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Superconducting and Magnetic Properties of Intermetallic YNi_2B_2C Single Crystal

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Complementary magnetization and heat capacity studies were conducted on a single crystal of YNi_2B_2C superconductor. The 17 mg crystal was studied at temperatures T from above T_c (15 K) to 2~3 K, in magnetic fields $H \parallel c$-axis from zero to $H > H_{c2}$, the upper critical field. The material exhibited little magnetic irreversibility, with a critical current density $\sim 10^{-4} \times J_o$, the depairing current density, enabling an analysis of its equilibrium properties: the thermodynamic critical field $H_c(T)$, $H_{c2}(T)$, and the magnetization $M(H,T)$ in both the normal and superconductive states. Magnetization studies revealed significant effects of nonlocality in a single crystal of YNi_2B_2C superconductor. Near T_c, the equilibrium magnetization M was London-like with $M \propto \ln(H)$. Well below T_c, however, M deviated from this simple local form and followed accurately the more general nonlocality relation of Kogan et al. [Phys. Rev, B 54, 12386 (1996)]. The nonlocal analysis yielded reasonable values for the nonlocality radius ρ and London penetration depth λ. The deduced values of the Ginzburg-Landau parameters κ_1 and κ_2 increased considerably as T decreased. This was consistent with the material's long electronic mean free path and the observation of nonlocal electro dynamics. In the framework of heat capacity and magnetization analyses, we obtained the thermodynamic critical field H_c from both heat capacity and magnetization data. The heat capacity data deviated from predictions for both weak- and strong-coupling superconductivity, but were described relatively well in a medium-coupling analysis. The precise t^3-dependence of the electronic heat capacity C_{es} has indicated the gap anisotropy with the presence of point nodes for YNi_2B_2C single crystal. These and other results will be presented.

keywords : YNi_2B_2C superconductor, magnetization, heat capacity, nonlocality, medium-coupling