Influence of Stoichiometry (Mg level) on B_{irr} and B_{c2} in MgB_2

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Introduction

A significant increase in the high field J_c of MgB_2 strands can been seen with excess Mg doping. This increase is heavily dependent upon Mg and B powder type, since for some B types best transport properties are seen for Mg lean compositions. For our samples with amorphous B, the best properties are seen for 15% excess Mg [1]. It has been postulated that Mg may most likely be increasing J_c either through increased grain boundary connectivity (reduction of oxides), or by increasing B_{c2}. In the present work, we directly measure B_{c2}, and show that a significant peak in B_{irr} and B_{c2} around 15% excess Mg, suggesting the increase in high field J_c is mostly due to B_{c2} enhancements.

Experimental

Monofilamentary PIT MgB_2 strands were fabricated with various amounts of Mg. All strands were heated in flowing Ar at 700C for 40 min. Four-point transport measurements were made on 1 cm long samples at the National High Magnetic Field Laboratory in Tallahassee at 4.2K to 20K in a 33 T resistive magnet. The samples were placed perpendicular to the applied field, values of $\mu_0 H_{irr}$ and $\mu_o H_{c2}$ being obtained taking the 10% and 90% transition points.

Results and Discussion

Resistivity was measured as a function of B for a series of strands as described above. B_{irr} and B_{c2} values were extracted as the 10% and 90% points of the transition, and the results are plotted in Figure 1. Here we see a significant peak in the critical fields at 15% excess Mg, and a relatively flat response elsewhere. These measurements were taken at 4.2 K.

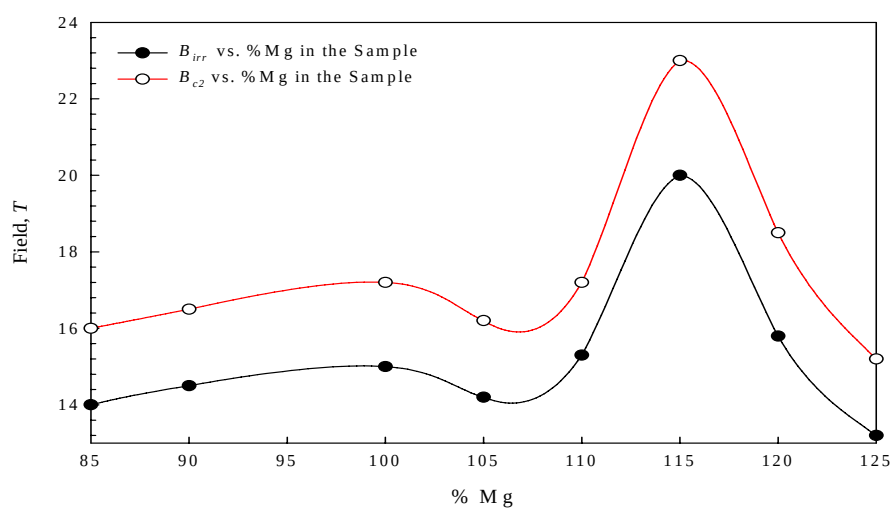

Figure 1. Influence of Mg level on B_{irr} and B_{c2} in MgB_2.

Conclusions

A significant increase in both B_{irr} and B_{c2} is seen in MgB_2 with excess Mg levels of about 15%. This increase is about 5-6 T, roughly a 30% effect, and is in the form of a peak localized at 15%, Mg levels above and below this are similar to no Mg addition. This suggests that some if not most of the increase in high field Jc seen with excess Mg [1] is due to increases in B_{irr} and B_{c2}, although the origin of the increase is not clear, possibly due to Mg-related defects, or the replacement of Mg loss during processing.

Acknowledgements

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References

[1] M.A. Susner, M.D. Sumption, M. Bhatia, X. Peng, M.J. Tomsic, M.A. Rindfleisch, and E.W. Collings, Physica C 456 180-187 (2007).