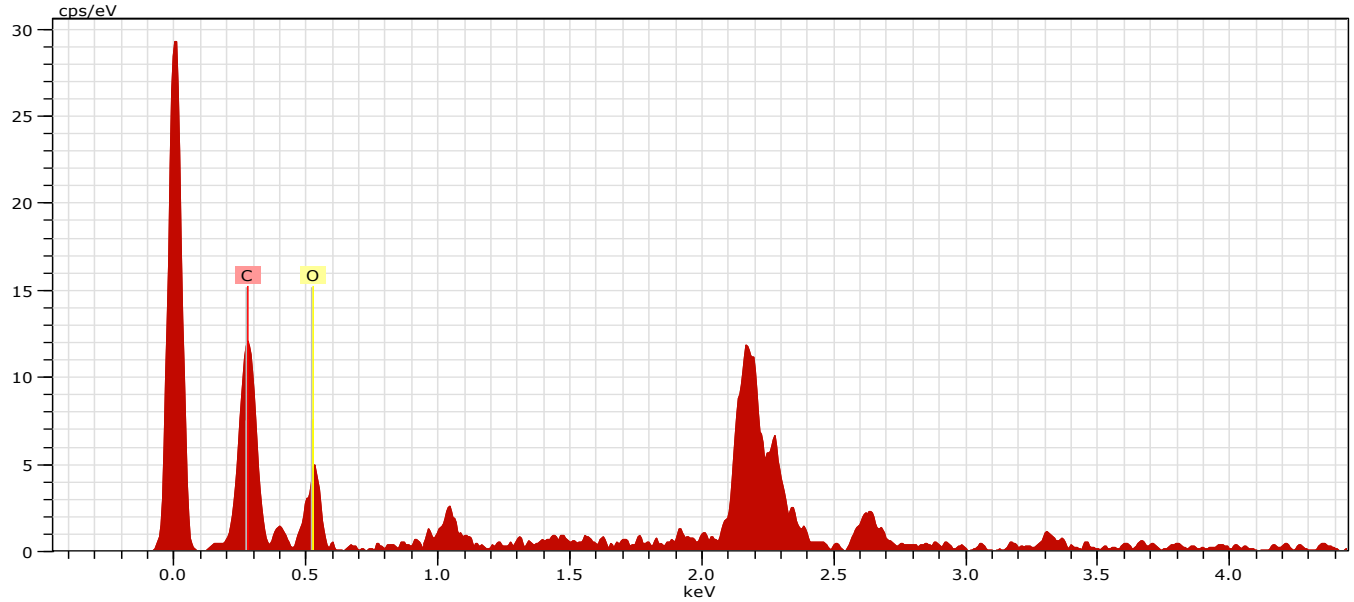
M. Sawabe

EDX Analysis



- Spectrum: Point
-
- Element AN Series norm. C Atom. C
- [wt.%] [at.%]
- ---
- Carbon 6 K-series 55.06 62.00
- Oxygen 8 K-series 44.94 38.00
- ---
- Total: 100.00 100.00
-
-
-

Again it's Carbon and oxygen!



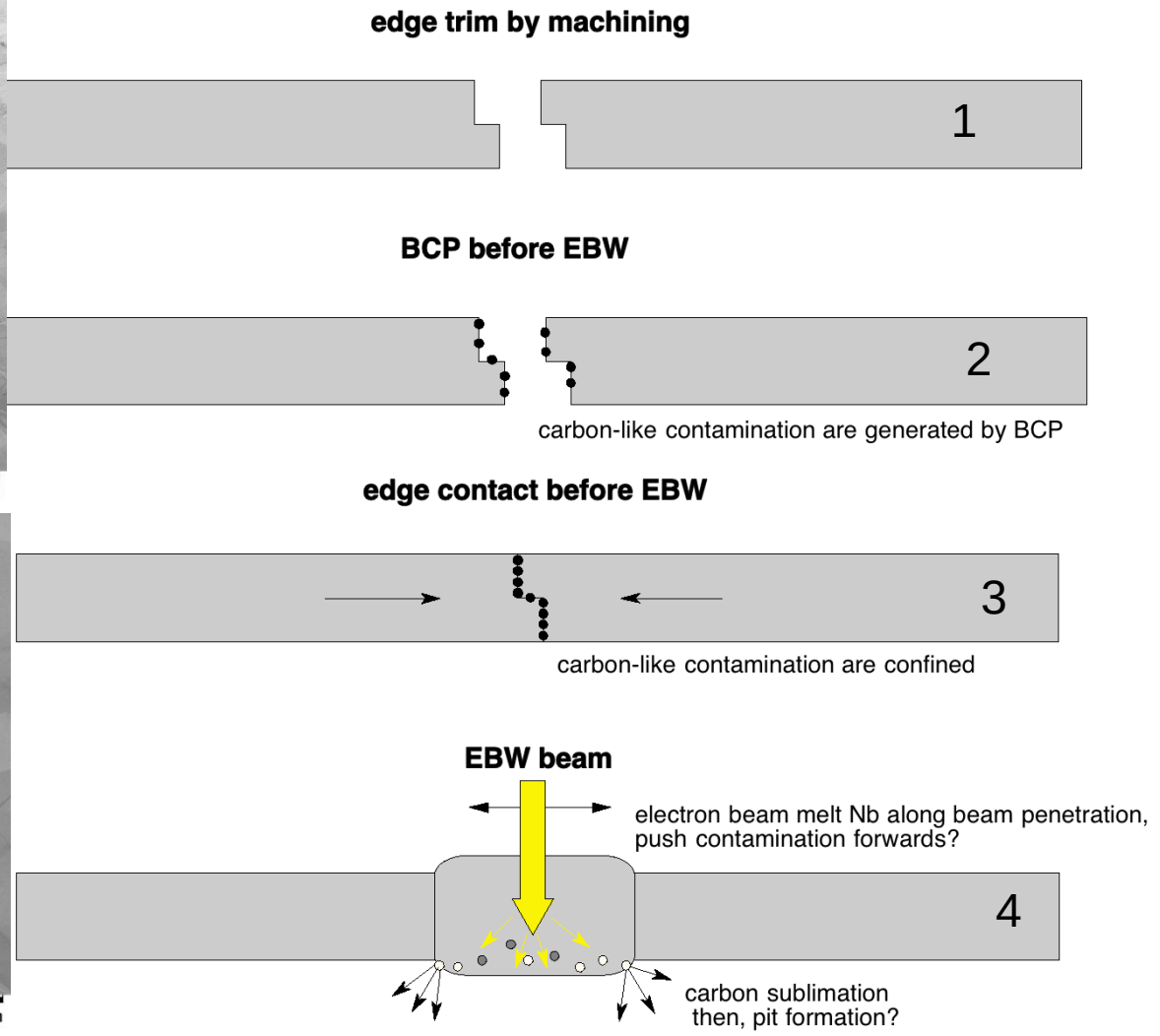
M. Sawabe

Speculation of the contamination effect on the cavity performance

(1) Possible source of field emission at high electric field region
(2) Possible heat source at high magnetic filed region
(3) Possible source of pit-like defect formation at EBW seam

Speculation of defect generation at EBW seam

One possible speculation for Pit defect appeared on inner EBW seam,
It will be from carbon-like contamination after BCP.
They are very solid and difficult to remove. Source of it is under research.



Source of the Carbon contamination

1) BCP acid/EP acid container (PTFE, PFA) ? Maybe NO

2) BCP Acid/EP acid contamination? Maybe NO

3) Contamination from environment? Maybe NO

4) Contamination in Nb (< 10ppm)? ~10ppm is effective?

Not yet understood

Removal of the Carbon contamination

Ultra-sonic rinse
HF rinse, HF + Ultra-sonic
EP acid rinse
Phosphoric acid rinse
Acetone + Ultra-sonic rinse
brushing

H_2O_2 (hydrogen peroxide)+ BCP etching

No removal,
No effect

H_2O_2 (hydrogen peroxide)+ UV light activation : effective!
(results maybe presented in the next TTC meeting at JLAB)

Summary

(1) Surface contaminations found on BCP sample coupon.

1 to 100μm size, move its position in every treatment.

(2) Surface contaminations found on Lab-EP sample coupon.

same as BCP contamination.

(3) Contamination is identified as Carbon and Oxygen compund.
However source of Carbon is not yet identified.

maybe came from Nb metal itself.

(4) Remove of Carbon is on a way

removal by chemical decomposition is possible.

(5) Effect on EBW seam pit, field emission, quench should be studied.

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