Anomalous Metallic State and Anisotropic Multiband Superconductivity in $Nb_3Pd_{0.7}Se_7$

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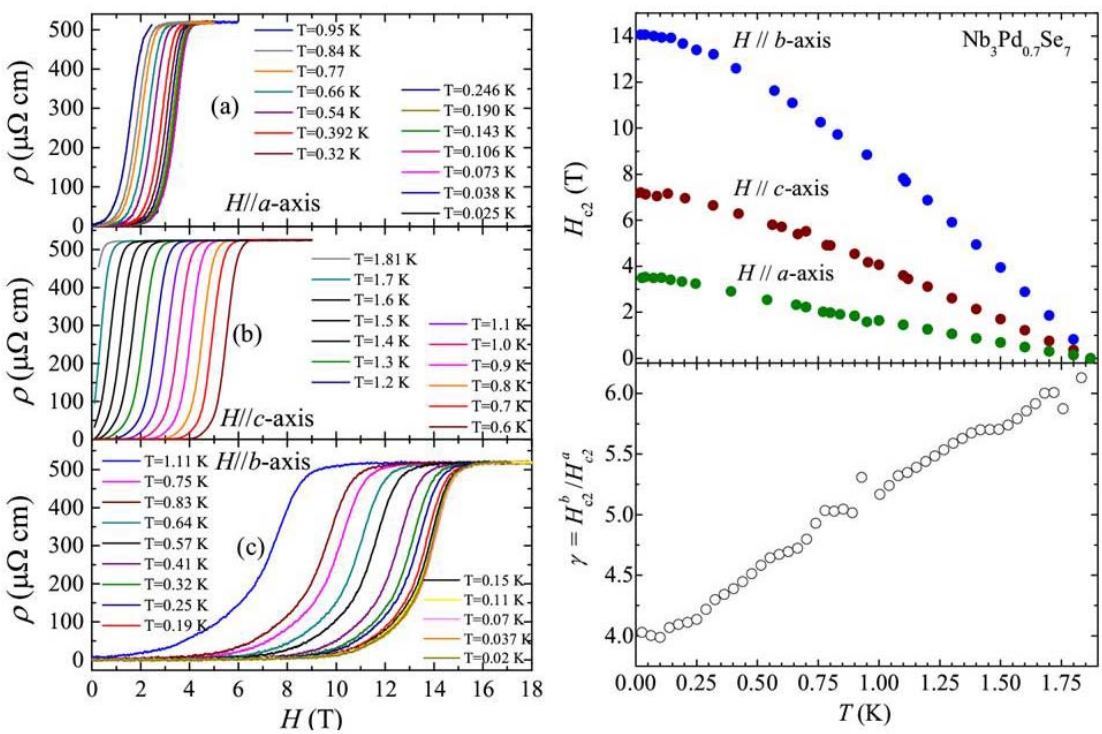
Introduction

We report the discovery of superconductivity in $Nb_3Pd_xSe_7$ with an x-dependent superconducting transition temperature as high as $T_c \cong 2.1$ K for $x \cong 0.7$ (middle point of the resistive transition). Needlelike single crystals display anisotropic upper-critical fields with an anisotropy $\gamma = H^b_{c2}/H^a_{c2}$ as large as 6 between fields applied along their needle axis (or b axis) or along the a axis. As for the Fe based superconductors γ is temperature-dependent, suggesting that $Nb_3Pd_{0.7}Se_7$ is a multiband superconductor. This is supported by band structure calculations which reveal a Fermi surface composed of quasi-one-dimensional and quasi-two-dimensional sheets of hole character, as well as three-dimensional sheets of both hole and electron character. Remarkably, H^b_{c2} is observed to saturate at $H^b_{c2}(T \rightarrow 0\ \text{K}) \sim 14.1$ T which is $4.26 \times Hp$ where Hp is the Pauli-limiting field in the weak-coupling regime.

Experimental

We used both SCM2 and SCM1 to draw the superconducting phase diagram of $Nb_3Pd_{0.7}Se_7$



Left panel: (a) Resistivity ρ as a function of the field H applied along the a axis of a $Nb_3Pd_{0.7}Se_7$ single crystal for several temperatures. (b) Same as in (a) but for fields along the c axis and at pumped ^{3}He temperatures. (c) Same as in (a) but for fields along the b axis. Right upper panel: phase boundary between superconducting and metallic states in the temperature (T)–magnetic field (H) plane for $Nb_3Pd_{0.7}Se_7$. Blue markers depict the phase boundary for fields applied along the needle, or the b axis of the crystal. Brown and green markers depict the phase boundary for fields applied along the c axis and the a axis, respectively. Lower panel: anisotropy in upper-critical fields $\gamma = H^b_{c2}/H^a_{c2}$ as a function of temperature. Notice that γ is temperature dependent as previously observed in multiband superconductors

Conclusions

An anomalous metallic state, low-dimensionality, multiband character, extremely high and anisotropic H_{c2}'s are all ingredients for unconventional superconductivity.

Acknowledgements

This work is supported L.B. is supported by DOE-BES through award DE-SC0002613.