UPPER CRITICAL FIELD OF HIGH-FIELD INTERMETALLIC SUPERCONDUCTORS

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Introduction

For use in superconducting magnet applications, both MgB_2 and Nb_3Sn require high upper critical field (H_{c2}). In these experiments we used the NHMFL facilities to characterize the H_{c2} of several alloyed bulk MgB_2 and Nb_3Sn samples.

Experimental

Bulk needles of binary Nb_3Sn, binary MgB_2, and doped MgB_2 were characterized resistively using a variable temperature, four-point resistivity technique. Details of the experimental apparatus may be found in [1]. Measurements were performed in a 33 T resistive magnet at the National High Magnetic Field Laboratory in Tallahassee, FL. Additionally, H_{c2} of similar binary and doped MgB_2 samples were measured in the 60T pulsed magnet in Los Alamos, NM in order to make use of the 33-40T field range.

Results and Discussion

Experiment 1 – Carbon doped MgB_2 samples of composition $Mg(B_{1-X}C_X)_2$ were produced by mechanical alloying of MgB_2 powder. The upper critical field as a function of carbon content is presented in figure 1. We determined that for our fabrication method, the maximum H_{c2} in this system can be achieved with X~0.05. We are currently preparing this work for publication.

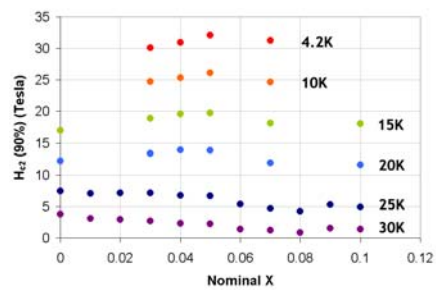

Figure 1. H_{c2} as a function of carbon content in bulk MgB_2.

Experiment 2 – We discovered that we could improve H_{c2} in MgB_2 through the addition of a transition metal, the identity of which we will disclose when our paper is submitted. For the purposes of this report we refer to it as XB_2. The benefit of doping with XB_2 over ZrB_2 and the undoped case are clear. We are currently preparing this work for publication.

Experiment 4 – The H_{c2} of ball-milled Nb_3Sn was measured at temperatures down to 1.5 K. At 1.5 K, we measured transitions up to H_{c2} = 30.0 T, the highest experimentally measured H_{c2} ever achieved in Nb_3Sn.

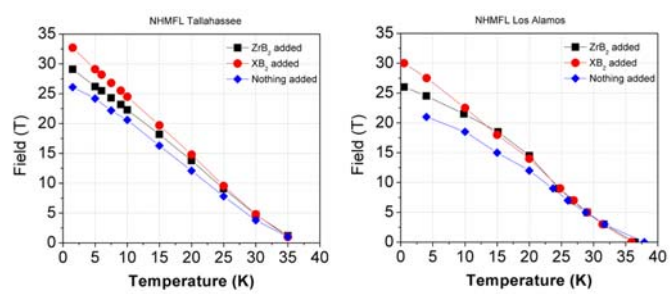

Figure 2. H_{c2} as a function of temperature and doping in bulk MgB_2.

Conclusions

Three separate experiments to measure the upper critical field of bulk Nb_3Sn and MgB_2 were performed. Record H_{c2} values were achieved for bulk Nb_3Sn. For MgB_2 the new dopant XB_2 was found to be nearly as effective as carbon in increasing H_{c2}. Additionally, the effects of carbon addition to pre-reacted MgB_2 were elucidated.

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References

[1] Godeke, A., *et al.*, *Superconductor Science and Technology*, **16**, 1019 – 1025 (2003).