Niobium for SRF

All Experimenters Meeting

02/13/2006

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Issues in SRF

![Graph showing quality factor vs. peak magnetic field]

- CEA C1-03 1.44 K before bake
- DESY AC70 2 K after baking
- Cornell-KEK 2 K re-entrant - world-record

Peak magnetic field (relative to 200 mT)
Niobium in strong RF fields

- Thermal activation of normal electrons above the gap in the energy spectrum - Boltzmann factor - scattering mechanisms and normal state conductivity gives rise to surface resistance (although 6 orders smaller than Cu) - so called BCS resistance;

- Magnetic-field – does penetrate Niobium in the form of so called vortices at fields between $H_{c1}$ and $H_{ctherm}$ (in DC condition – what about RF?). Few penetrated vortices can cause quench!

- Huge currents are flowing within a layer of thickness $\lambda$ (~40 nm) - ~ 3MA/mm². Main parameters that need to be understood: width of gap, first critical field, normal state resistivity in first 40 nm!

A. Gurevich (UW)
Related activities at Fnal&Co

- Measurements of the material purity:
  - Eddy current (Fnal – DESY)
  - RRR (Fnal)
  - Chemical analysis (Fnal, JLab, NU)

- Mechanical and Thermal Properties (at MSU)
  - Stress-strain, texture
  - Thermal cond. & Kapitza conductance

- Superconducting Properties (at UW)
  - Magnetization
  - Magneto-Optics
  - Transport
Eddy current scanning

Eddy Current Scanning:
- detect surface imperfections and sub-surface defects,

Figure: examples of calibration disc measurement and optical measurement of pit
3D atomic probe at NU

Nanochemistry of first 50 nm and grain boundaries! ppm resolution!

K. Yoon, D. Seidman (NU)

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Magneto optics at UW

vortex penetration study in bi-crystal samples using magneto-optical measurements – weaker superconductivity in grain boundary?

A. Polyanskii, P. Lee (UW)
Processing R&D at FNAL

A balloon is inflated in the cavity to direct the acid flow toward the equator.

Temperature maps in 3 cells cavities during BCP

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P. Bauer
Processing R&D at Fnal

Studies of EP in small samples to understand the process

![Diagram of EP process](image1)

![Graph of V-I Characteristic EP](image2)

![Images of EP and BCP](image3)

P. Bauer
Summary

• Our understanding of the material is challenged once again as the performance of cavities nears the theoretical limit!
• Understanding required at all scales (nano-micro and macro) – an interdisciplinary approach is needed;
• We have put together a group with participants from academia and National Labs to address this issue!
THANK YOU