Effect of nano-SiC doping on the structure and superconducting properties of Mg $(B_{1-x}C_x)_2$

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Since its discovery, MgB_2 is presented as a candidate to replace conventional superconductors in several applications such as SMES and Magnetic Resonators. This possibility is based on its critical temperature (T_c), its low cost, and the possibility of forming cables by the "Powder In Tube" (PIT) method. Considerable research has been carried out to optimize the material and the cable conformation [1]. It was determined that the superconducting properties can be improved by inducing changes in the microstructure, with different synthesis methods [2], and/or the crystalline structure, by doping [3]. In this work, two different samples were prepared and characterized to find convenient methods to improve the material and the cables superconducting properties without increasing the cost.

The Mg $(B_{1-x}C_x)_2$ samples were prepared starting from Mg and C-doped nano-B powders, with and without the addition of nano-SiC. The compounds were mixed in an agate ball mill inside a glove box. Then, they were compacted into pellets and sintered in a tube furnace with a circulating controlled Argon atmosphere. The samples were heat treated at two temperatures, 700ºC and 900ºC, for different periods. The specimens were characterized by X-ray diffraction (XRD), transmission electron microscopy (TEM) (Fig. 1), and SQUID magnetometry. XRD data were refined by the Rietveld method with FullProf [4] as can be seen in Fig. 2. Finally, 700ºC in-situ syntheses were performed on a nano-SiC doped sample at the P61A line in DESY, to study the reaction development.

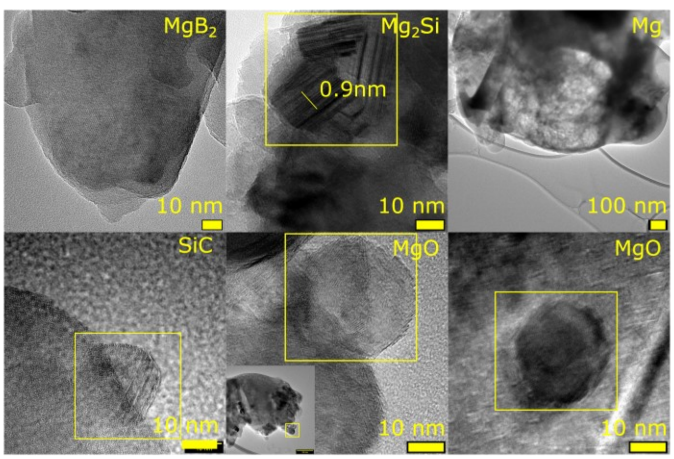

Figure 1. TEM images of compounds present in the sintered material.

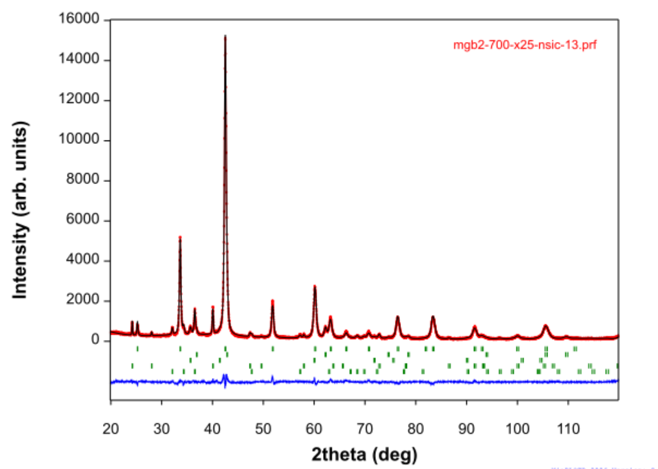

Figure 2.XRD refined data.

With these techniques, we were able to determine the lattice parameters, the existing phase percentages, the grain sizes, the stress state, and the T_c. These data together allow for a better understanding of the synthesis parameters and the effect of doping on the phase formation as a way to improve the superconducting properties of the material.

[1] Buzea, C. Yamashita, T., (2001). *Supercond. Sci. Technol.*, vol. 14, no. 11, p. R115, 2001.

[2] Silva, L. B. S. Da, Serquis, A., Hellstrom, E. E., & Rodrigues, D. (2020). Superconductor Science and Technology, 33(4), 45013.

[3] Serrano, G., Serquis, A., Dou, S. X., Soltanian, S., Civale, L., Maiorov, B., Holesinger, T. G., Balakirev, F., Jaime, M. (2008). *J. Appl. Phys.*, vol. 103, no. 2, pp. 1–5, 2008.

[4] J. Rodriguez-Carvajal (1990). Abstracts of the Satellite Meeting on Powder Diffraction of the XV Congress of the IUCr, p. 127.

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