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Characterizing and controlling recovery and recrystallization in Nb for improved SRF cavity performance

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Crystal defects, such as dislocations and low-angle boundaries, provide sources of magnetic flux trapping in the Nb materials used for superconducting radio frequency (SRF) resonating cavities. Improving the performance of SRF cavities, as measured through the quality factor, requires reducing these defects. SRF cavity production involves deformation processing, such as rolling and forming, and strategic annealing heat treatments. The resulting microstructures can be recovered, recrystallized, or both. Because recovery leaves many defects that can trap flux, recrystallization should improve cavity performance. Thus, processing schedules that produce complete recrystallization without excessive grain growth need to be designed. Solutions to this problem require understanding physical metallurgy and differentiating between recovered and recrystallized regions of microstructure. Backscattered electron microscopy techniques are applied to this end. We demonstrate that the conditions required to produce fully recrystallized microstructures depend on Nb impurity content, suggesting that processing schedules may need to be adjusted by material heat or lot. We also demonstrate that processing can be used to control recrystallized grain growth to maintain mechanical strength in fully recrystallized materials. Forming cavities from cold-rolled Nb sheet material may provide strategic new routes to obtain microstructures that improve SRF cavity performance.

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Yes

Footnotes

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Author: TALEFF, Eric (The University of Texas at Austin)

Co-authors: Ms BANERJEE, Sucharita (The University of Texas at Austin); Dr BENNETT, Thomas (Sandia National Laboratories); BALACHANDRAN, Shreyas (Florida State University; National High Magnetic Field Laboratory); CHETRI, Santosh (Florida State University; National High Magnetic Field Laboratory); Mr BORITZ, Trent (Florida State University; National High Magnetic Field Laboratory); DHAKAL, Pashupati (Thomas Jefferson National Accelerator Facility); Mr THUNE, Zack (Michigan State University); Prof. EISENLOHR, Philip (Michigan State University); LEE, Peter (National High Magnetic Field Laboratory); Prof. BIELER, Thomas (Michigan State University)

Presenter: TALEFF, Eric (The University of Texas at Austin)

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