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Stoichiometry Dependent Anisotropic Multiband Superconductivity in Single Crystal $Nb_2Pd_xSe_5$

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Introduction

Anisotropic superconducting phases are found in Nb-Pd-Se systems. $Nb_2Pd_xSe_5$ and $Nb_3Pd_xSe_7$ display large upper critical fields H_{c2} that far exceed the Pauli limit ($H_{c2}/T_c < 1.85$ T/K) [1,2]. The largest H_{c2}/T_c ratios reported in these families exceed the Pauli limit by a factor of approximately 4.

In the $Nb_2Pd_xSe_5$ system, only a small range of Pd stoichiometries were previously accessible: x=0.67..0.74 in single crystals. We have succeeded in growing high quality single crystals over a broader range of palladium stoichiometries expending the range to x=0.67..0.95 and show the anisotropic superconducting field dependence up to 18T here.

Experimental

High quality $Nb_2Pd_xSe_5$ single crystals of various Pd stoichiometries were selected for using X-ray diffraction. Platinum or gold leads were attached to the samples in 4-probe geometry by silver paint. The samples were then mounted flush with the platform of the rotating probe in DC Field SCM 2. Field sweeps were carried out in two crystallographic orientations for a range of temperatures below the superconducting transition.

Results and Discussion

We clearly see a change in the superconducting properties for samples of different palladium stoichiometry in this system. Fig 1 below shows the saturation field for $Nb_2Pd_{0.81}Se_5$, $Nb_2Pd_{0.86}Se_5$, and $Nb_2Pd_{0.89}Se_5$ aligned with the crystallographic b axis parallel with the applied field. Saturation fields were determined using the 50% transition practice. The highest H_{c2} values were observed in this orientation with the b axis parallel with field. The lowest H_{c2} values for this system are shown in Fig 2 below, where the field is perpendicular to the [-2 0 1] crystallographic face.

Conclusions

We see clear differences among the samples with different palladium content in terms of transition fields and temperatures. Higher fields will be used in future experiments to gain a better understanding of the phase diagram for the superconducting samples with the higher H_{c2} behavior.

Acknowledgements

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References

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[2] Q. R. Zhang, *et al.* Phys. Rev. B 88(2), 024508 (2013).

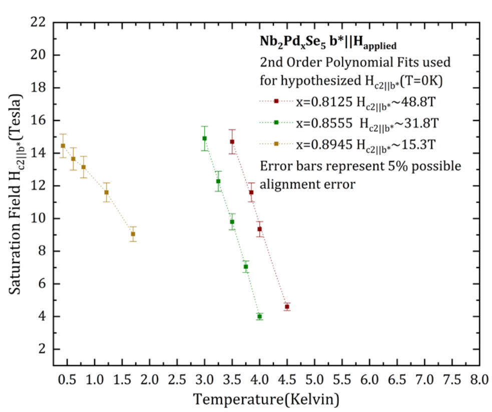

Fig.1 Field applied along crystallographic b axis where the highest H_{c2} values are observed.

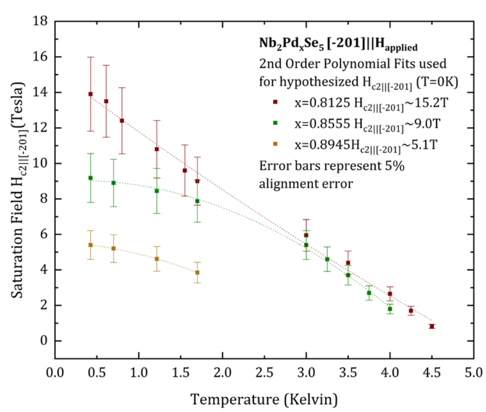

Fig.2 Field applied perpendicular to the b axis where the lowest H_{c2} values are observed.