

Structural and Thermal properties of MgB₂

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Abstract – The easy processing of the MgB₂, the relatively low cost of the precursor material as well as the discovery of its superconductivity properties have stimulated a number of scientific and technological works since year 2001. However, systematic studies on the processing of this material are still needed in order to collect knowledge to improve the quality of the final product, which in general presents high porosity in prejudice of its mechanical and superconducting properties. In this work MgB₂ is processed at different temperatures and analyzed by different techniques, like XRD, gas adsorption and thermal analysis.

The discovery of the superconductivity property in this material at 39K [1], has given origin to new investments in the research of superconducting materials and devices. This fact is justified by the easy processing of the MgB₂ as well as by the relatively low cost of the precursor materials. One of the most studied themes of research on this material is its doping with several carbon compounds. Several compounds were added to the MgB₂ matrix, but the most used one is silicon carbide, SiC [2].

The aim of most investigations is to increase the critical current density and magnetic field in order to enlarge the range of its application. By the other side, this work intends to show the influence of the sintering temperature (650°C, 750°C and 850°C) on the microstructure and properties of pure and 10 wt.% SiC nanopowder doped MgB₂.

To improve the microstructure characteristics of the MgB₂, such as grain boundaries, crystallographic defects and porosity, the prepared material strongly depend on the temperature which the precursor powder are exposed during the sintering. The processing also influences the creation of pinning centers and, consequently, the superconducting phase.

The X-ray diffractograms obtained for the samples provided the Full Width at Half Maximum to estimate the crystallite average size. The analyses indicate that the addition of SiC favors a preferential growth of crystallites when MgB₂ is obtained at higher temperatures.

The surface areas of the samples were investigated by nitrogen adsorption technique (BET). The data showed that the SiC containing specimen always present bigger surface area then the MgB₂ pure samples, reaching much higher values, such as five times, which it is confirmed to its higher porosity, fig 1, and lower mechanical resistance observed in these samples when compared with pure MgB₂.

The differential thermal analysis (DTA/TG) was used to investigate the formation mechanism of MgB₂ in several cases of doping. These results also showed how two completely different granulations (flakes and nanopowder) of magnesium powder may influence the kinetics of formation of MgB₂.

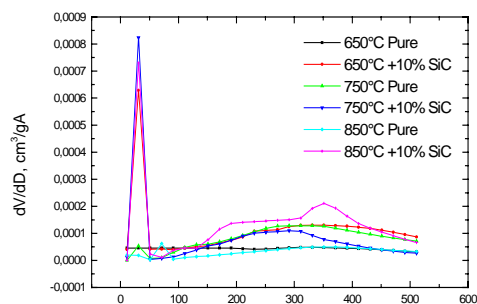


Figure 1: Pore size distribution obtained for doped and pure MgB₂ samples heat treated at different temperatures.

References

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