Vortex Q Calculation

Critical Temperature

$$T_c = 8\,K$$

Gap Energy

$$\Delta = 1.75 K_b T_c \sqrt{(1 - \frac{T}{T_c})}$$

Fermi Velocity

$$v_{\text{fermi}} = 1.76 \times 10^6$$

Coherence Length

$$\eta = \frac{\eta_0}{\sqrt{1 - \frac{T}{T_C}}}$$

$$\eta_0 = 39\,nm$$

London Penetration depth

$$\lambda = \frac{\lambda_0}{\sqrt{1 - (\frac{T}{T_c})^4}}$$

$$\lambda_0 = 47\,nm$$

Critical Field (T)

$$B_c = 1.5$$

Critical Current Density

$$J_c = \frac{cB_c}{4\pi\lambda}$$

Critical Current

$$I_c = J_c A$$

Normal state resistivity @ 9.6K (Ohm-m)

$$\rho_n = 81.9 \times 10^{-12}$$

Vortex Viscosity

$$\nu_v = \frac{\Phi_0^2}{2\pi\eta\rho_n}$$

Max Lorentz alpha

$$\alpha = J_c B_{app}$$

Pinning potential "Spring" constant

$$k_p = \frac{2\pi\alpha\sqrt{\Phi_0}}{c\sqrt{B_{app}}}$$

Depinning Frequency

$$f_D = \frac{k_p}{2\pi\nu_v}$$

Threshold Field

$$B_t = \frac{2\Phi_0 \ln(\frac{2w}{\pi\eta})}{\pi w^2}$$

Flux Creep Strength

$$\epsilon = 1$$

Complex Resistivity of Vortex

$$\rho_v = \frac{\Phi_0(B_{app} - B_t)}{\nu_v} \left(\frac{\epsilon + i\frac{f}{f_D}}{1 + i\frac{f}{f_D}} \right)$$

Reduced Critical Current density

$$j_0 = \frac{J(x)^2}{< J(x) >^2}$$

J(x) was calculated with the closed form equations provided by Van Duzer for the limiting case of the thickness comparable to the penetration depth and the width, w ¿¿ λ

$$J_{middle}(x) = J(0)(1 - (\frac{2x}{w})^2)^{-1/2}$$

$$J_{edge}(x) = J(\frac{1}{2}w)exp[-(1/2w - |x|)\frac{t}{\lambda^2}]$$

$$J(\frac{1}{2}w) = \frac{1.165}{\lambda}\sqrt{wt}J(0)$$

J(0) was normalized to 1 because it will drop in the calculation of j_0

vortice resistance

$$R_v = j_0 \mathrm{Re}[\rho_v] \frac{l}{wt}$$

Inductance per unit length

$$\mathcal{L} = 3 \times 10^-7$$

Vortex Q

$$Q_v = \frac{R_v}{l 2\pi f \mathcal{L}}$$