Nb_3Sn on Nb: Challenges

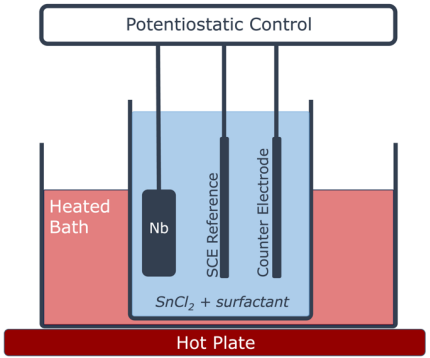
Goal for conduction-cooled SRF cavity technology: Reach higher Q_0 at 4.2K

Main challenge: achieve a smooth Nb_3Sn film with uniform thickness and stoichiometry

→ Improving vapor diffusion:

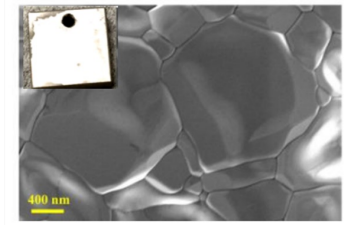
sample studies have shown that pre-nucleation chemical treatments affect tin coverage on Nb substrate

→ Alternative growth method: electrochemical synthesis

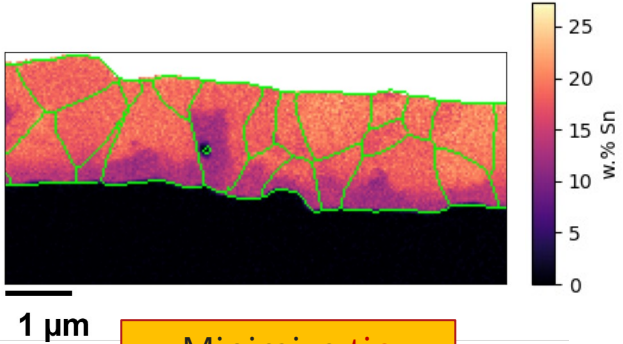


Electrochemical deposition

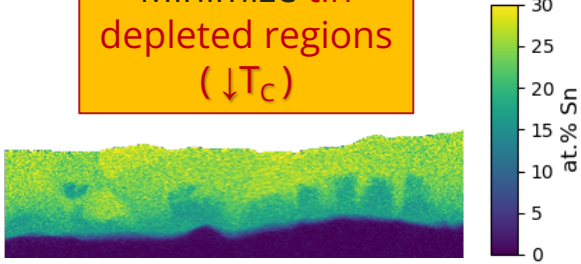
Anneal > 900℃ to thermally convert to stoichiometric, smooth Nb_3Sn



Lower surface roughness



Minimize tin depleted regions ($\downarrow T_c$)

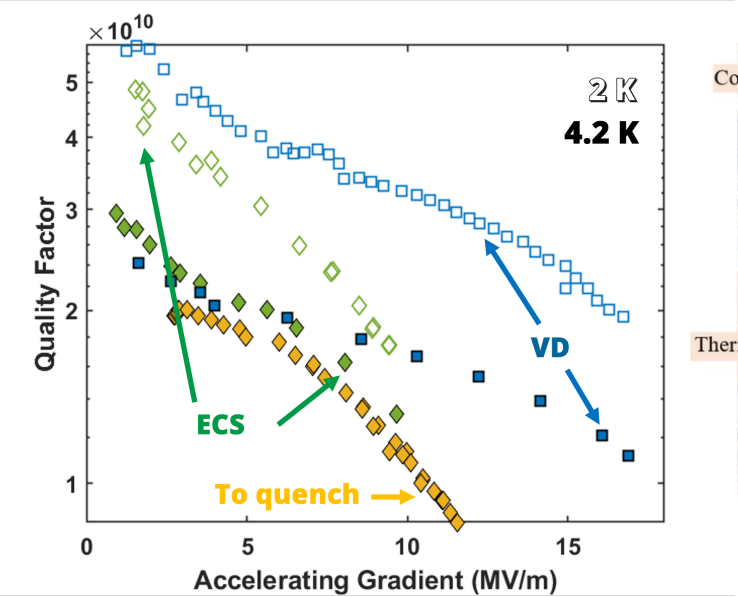


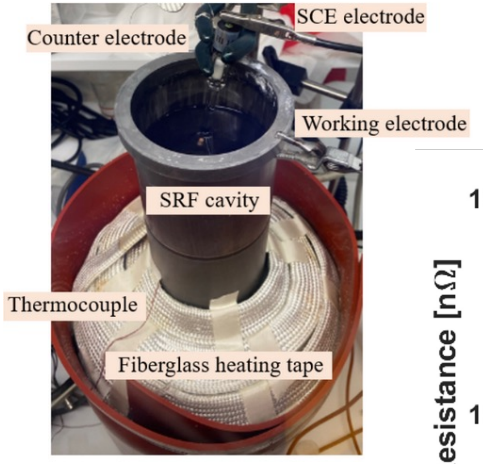
Z. Sun *et al* 2023 *Supercond. Sci. Technol.* **36** 115003
DOI 10.1088/1361-6668/acf5ab

Proof of Principle: Electrochemical Synthesis

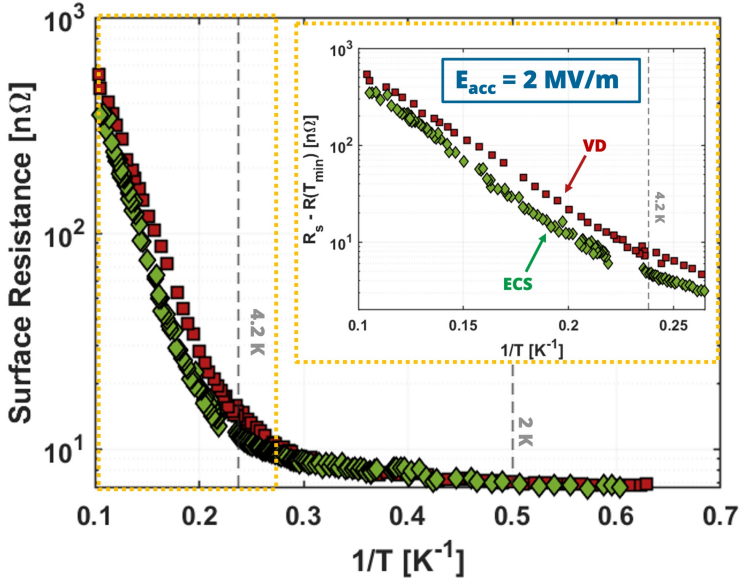
This alternative growth method provides uniform tin nucleation and sufficient Sn supply in critical times

⟹ **smoother** Nb_3Sn films with **little variation in Sn concentration with depth**.





→ Very low BCS low resistance



→ First ever alternative growth method to vapor diffusion to achieve **quality factors >10^{10}** at **4.2K**