**Correlation of Thermal Conductivity with Vacancies and Dislocations in High Purity Nb at 2-4 K.**

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Superconducting Nb cavities, as used in particle accelerators, operate efficiently at temperatures of 2-4 K. A contributing factor to the high efficiency is maintaining large values of thermal conductivity k, which enhances heat dissipation into the He bath arising from local defects on the RF surface. For T <3 K, with conductivity $k_3$, the dominant mode of heat conduction is by phonons, with a local maximum $k_{pp}$ occurring at about 1.8 K. Vacancies and dislocations can disperse phonons that have trajectories toward the outer wall, and thus reduce *k*. There is keen interest in understanding the relationship between *k* and the manufacturing processes employed to making a cavity. The relationship between the variation of *k* and pre-existing dislocations, dislocation substructures, deformation, and annealing phenomena is examined. Orientation gradient maps were generated for Nb specimens in their as-received condition and after 2 h heating under vacuum. Local average misorientation (LAM) maps indicate the spatial arrangement of geometrically necessary dislocations. One specimen in its as-received condition had the lowest amplitude and widest LAM distribution, indicating a higher fraction of dislocations were present within this one specimen. The LAM following heat treatment for 2 h at a temperatures of 600, 800, 1000, or 1200 °C indicated that a significant reduction of dislocation density occurred at 1000 and 1200 °C. The LAM distribution for these specimens did not correlate directly with the recovery of the phonon peak in *k*. The discrepancy may stem from inadequate sample size on the surface. The bulk measurement of k examines a much larger volume. Thus, high-energy x-ray diffraction was performed to test this hypothesis. Diffracted peak broadening corresponding to the {222} slip directions was used to estimate qualitatively dislocation and imperfection content of the specimens by comparing the full width at half maximum of the diffraction peaks (FWHM) for the four specimens. The specimen heat-treated at 1000 °C had the smallest FWHM, implying the fewest crystal imperfections in that specimen. The higher defect density at 1200 °C may reflect a higher vacancy concentration, as there were few sites available to absorb vacancies. Taken together, the normalized phonon peak ($k_{pp}/k_3$) is sensitive to both dislocation and vacancy densities.