Critical Currents and the Peak Effect in YBCO

J.W. FARMER, D.L. COWAN, M. KORNECKI, University of Missouri-Columbia — We have studied the peak effect (PE, a maximum in j(B)) through creep and hysteresis measurements in single crystals of YBCO, variously grown, doped, and in two cases neutron irradiated. Three sets of crystals show clear signs of cooperative fluxoid pinning by many weak defects, and all crystals from these sets exhibit a pronounced PE near 0.7 T_c. The other three sets of crystals, including the irradiated ones, are all strongly pinned at low T, and do not exhibit a PE. Low T pinning data alone suffice to predict the PE. We believe the PE is a consequence of thermally driven fluctuations in the fluxoid lattice, averaging and weakening the pinning potential. FFH[1] and others have shown the mean square displacement of a fluxoid is given by $W \propto T\lambda^2(T)/B^{1/2}$ where $\lambda$ is the magnetic screening length. We test the hypothesis by comparing $dj/dB$ and $dj/dT$ in the region where $j$ rises toward a peak, using the relation $\lambda^2 = \lambda^2_{GL} = \lambda^2_o/(1-T/T_c)$. The agreement is very good below $B_p$, the value of B where $j$ crests. A Lindemann-type melting model provides a good description of the peak field $B_p(T)$.\[pard]D.S. Fisher, M.P.A. Fisher, and D.A. Huse, Phys Rev B 43, 130 (1991).