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Identifying the connections between grain growth and flux expulsion in low RRR niobium SRF cavities

The SRF community has shown that high temperature annealing can improve the flux expulsion of niobium cavities during cooldown. The required temperature will vary between cavities and different batches of material, typically around 800 C and up to 1000 C. However, for niobium with a low residual resistance ratio (RRR), even 1000 C is not enough to improve its poor flux expulsion. The purpose of this study is to observe the grain growth behavior of low RRR niobium coupons subjected to high temperature annealing to identify the mechanism for improving flux expulsion. We observe that low RRR material experiences less grain growth than high RRR when annealed at the same temperature. We search for the limitations to grain growth in low RRR material and develop a diagnostic based on grain structure to determine the appropriate recipe for good flux expulsion. The results of this study have the potential to unlock a new understanding on SRF materials and enable the next generation of high Q/high gradient surface treatments.

Primary author: HOWARD, Katrina (University of Chicago)

Co-authors: BAFIA, Daniel (Fermi National Accelerator Laboratory); SUNG, Zuhawn (Fermi National Accelerator Laboratory); DZIEDZIC-MISIEWICZ, Wieslawa (Fermi National Accelerator Laboratory); KIM, Young--Kee

Presenter: HOWARD, Katrina (University of Chicago)