Thermal Stability of Nb₃Sn Surface Oxide Layer
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Motivation
Our scientific motivation is to synergize fundamental material science and SRF technology to push forward the state-of-the-art Q-gradient in Nb₃Sn-based SRF cavities. By investigating and optimizing the properties of the surface oxide layer, we aim to develop innovative surface nanoengineering strategies that effectively reduce its impact on the surface resistance, leading to improved performance and efficiency of the cavities.

Results/Discussion

XPS Nb 3d curve-fitting: progressive evolution of the surface oxide layer in Nb₃Sn-coated SRF grade Nb, upon heating from 325 ºC to high temperature (~700 ºC).

Setup for coating processes for Nb₃Sn in 1.3 GHz TESLA-type cavity, with anodized surface at 50 V.

Pre-coating anodized Nb 1.3 GHz cavity

Witness sample Nb₃Sn Post-coating

Ra = 0.195

Surface characterization
a) Micrograph by SEM;
b) LCSM image and c) surface roughness estimation

Nb₃Sn thermal evolution from Sn a) SnO₂/Sn at. % evolution, b) Sn 3d curve-fitting spectra and c) X-ray induced Sn MNN Auger line in the range from 200 to 600 ºC.

Future work
We are actively engaged in the development of groundbreaking thermal treatments to effectively remove the native oxide layer in Nb₃Sn. Our objective is to address intrinsic energy losses, minimize surface resistance, and ultimately maximize the Q-factor at high fields.