Cornell Laboratory for Accelerator-based Sciences and Education (CLASSE)

LINAC GENEVA 14

Nb_3Sn Materials Studies

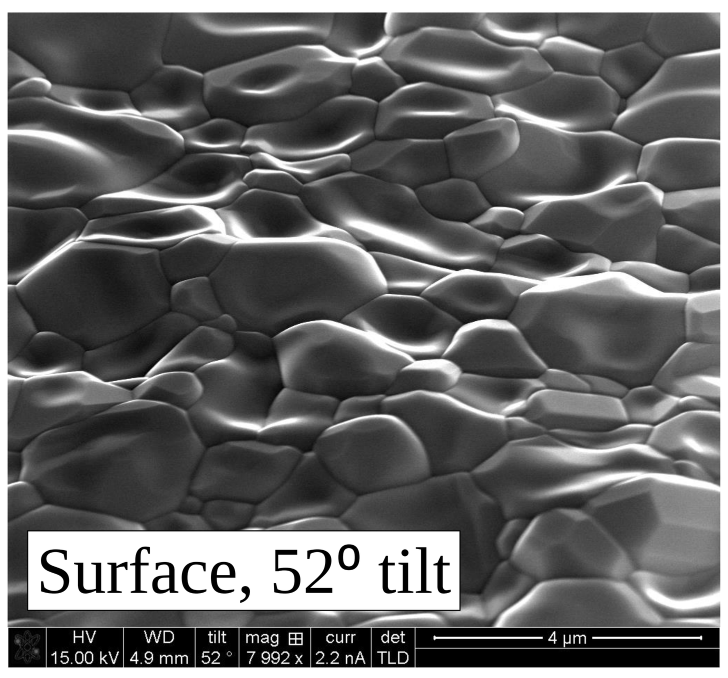
Sam Posen, Matthias Liepe, and Thomas Proslier

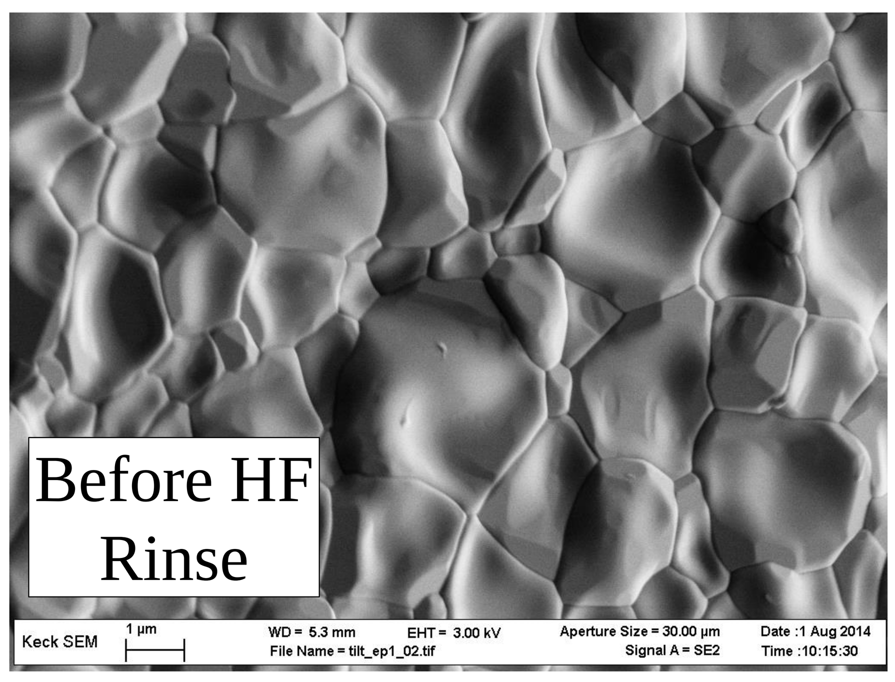
Introduction

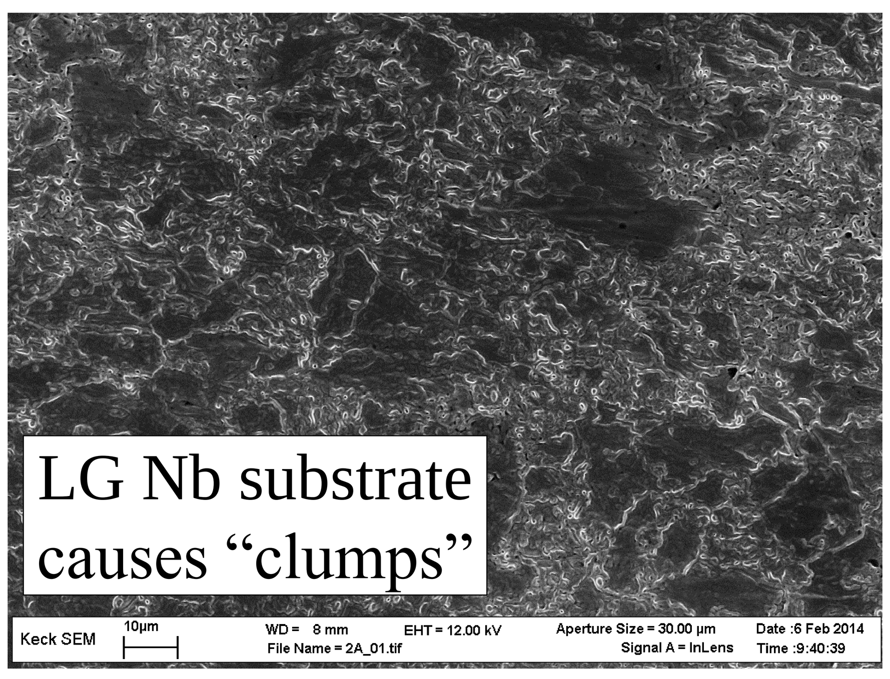
Nb_3Sn is a material with great potential for SRF applications, offering large potential gains in Q_0 and E_{acc} compared to niobium due to its large T_c and predicted B_{sh}. At Cornell, infrastructure has been developed to coat single cell 1.3 GHz niobium SRF cavities with Nb_3Sn using the vapor deposition technique. The first cavities produced have had very promising RF performances, achieving quality factors above 10^{10} at 4.2 K and 13 MV/m (see TUIOC03). In order to push performance further, it is important to better understand this material. In this work, we present both microscopic and bulk studies.

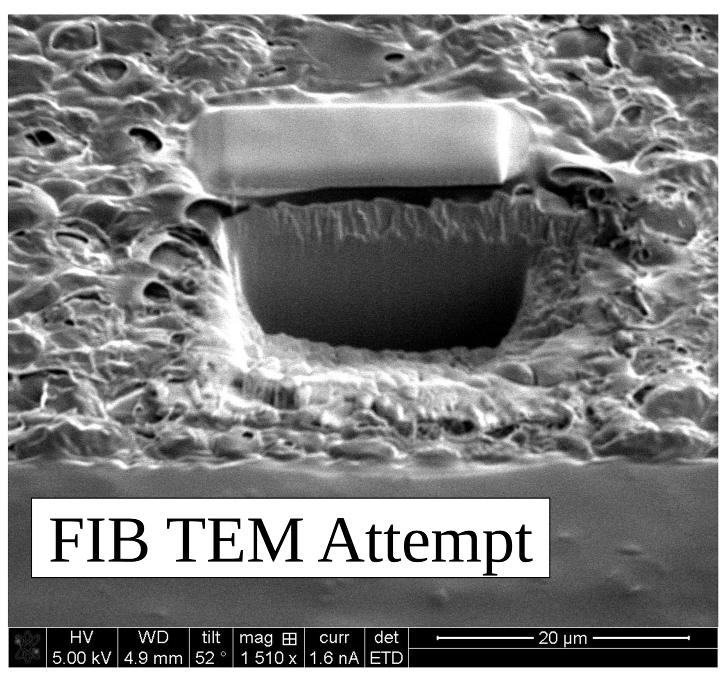
Microscopic Investigations

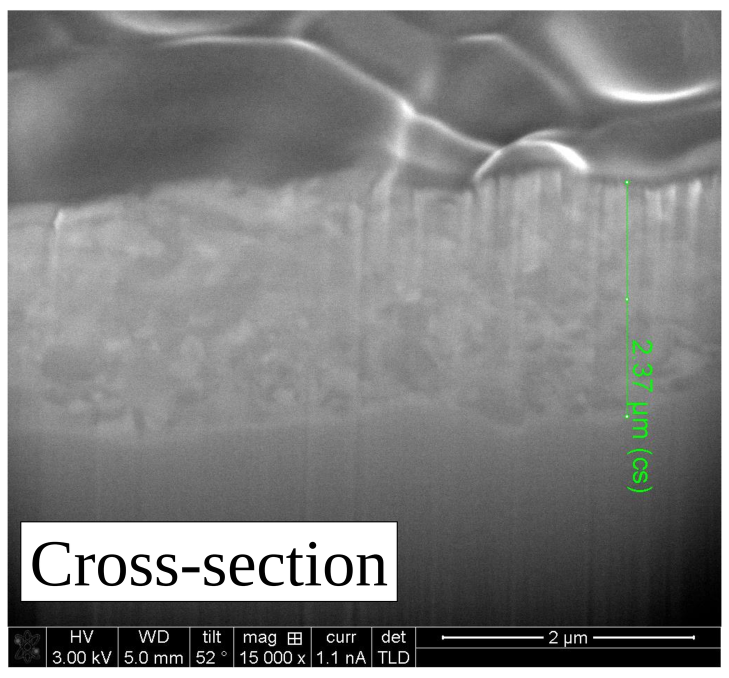
Superconducting behavior is determined by properties on the length scale of ξ (~3-4 nm) and λ (~100 nm), so it is important to understand the material on this scale in order to make correlations to its SRF properties. In this section we present microscopy studies performed with SEM/EDX and FIB.

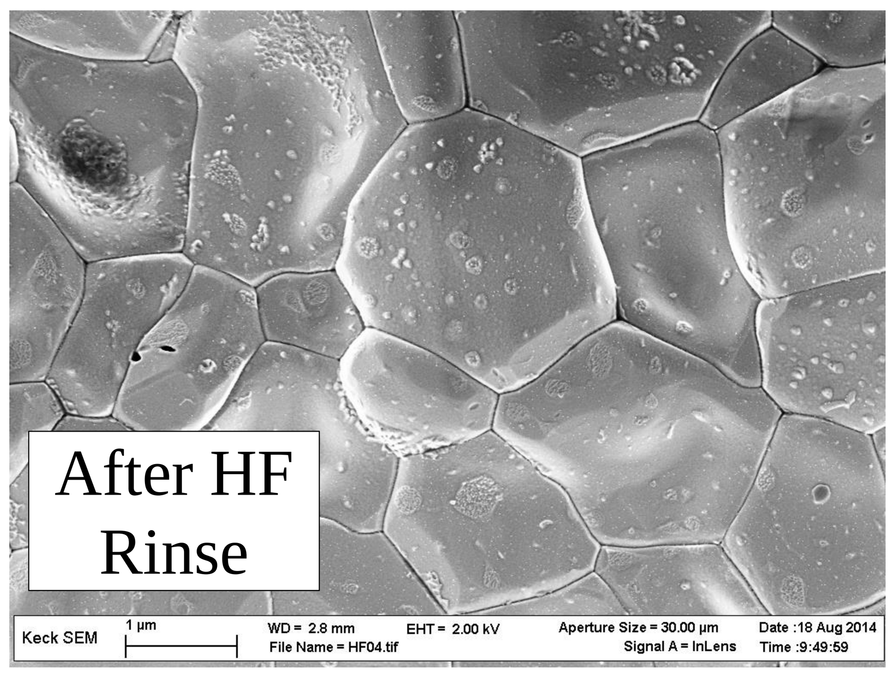


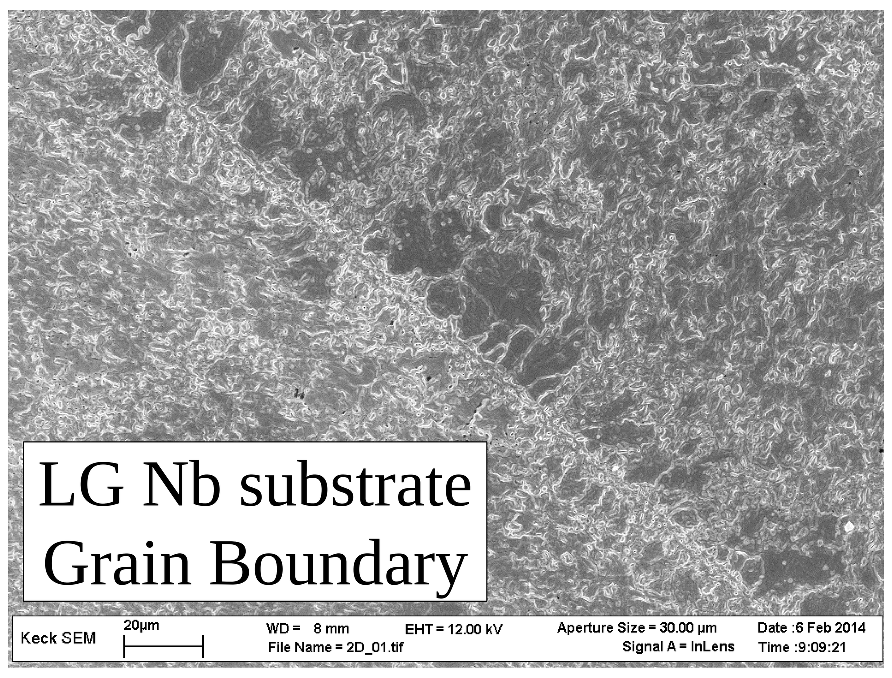


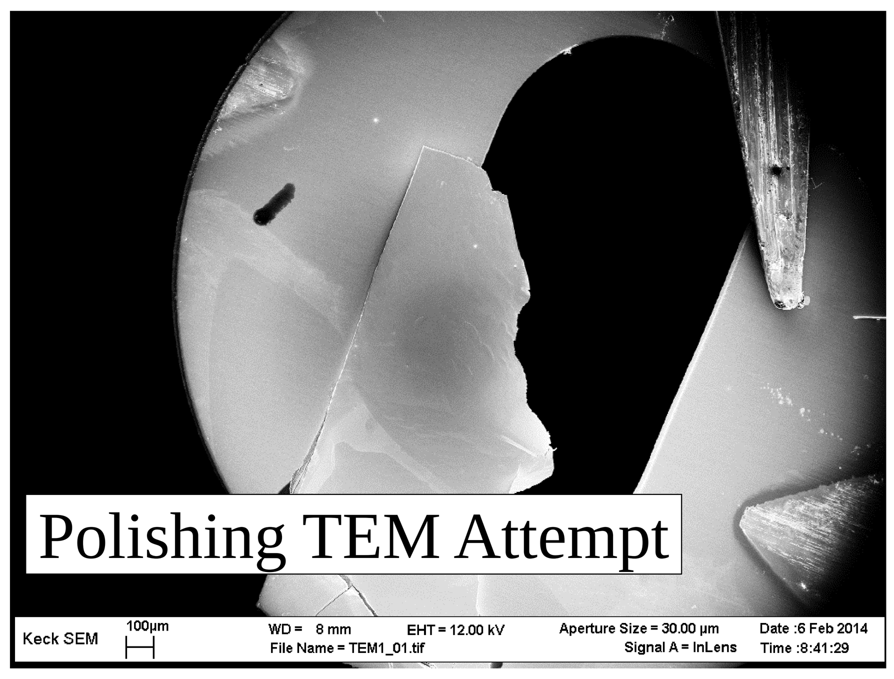












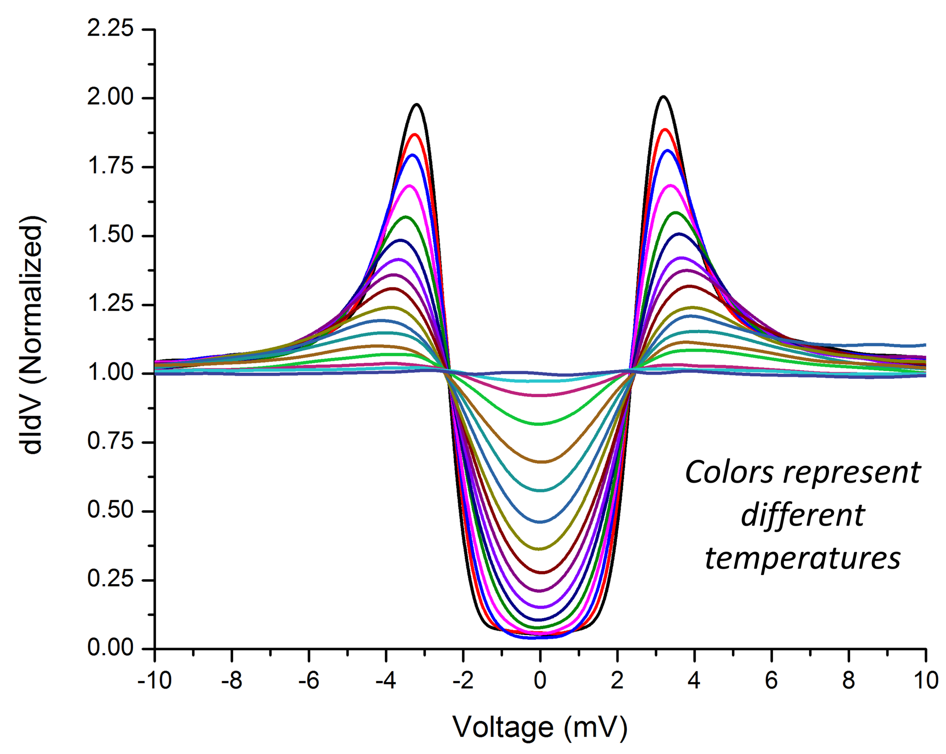
Typical coating is 2-3 µm thick with 1-2 µm grains

HF rinsing causes structures to appear on surface – EDX inconclusive

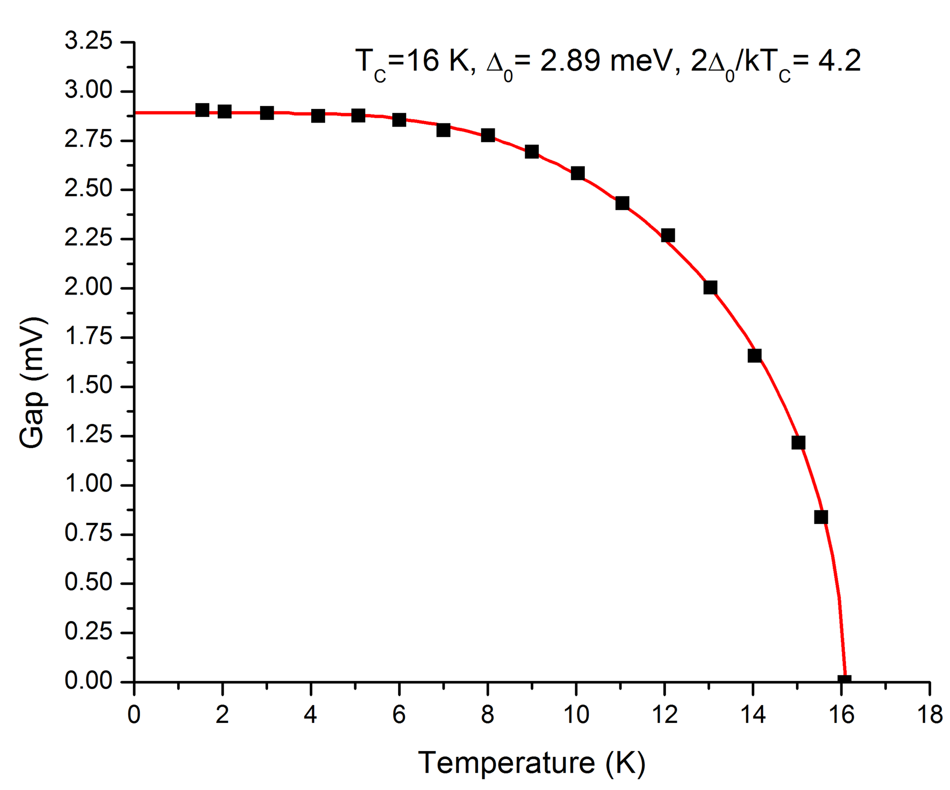
On large grain Nb substrate, Nb_3Sn grains smear together in some regions

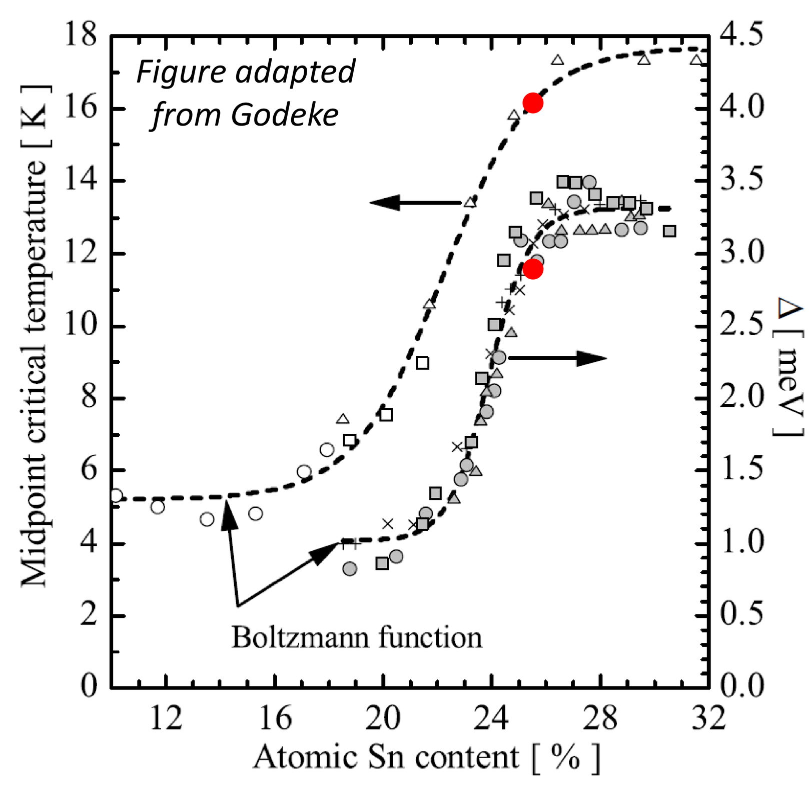
Attempts to create TEM samples via FIB and polishing but no success yet

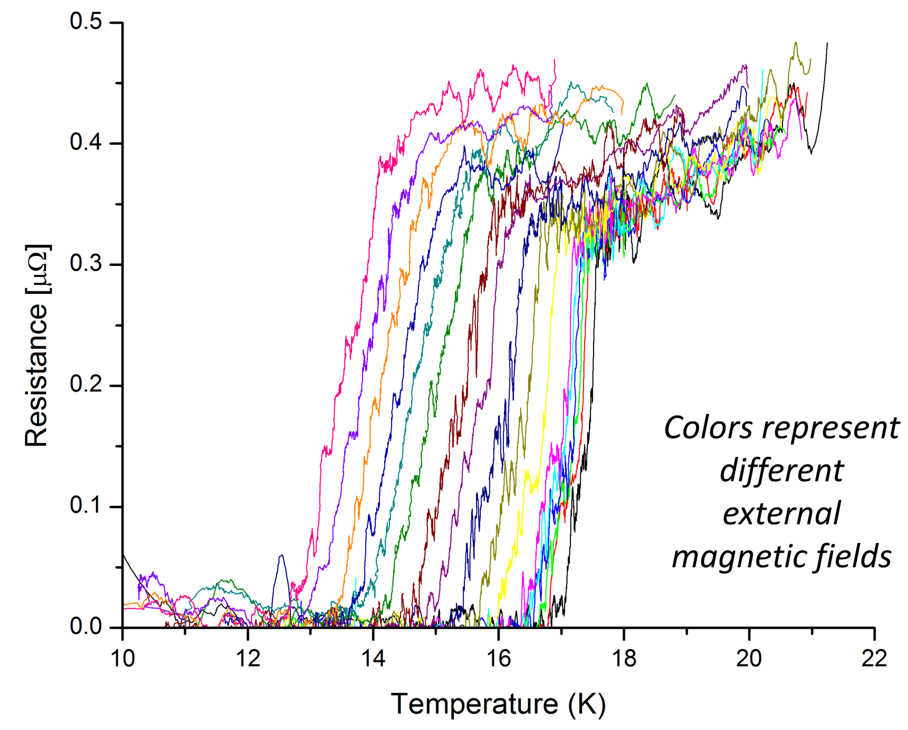
Bulk Investigations



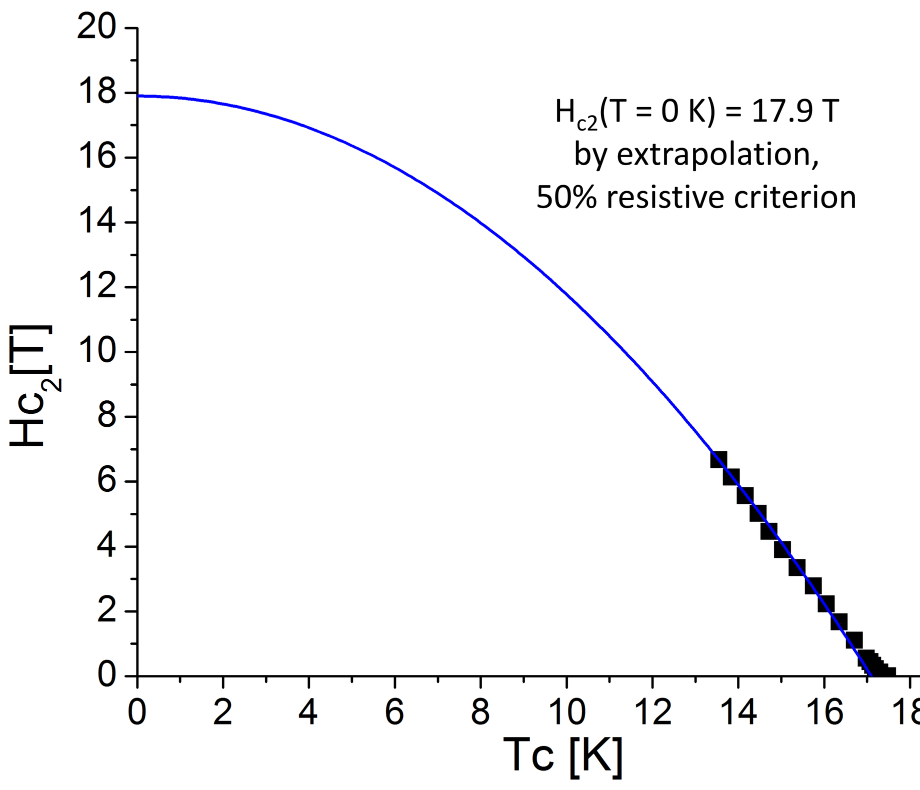
Point contact tunneling at ANL measures superconducting energy gap as a function of temperature. The sharp gap indicates high superconducting quality at surface. Extracted values (red) for gap and critical temperature appear to follow correlations from [A. Godeke, Supercond. Sci. Tech. 19, R68 (2006)].

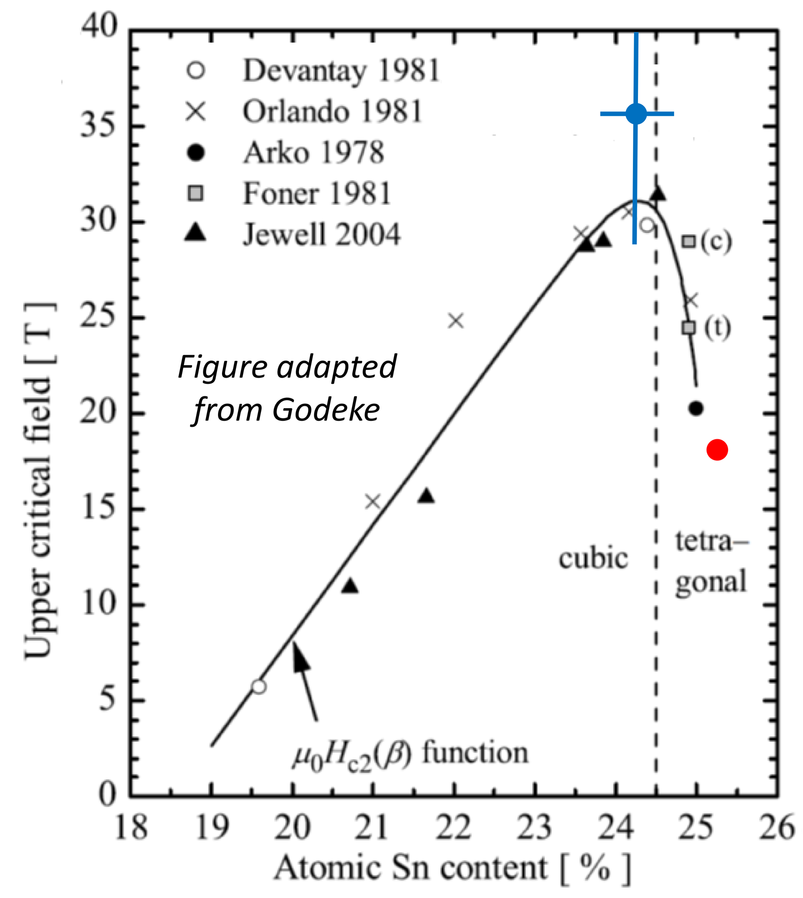






Upper critical magnetic field H_{c2} measured at ANL as a function of temperature by resistive method. Extracted H_{c2}(T = 0 K) (red) appears to follow correlations by Godeke based on composition from EDX. H_{c2} calculated from material parameters measured in RF tests also shown (blue).





* sep93@cornell.edu

CLASSE facilities are operated by the Cornell Laboratory for Elementary Particle Physics (LEPP) and the Cornell High Energy Synchrotron Source (CHESS) with major support from the National Science Foundation.