Enhanced Connectivity and Percolation in Binary and Doped in-situ MgB_2 Wires after Cold High Pressure Densification

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Abstract - The cold high pressure densification technique (CHPD) was recently developed in Geneva for improving the infield critical current density J_c of in situ binary and alloyed MgB_2 wires and tapes [1, 2]. J_c of CHPD treated square wires alloyed with malic acid ($C_4H_6O_5$) was enhanced by a factor 2 at 10 T and 4.2 K, the behavior being almost isotropic. In order to understand the fundamental mechanism behind this strong improvement of J_c, the properties of binary and alloyed MgB_2 wires have been investigated before and after CHPD, using resistivity and specific heat measurements in the temperature range between 5 and 35 K at magnetic fields up to 15 T. In particular, a deconvolution of the specific heat data was used to determine the distribution of T_c in the samples.

We have found that the effect of the densification process on the electrical and transport properties is related to the improved grain connectivity and percolation. By combining the results arising from the analysis of the T_c distribution and those from resistivity measurements, it follows that the minimum superconducting volume fraction needed for the percolation of a superconducting path is strongly reduced in samples treated by CHPD.

Index Terms - MgB_2, cold densification, connectivity, percolation, specific heat, T_c distribution.

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