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Near-surface region characterization of nitrogen treated single-crystal Nb (100)

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Modern particle accelerators rely on niobium RF (Radio-Frequency) cavities for their operation and there is a big drive for performance improvement of such devices. Achieving a higher quality factor (Q0), will lead to higher luminosity while reducing the dynamic heat load, resulting in potential cost savings. Nitrogen doping is known to increase the performance of niobium cavities [1], however, the physical and chemical processes and phenomena involved are not yet understood [1,2]. In this work, the niobium (100) surface was subjected to a step-wise preparation based on the so-called 'nitrogen infusion'process, which has recently showed an increase in Q0 and accelerating gradient for 1.3 GHz SRF cavities [3]. The progressive dissolution of the natural oxide layers upon temperature increase and nitrogen presence were tracked in-situ by means of X-Ray Reflectivity (XRR) while the effects of oxygen and nitrogen interstitials was retrieved from Depth-Resolved Grazing Incidence High Energy Diffuse X-Ray Scattering (GIXRD) measurements obtained at ESRF beamline ID31. Additional surface sensitive characterization techniques, namely X-Ray Photoemission Spectroscopy (XPS) and Scanning Electron Microscopy (SEM) were performed at DESY Nanolab to bring further understanding to the system.
[1] A. Grassellino et al, Supercond. Sci. Technol.26 102001(2013).
[2] P. Dhakal et al, IEEE Tran. on App. Superc.25 3500104(2015).
[3] A Grassellino et al, Supercond. Sci. Technol.30 094004(2017).

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