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Effect of strain rate on the tensile mechanical properties of high–purity Nb single crystals and EB welded sheets for SRF applications

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Seamless SRF cavities have been proposed to improve performances (i.e. higher quality factor at high accelerating gradients) and reduce the risk of a quench in the vicinity of the equatorial weld. However, the anisotropic mechanical properties of high–purity niobium tubes with large grains or the low ductility of small-grained tubes remain important limiting factors during forming.
An investigation of the mechanical properties of differently oriented high–purity niobium single crystals and electron beam welded polycrystalline Nb deformed in tension at strain rates between 10^{-4} to 10^{3} s^{-1} is presented. Specimens were respectively cut from a large grain niobium disk used for the manufacturing of SRF cavities and welded polycrystalline sheets. The effects of strain rate on the mechanical properties, the microstructure and the ductility are presented. For single crystals, different crystallographic tension directions exhibit significantly different softening and hardening behaviors. Such anisotropy is reduced at high strain rates. The effect of activation of multiple slip systems and adiabatic heating on the tensile split Hopkinson results is discussed. An attempt is made to explain the influence of those properties in high-speed sheet forming of SRF cavities with electro-hydraulic forming.

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