Low energy muon spin rotation (LE-μSR)

LE-μSR enables the measurement of the magnetic field inside a sample as a function of depth (Fig. 1). An external magnetic field with a value below H_{c1} can be applied to probe the London penetration depth of a superconductor. If no external magnetic field is applied, LE-μSR can be used as a local probe for surface magnetism (Fig. 2).

Point Contact Tunneling (PCT)

PCT can be used to measure the density of states (DOS) of superconductors. Our Nb/Cu samples show broadened DOS, a finite zero bias conductance, areas with zero bias conductance peaks and areas with low energy gap values (Fig. 3). These findings are consistent with inelastic quasiparticle scattering of a magnetic impurities. Areas of low energy gap values will create hot spots and a field dependent surface resistance/Q-slope (Fig. 4).

Conclusion

It has been shown how sub gap values as measured with PCT can have a direct influence on the Q-slope of superconducting cavities by creating hot spots. For bulk niobium it has been shown that sub gaps states can be suppressed by high temperature baking [P. Dhakal et al. PRSTAB, 16:042001, 2013]. For Nb/Cu cavities such a treatment is not possible due to the lower melting temperature of copper. The origin of the Q-slope of Nb/Cu might be related to magnetic nanoparticles in the oxide layer and possibly between grain boundaries. It is known from literature that magnetic impurities can severely decrease the energy gap of superconductors [Reif et al. Phys. Rev. Lett., 41:1509, 1978]. If there is a defect with suppressed gap value as a function of applied magnetic field. The model is inspired by the model for thermal breakdown from Padamsee et al. [RF superconductivity for accelerators. Wiley, Weinheim, 2. edition, 2008] (see Fig. 5). It assumes a defect with a suppressed gap value of radius a. From the heat flow the surface resistance from the area around the defect is calculated by solving the equations displayed above numerically.

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