

INVESTIGATION OF STRUCTURAL DEVELOPMENT IN THE TWO-STEP DIFFUSION COATINGS OF Nb₃Sn ON NIOBIUM

Uttar Pudasaini (College of William & Mary)

Grigory Eremeev, Charlie Reece (Jefferson Lab)

Michael Kelley (College of William & Mary and Jefferson Lab)

James Tuggle (Virginia Tech)

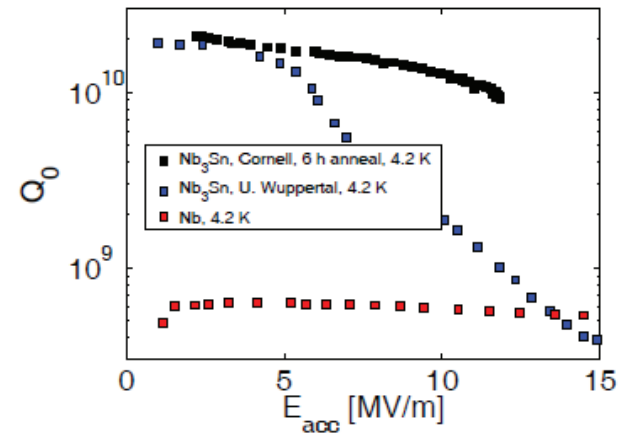
OUTLINE

- Motivation
- Nb₃Sn Coating Process
- Experiments and Results
- Summary

Nb₃Sn: ALTERNATE SRF CAVITY MATERIAL

- Nb cavities are approaching the intrinsic material limit and expensive to run.
- **Higher T_c and H_{sh}** of Nb₃Sn promise potential cavity operation at 4.2 K and higher E_{acc} .
- Researched since 1970s, Nb₃Sn is a **challenging material** for cavity fabrication.

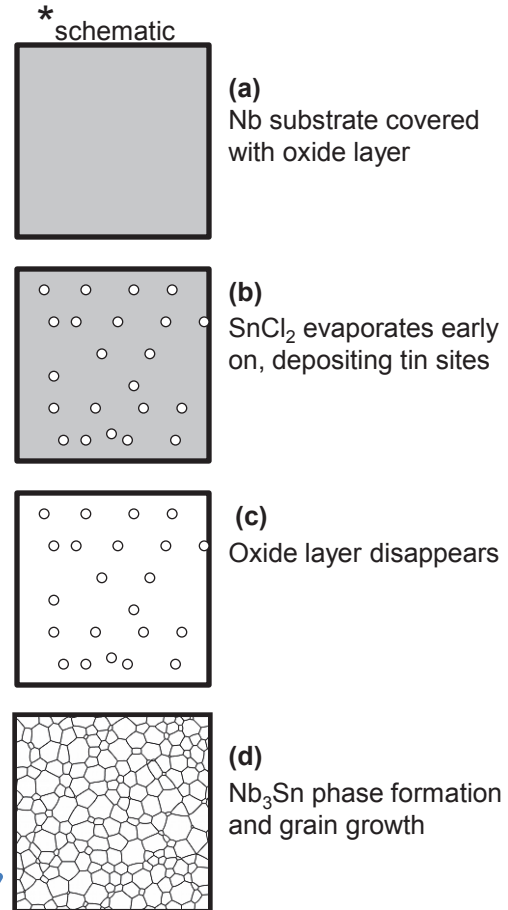
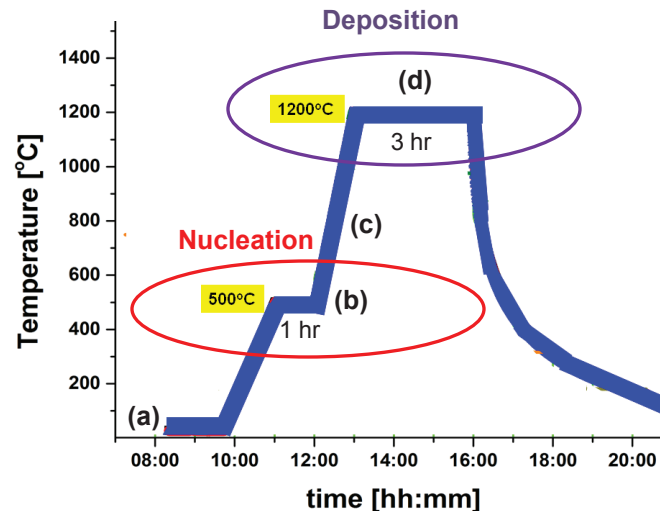
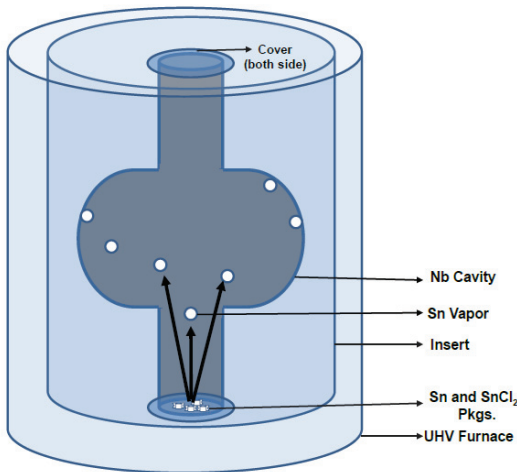
	Nb	Nb ₃ Sn
T_c	9.2 K	18.3 K
H_{sh}	~200 mT	~400 mT



S. Posen and M. Liepe, LINAC 2014, TUIOC03

Nb₃Sn COATING PROCESS

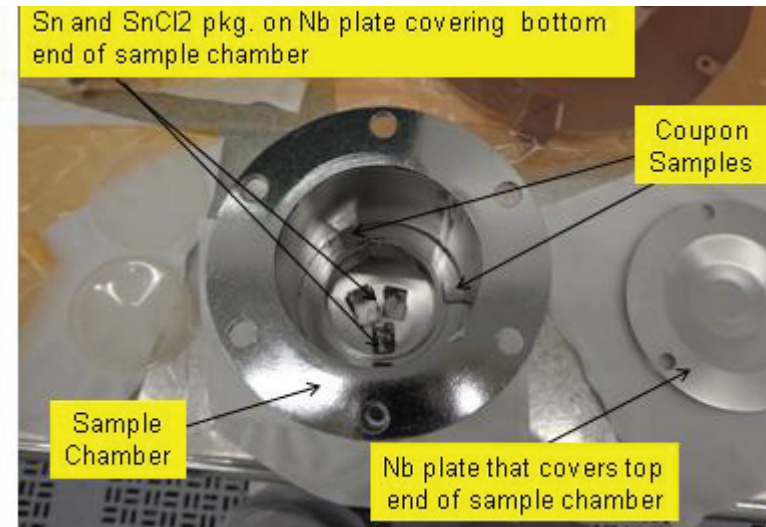
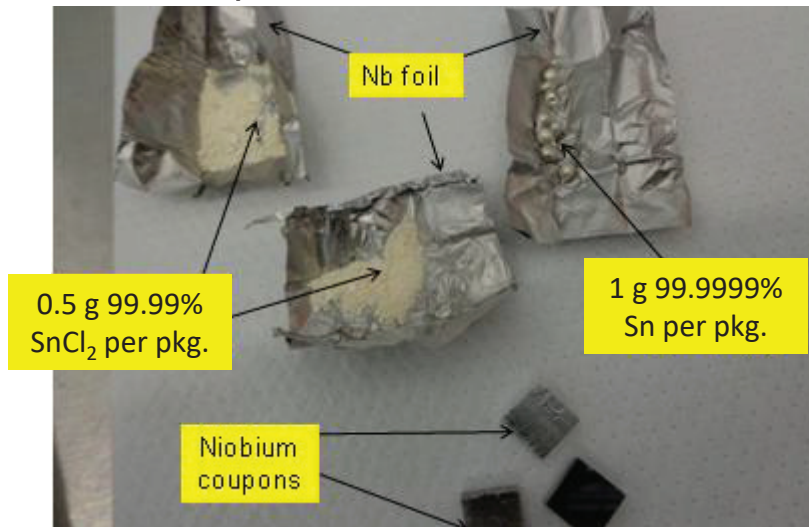
- Tin vapor diffusion is a promising coating technique.
- Two steps: Nucleation followed by Deposition.



Nb₃Sn coating at Jlab

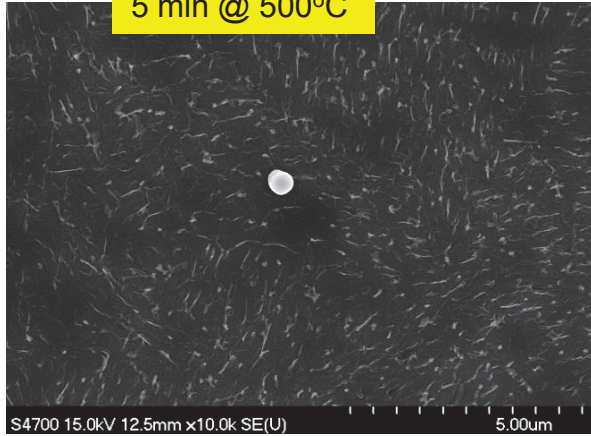
EXPERIMENTAL STUDIES

- Nucleation Experiments
 - Characteristics of nucleated surface
 - Effect of changing nucleation parameters
- Coating Interruption Experiments
 - How does the final composition/topography/crystallography of the coating develop?

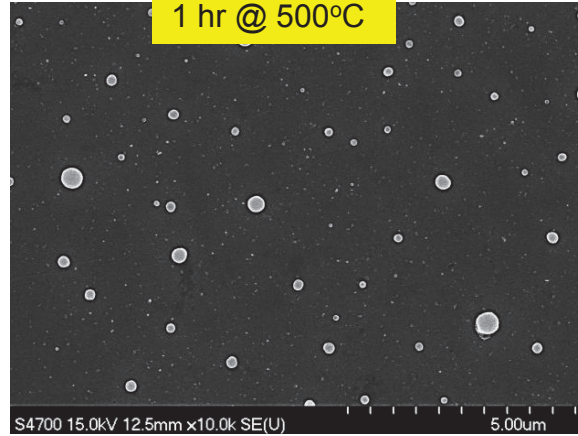


Nucleation Time Variation @ 500°C

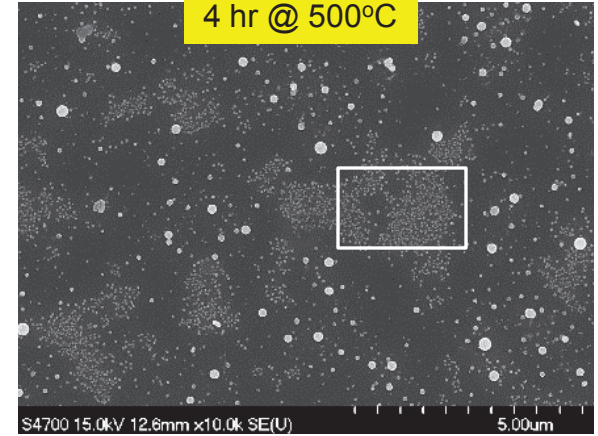
5 min @ 500°C



1 hr @ 500°C



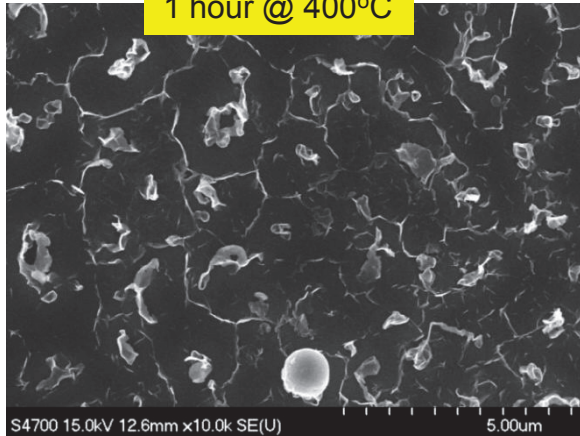
4 hr @ 500°C



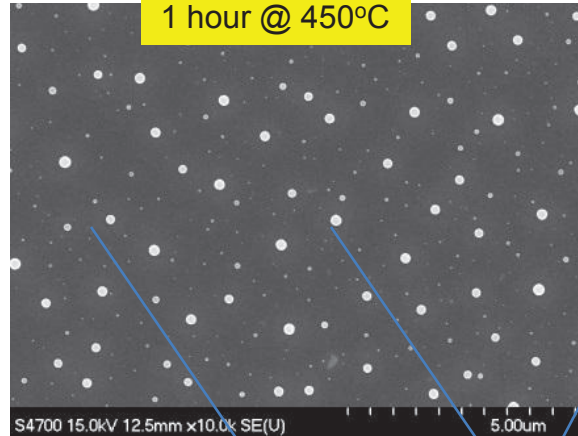
SEM/EDS : < 10% Sn coverage

Nucleation Temperature Variation

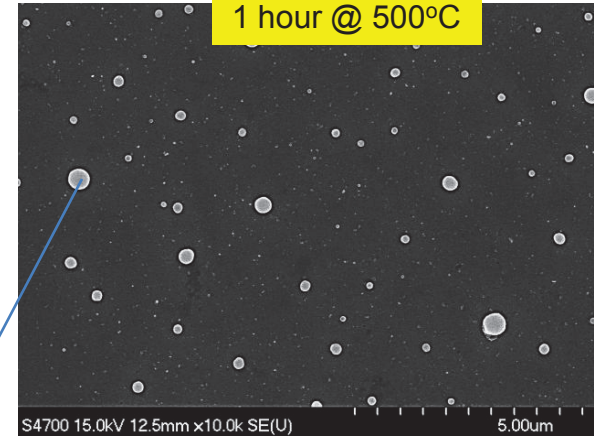
1 hour @ 400°C



1 hour @ 450°C



1 hour @ 500°C

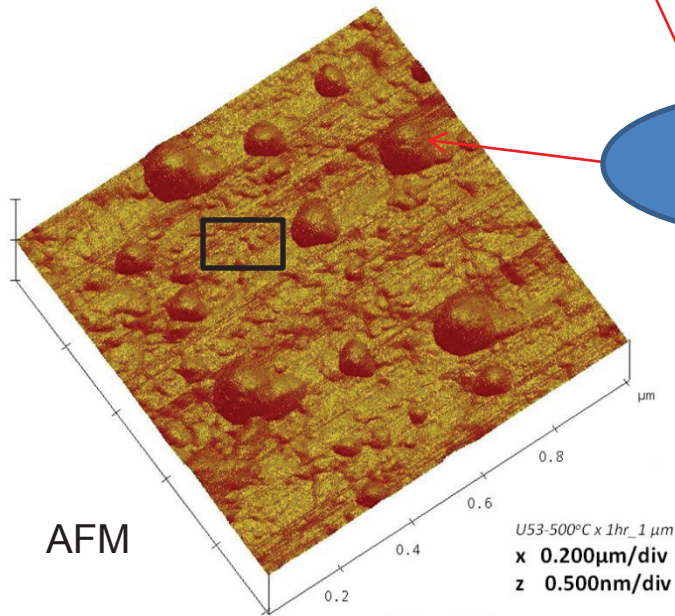
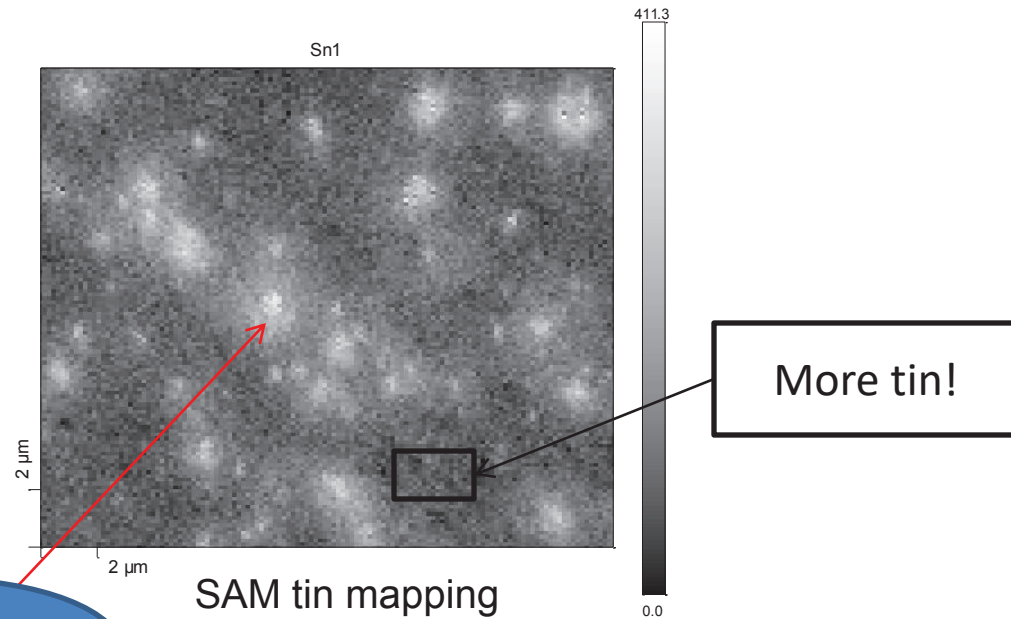
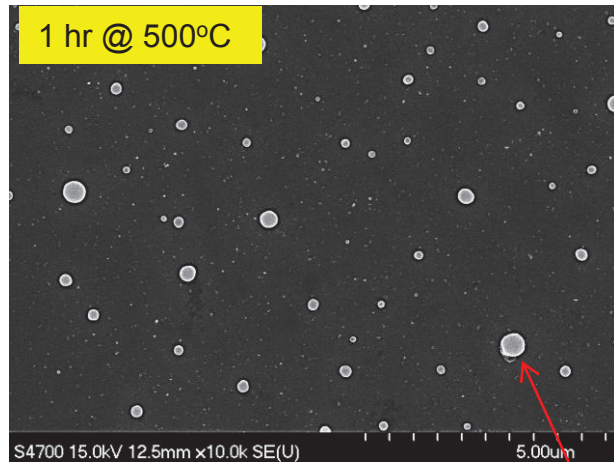


Nb

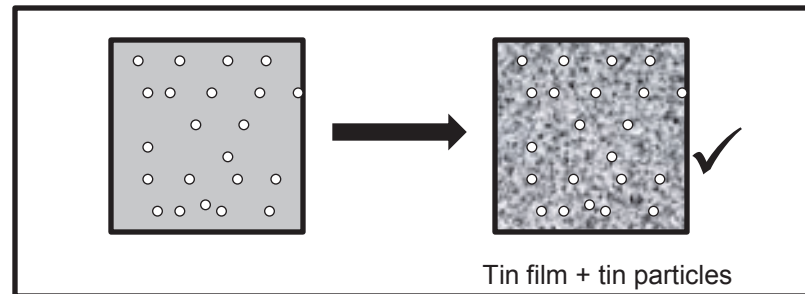
Sn

XPS shows more tin ! No Chlorine.

Supplementary Analysis

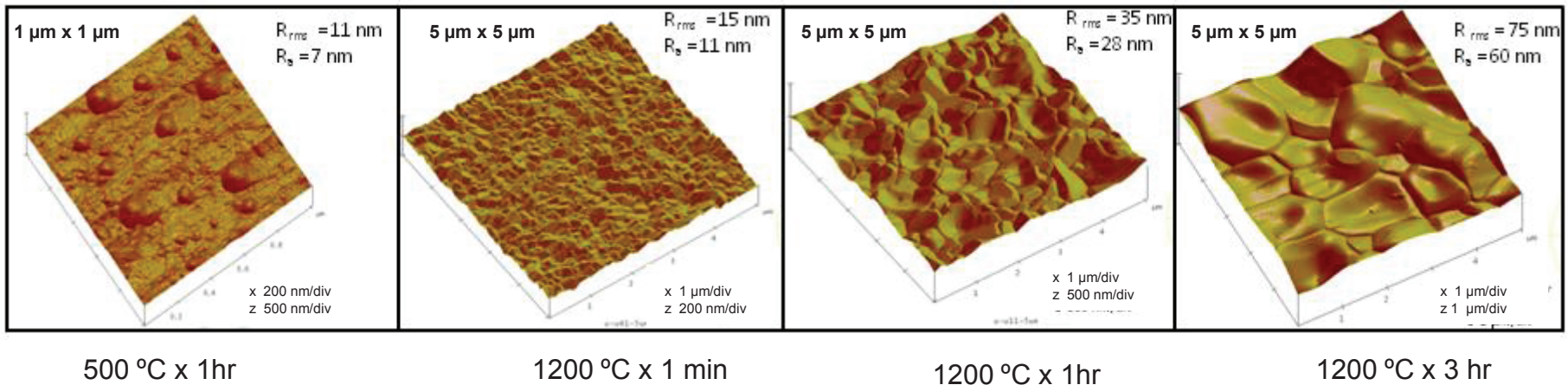


Sn
Particles



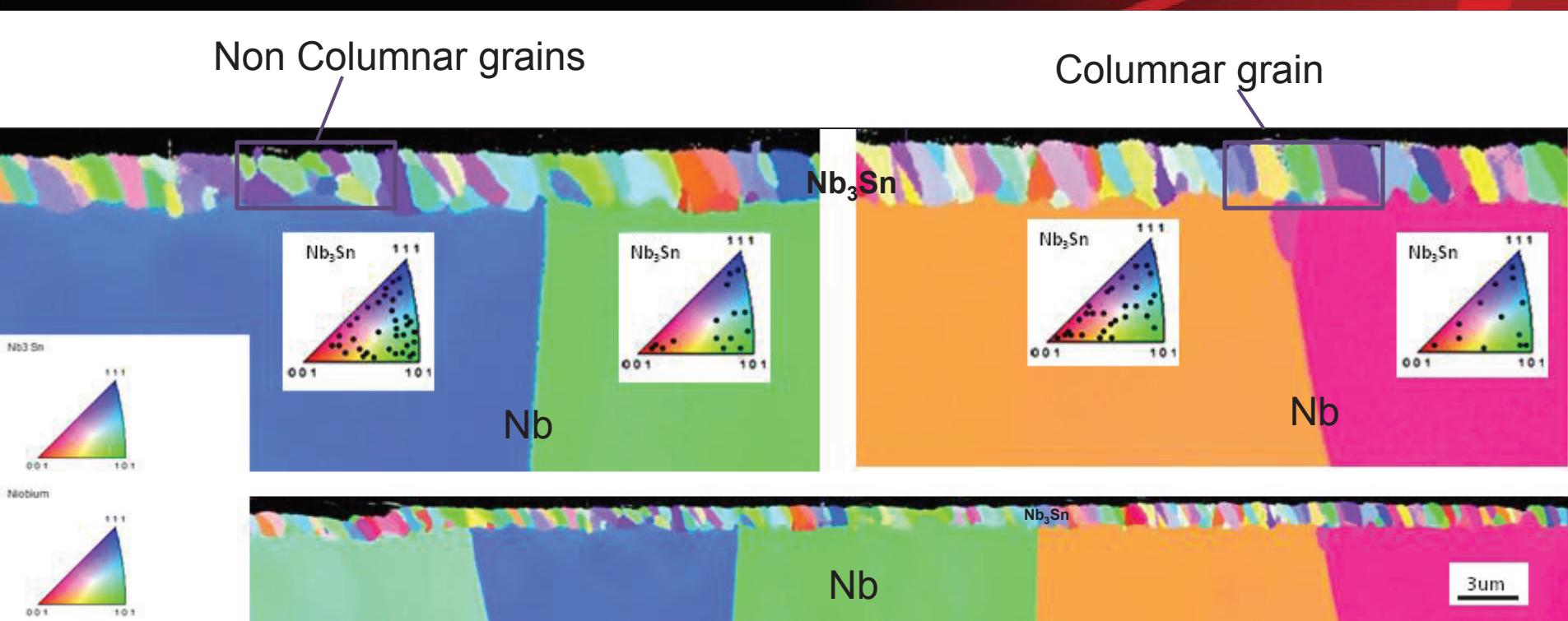
TOPOGRAPHY EVOLUTION

- Nb_3Sn coated surfaces are rough; independent of substrate preparation.



- Substantial topography develops during deposition step.

CRYSTALLOGRAPHY



No evident effect of substrate grain orientation into that of final coating.

SUMMARY

- SnCl_2 deposits tin particles and tin film on the niobium surface.
- No Chlorine.
- Roughness was found to increase during Nb_3Sn growth process during deposition.
- No explicit evidence that substrate grain orientation influences the grain orientation of final coating.

Acknowledgement

We are grateful for support from the Office of High Energy Physics, U.S. Department of Energy under grant DE-SC-0014475 to the College of William & Mary.

