# SRF Materials: Niobium Oxidation, Control A New Explanation for Baking!

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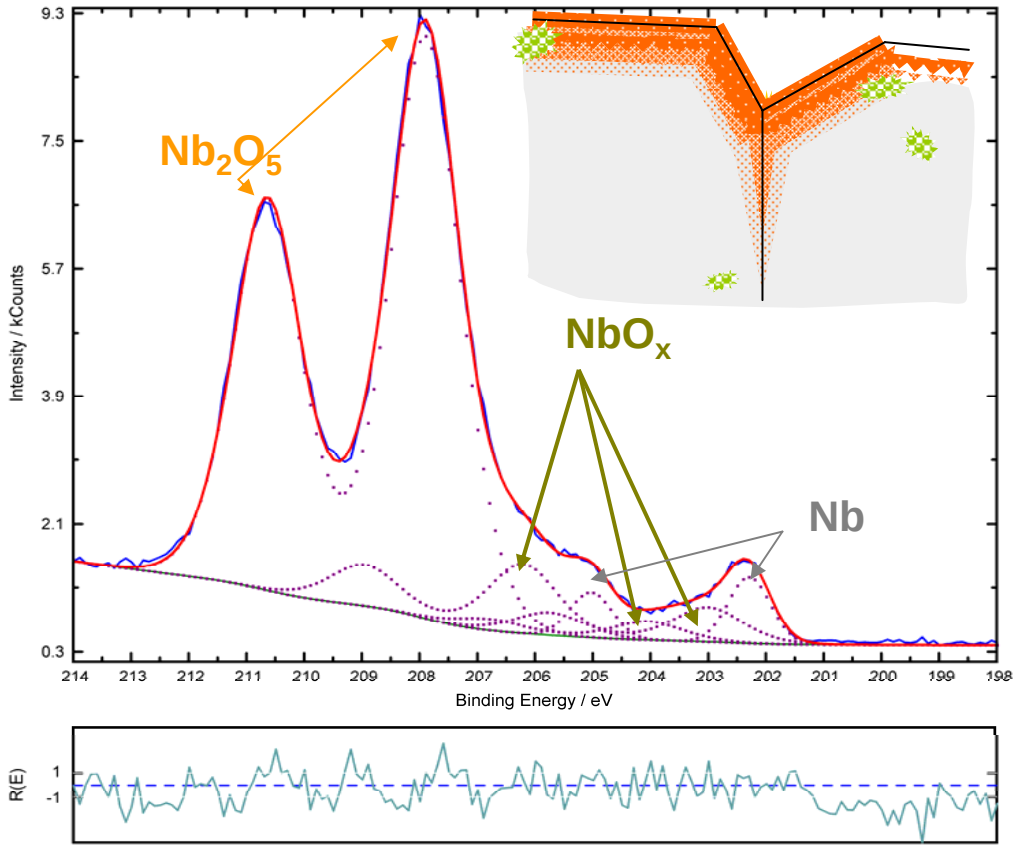
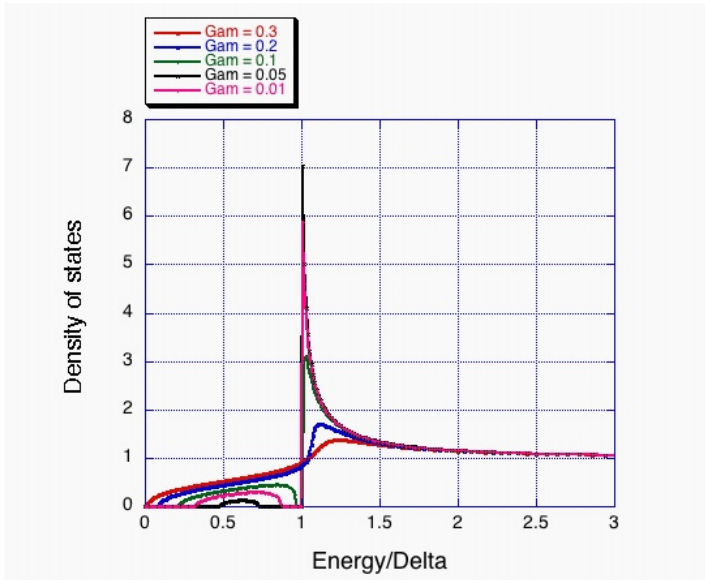
ANL-LDRD

# XPS a Surface Probe of Nb Oxidation

**Dielectric $Nb_2O_5$**
**$Nb_2O_{5-\delta}$, $NbO_{2-\delta}$ are magnetic**
**$NbO_x$ (0.2 < x < 2),metallic**
**$NbO_x$ precipitates (0.02 < x < 0.2)**

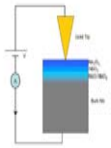



Scattering off magnetic interfaces or precipitates gives rise to Shiba states inside the gap. These cause dissipation (lowering Q).

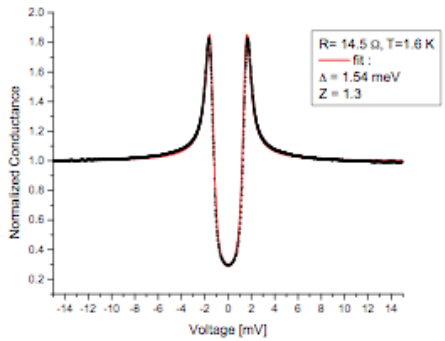
Nb samples supplied by FNAL!

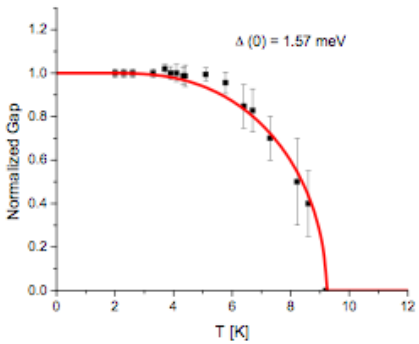
# Point Contact Tunneling – direct measure of surface superconducting properties



**Magnetic impurities must be in the oxide layer!**

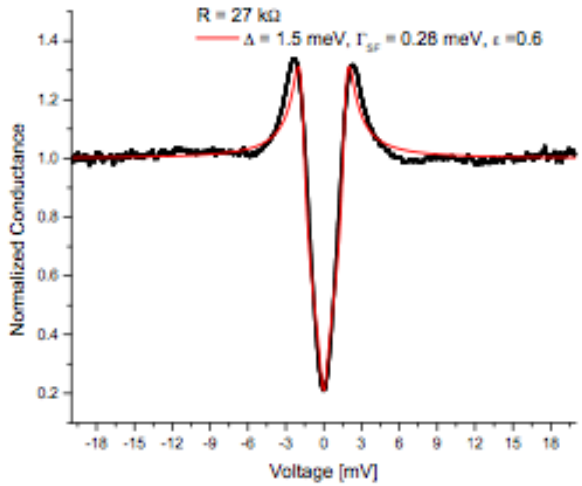
## Nb "Metal" PCT



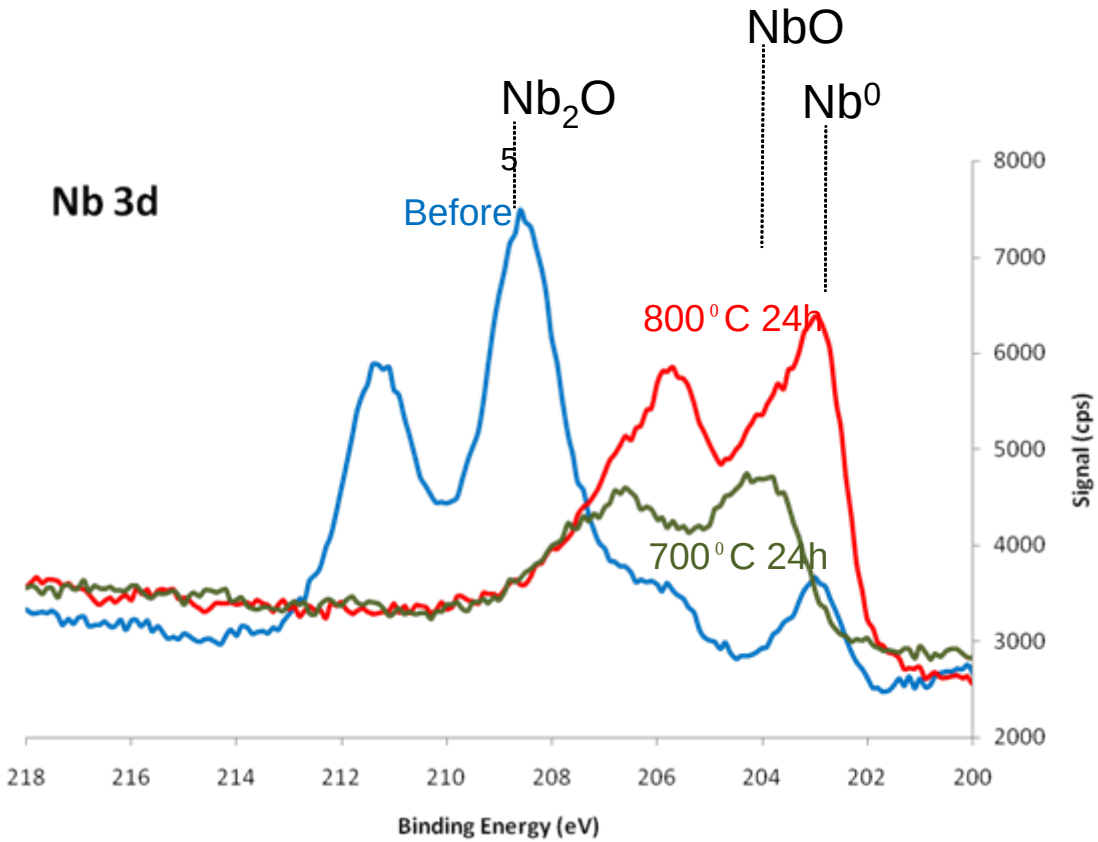

**Low Resistance Point Contacts on Nb**
Tip Perforates Oxide layers, data can be fit without magnetic scattering.

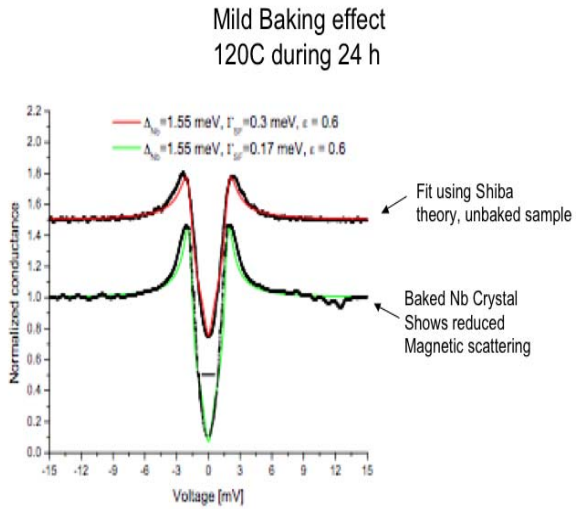
## Nb Oxide PCT




**Ohmic Point Contacts on Nb**
Electrons tunnel through the oxide layers, data can only be explained with magnetic scattering.

# Alumina barrier layer coating -




Baking can be used (following an alumina overcoat ) to reduce magnetic scatter) (Green fit vs. red fit)

Nb 3d spectra show reduction of oxide with protective ALD coating + heat treatment

# Conclusions

- Magnetic Oxides are present and lossy!
- Current cavity post process bake reduces Oxygen Vacancies removing magnetic oxides.
- Preprocess H bake may set up  the strain inducing the vacancies.
- ALD alumina capping allows control of oxidation layers with baking.

- Cavity Coating is proceeding.
  - Have a J Lab Cavity (Fermi by December 15)
  - Clean Room Procedures have been established (thanks M. Kelly)
  - ALD Machine design complete.