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热中子辐照提高YBCO和GdBCO超导材料J_c的研究

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摘要 利用重水反应堆水平孔道热中子对熔融织构生长(Melt-Textured Growth)的YBa_2Cu_3O_(7-y)和GdBa_2Cu_3O_(7-y)超导材料进行辐照研究。前者共8个样品,热中子注量为3.7×10~(11)-1.4×10~(17)cm~(-2);后者共6个样品热中子注量为5.2 ×10~(13)-4.7×10~(16)cm~(-2)。样品辐照前后,用移动样品磁强计测量其磁滞回线并推算出临界电流密度进行比较。YBCO结果表明,当热中子注量大于10~(17)cm~(-2)时,J_c可增加一倍以上。GdBCO样品也有明显增加。在上述热中子注量范围内,J_c值增量随辐照注量增加而增加,并且高场时增加值比低场时更大。这可能是由于随着辐照注量增加,缺陷增多,钉扎中心密度增加,两钉扎中心的相对距离减小。这更有利于高场下的钉扎作用。

关键词 热中子辐照 超导材料 临界电流密度J_0 熔融织构生长 钉扎中心

分类号

THE STUDY ON ENHANCING THE CRITICAL CURRENT DENSITY J_c OF THE MTG YBCO AND GdBCO SUPERCONDUCTORS BY THERMAL NEUTRON IRRADIATION

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Abstract It is proved that the neutron irradiation on the high T_c superconductors is one of the most ef-fective methods to increase their critical current. In the paper, the effect of the thermal neutronirradiation on critical current density J_c of Melt-Textured Growth (MTG) YBa_2Cu_3O_(7-y) andGdBa_2Cu_3O_(7-y) superconductors are studied systematically within a horizontal beam hole of theHeavy Water Research Reactor(HWRR). Neutron irradiation experiments include eight samples of YBCO with thermal neutron fluences from 3.7×10~(11) to 1.4×10~(17)cm~(-2) and six samples ofGdBCO with thermal neutron fluences from 5.2×10~(13) to 4.7×10~(17)cm~(-2). For all MTG supercon-ductive samples, the critical current density J_c, which are determined by the hysteresis loops mea-sured by a moving sample magnetometer, are compared before and after irradiation. The results ofYBCO show that the J_c values of irradiated samples with thermal neutron fluence of 10~(17)cm~(-2) aretwice as high as that of unirradiated samples, and the results of GdBCO also show that the J_c val-ue are enhanced significantly. It is found that the increments of the J_c of irradiated samples are in-creasing with the augmentation of the thermal neutron fluence and the increment of the J_c in high-er magnetic field is larger than that in lower magnetic field. This phenomenon seems to be ex-plained as follows. With the augmentation of the thermal neutron fluence, the increase of thecrystal defects as flux pinning centers is increasing, namely the density of flux pinning centers isincreasing and the distance between pinning centers is shortened, so as to be advantageous to thepinning function at higher magnetic field.

Key words Thermal neutron irradiation Superconductive materials Critical current density J_c Melt-textured growth Pinning centers

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