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Insight into Low-Temperature Surface Treatments Used to Prepare Nb SRF Cavities from Low- Energy μSR

Surface treatments are an integral step in the preparation of superconducting radiofrequency (SRF) cavities fabricated using Nb, which are often used in particle accelerators. Common treatment approaches involve "baking" the metal in vacuum or a gaseous atmosphere at temperatures < 200 ℃ (see, e.g., [1]), causing light chemical doping of its subsurface up to depths of ~100 nm. As this chemical adulteration is spatially inhomogeneous, it is expected to distort the element's Meissner response; however, quantifying the effect has proved challenging, with conflicting reports in the literature on the effect's magnitude [2, 3]. Here, we chronicle recent progress in understanding the phenomenon using low-energy muon spin spectroscopy (μSR) [2-5]. While the effect is subtle for the famed 48 h/120 ℃ vacuum annealing "recipe," we find evidence that the Meissner profile is deformed at depths < 40 nm, which can be difficult to distinguish from a large non-superconducting surface "dead layer." Implications for Nb SRF cavities are discussed.

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