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N-doping of Niobium: In-situ EXAFS experiments

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The preparation of superconducting Nb-cavities for particle accelerators comprises several treatments including e.g. buffered chemical polishing, electropolishing, high pressure rinsing and dry-ice cleaning. Recent experiments have shown that the RF-superconducting properties of the Nb-cavities can substantially be improved using heat treatments under dilute nitrogen or argon atmospheres, yielding a significant reduction of the electrical resistivity. The formation of niobium nitride (NbN) with an increased critical temperature was discussed to explain the observed phenomena, however, a full understanding of the structural changes which lead to these improvements is still lacking. Here we will present results of EXAFS measurements, probing the structural changes during the heat treatments of metallic Nb in-situ. The processing included a treatment in vacuum for 1 h at 900 ℃ and a subsequent exposure to high-purity nitrogen for varying times. EXAFS data were collected prior to any heat treatment as well as during the different process steps at elevated temperature, and after cooling to room temperature. Results of a quantitative EXAFS data evaluation will be presented, showing that the data can be fitted using metallic Nb-Nb coordinations only. No impurity phases such as Nb-nitride were found. In contrast, the disorder parameters for the first few Nb-Nb shells substantially increase with process time and N2-exposure. Reasons for such an increased disorder will be discussed.

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