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Development and Understanding of Nb3Sn films for radiofrequency applications through a sample-host 9-cell cavity

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Nb3Sn is a promising advanced material under development for superconducting radiofrequency (SRF) cavities. Past efforts have been focused primarily on small development-scale cavities, but large, often multi-celled cavities, are needed for particle accelerator applications. In this work, we report on successful Nb3Sn coatings on Nb in a 1 m-long 9-cell Nb sample-host cavity at Fermilab. The geometry of the first coating with only one Sn source made it possible to study the influence of Sn flux on the microstructure. Based on these results, we postulate a connection between recently observed anomalously large thin grains and uncovered niobium spots observed in the past by other authors [Trenikhina 2018]. A phenomenological model to explain how these anomalously large grains could form is proposed. This model is invoked to provide possible explanations for literature results from several groups and to guide key process parameters to achieve uniform vapor-diffusion coatings, when applied to complex structures as the multi-cell cavity under study.

Primary authors: SPINA, Tiziana (Fermilab); POSEN, Sam (FNAL); LEE, Jae Yel (Northwestern University-Fermilab); SEIDMAN, David (Northwestern University); TENNIS, Brendan (Fermilab)

Presenter: SPINA, Tiziana (Fermilab)

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