11th International Conference on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

$CaCO_3$ addition effects on the MgB_2 superconducting properties

German D. Serrano, Germán Bridoux, Adriana Serquis*

Centro Atómico Bariloche- Instituto Balseiro - CONICET, S. C. de Bariloche, Argentina,
* Corresponding author. e-mail: aserquis@cab.cnea.gov.ar

Abstract – We present a study of the effect of $CaCO_3$ additions in the microstructure, critical current density and upper critical field of MgB_2 bulk superconducting samples. The aim of the work is to study a possible counterbalance effect due to the simultaneous hole and electron doping, and to identify the possible formation of ideal nanoscale defects to optimize the critical current density under different applied field regimes.

Since the discovery of superconductivity at 39 K[1] in MgB_2, considerable progress has been made in the understanding of the fundamental properties of this material. MgB_2 appears to be a suitable candidate for superconducting technologies currently based on Nb-alloys wires to produce large magnetic fields. However, to make practical devices using MgB_2, it is essential to optimize simultaneously the critical current density J_c and critical magnetic field (H_{c2}). This can be achieved by an improvement in grain connectivity [2] but also to the addition of suitable defect nanoparticles or doping, i.e. $Mg(B_{1-x}O_x)_2$ [3], SiC [4-6], Al [7], and carbon nanotubes (CNT) [8–11]. It is also well known that C doping (or the addition of C-compounds) also improves H_{c2} due to the effect on the interband scattering coefficients of this two-gap superconductor [11-12].

The study of a counterbalance effect due to the simultaneous hole and electron doping is still very atttactive in this material. In the present work it is described the preparation of the MgB_2 samples with 0, 1 and 5%at $CaCO_3$ additions, that may contribute with C and Ca, to replace B or Mg in the crystalline structure of the matrix, plus the formation of other precipitates, depending on the synthesis temperature. Microstructural characterizations through SEM and XRD, were used to determine the possible distribution and composition of the obtained samples. Magnetization was used to determine J_c while transport measurements were used for critical field determination. For samples treated at 900 C, it is interesting that T_c is barely diminished by $CaCO_3$ additions (see Figure 1) but J_c was improved in high magnetic fields due to an increase in H_{c2} (see Figure 2).

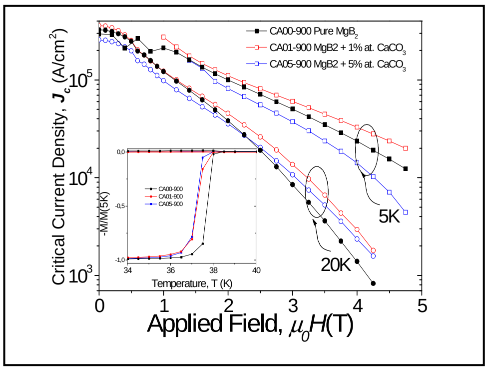

Figure 1: *Jc* field dependence determined by magnetization at two temperatures. The inset shows the critical temperature of same samples.

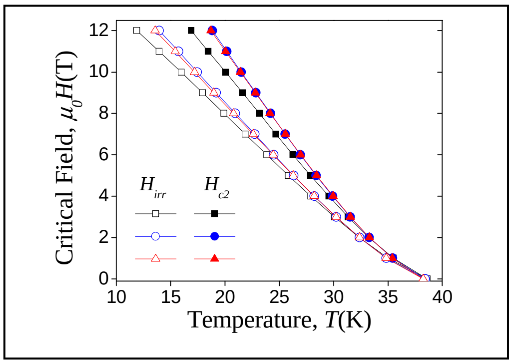

Figure 2: Transport measurements of the upper critical field (H_{c2}, solid symbols) and the beginning of the dissipation (H_{irr}, open symbols)

Financial support acknolowgement: UNCuyo and ANPCyT.

References

[1] C. Buzea and T. Yamashita, Supercond. Sci. Technol. 14, R115 (2002).
[2] D. Rodrigues Jr. et al, Adv. Cryog. Eng. 54, 359 (2008).
[3] X. Z. Liao et al, J. Appl. Phys. 93, 6208 (2003).
[4] S. X. Dou et al, Appl. Phys. Lett. 81, 3419 (2002).
[5] S. H. Zhou et al, Physica C 387, 321 (2003).
[6] A. Serquis et al, Supercond. Sci. Technol. 20, L12 (2007).
[7] A. Berenov et al, Supercond. Sci. Technol. 17, 1093 (2004).
[8] S. X. Dou, Appl. Phys. Lett. 83, 4996 (2003).
[9] W. K. Yeoh et al, IEEE Trans. Appl. Supercond. 15, 3284 (2005).
[10] W. K. Yeoh et al,Supercond. Sci. Technol. 19, L5 (2006).
[11] G. Serrano et al,.J. Appl. Phys. 103, 023907 (2008).
[12] A. Gurevich, Phys. Rev. B 67, 184515 (2003).