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M2Or3C-05: Evidence that bi-modal grain size leads to variations in flux trapping in polycrystalline Nb

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Nitrogen doping and heat treatment procedures have boosted the performance of SRF cavities by reaching higher quality factors (Q ˜5E10) due to the lowering of BCS resistance (RBCS). Simultaneous to the decrease in RBCS, an unpredictable variability in cavity Q's has been observed in both fine grain and large grain SRF Nb cavities that has been attributed to increases in residual resistance caused by bulk flux trapping during cool down through the superconducting transition. In nitrogen treated cavities with quality factors reduced by flux-trapping, it has been found the heat treating at a high temperature beyond the standard 800℃/3h can reduce flux trapping and return the cavities to the expected high-quality factor. An issue with high-temperature heat treatments is of additional cost and reduction in mechanical strength of Nb cavities. Correlations between microstructure and flux trapping in SRF Nb have generally been elusive, although there have been indications that microstructure plays a role. In this present study, we present direct evidence of the relationship between microstructure and flux trapping in a series of sequential remanent field images obtained by Magneto-Optical Imaging (MOI) of an RRR 160 Nb bicrystal that has given heat treatments from 600℃ to 1000℃. We find strong correlations between the grain size distributions revealed by orientation imaging microscopy and the flux-trapping revealed by MOI. The result indicates a clear dependence of grain structure and grain size to flux trapping in Nb.

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