Effect of Ball-Milling on the Superconducting Properties of MgB_2 Doped with C and C-Based Compound

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Magnesium diboride (MgB_2) is an attractive superconducting material for its potential applications in the temperature range 20±30K. However, the critical current density (J_c) drops rapidly with increasing magnetic field strength. To minimize this problem, several methods have been employed such as the introduction of structural defects, grain refinement and doping with exotic materials (e.g. SiC or C). High energy ball-milling is an effective method both to introduce lattice defects and to refine grain size. In the present, we have examined the effect of ball-milling on the superconducting properties of MgB_2 doped with C. The doping was carried out by dry or wet ball-milling of C or diethylenetriamine ($C_4H_{13}N_3$) with MgB_2 powder. The latter compound (diethylenetriamine) whose chemical formula contains no oxygen was chosen to avoid an excess oxidation during doping. Furthermore, the compound is not toxic and relatively inexpensive. The ball-milled and doped MgB_2 powders were die-compacted and heat-treated at various temperatures in a Ar atmosphere. The superconducting transition temperature (T_c) of the doped MgB_2 was only slightly smaller than that of undoped MgB_2 (37.1 K). The critical current density (J_c) of the doped MgB_2 was much higher than that of undoped MgB_2. The J_c enhancement was more pronounced at higher magnetic fields. The observed J_c improvement is attributed to a combined effect of C-doping and high-energy ball-milling.

Keywords : MgB_2 superconductor, Carbon doping, Ball milling