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Formation of homometallic ludwigite $Co_3O_2BO_3$ as a result of oxidation of amorphous Co-B powder

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Abstract – Recently the homometallic ludwigite $Co_3O_2BO_3$ has received attention because the nontrivial physical properties. In this work, we studied the formation of $Co_3O_2BO_3$ during the oxidation of amorphous Co-B powder prepared by chemical reduction. Thermogravimetric analysis was used to monitor the $Co_3O_2BO_3$ formation during the oxidation of the amorphous Co-B powder. The oxidation products at temperatures between 500 and 1000 °C was characterized by X-ray diffractometry and the XRD patterns were fitted using the Rietveld method. These results will be used to optimize the preparation of $Co_3O_2BO_3$.

The iron ($Fe_3O_2BO_3$) and cobalt ($Co_3O_2BO_3$) oxyborates are the only homometallic ludwigites known. In view of the similar structural parameters and ionic configurations, it is expected to find similar properties in both materials with eventual differences in nonuniversal quantities such as the temperatures of the structural and magnetic instabilities. However, recently it was found that the $Co_3O_2BO_3$ does not present any one structural changes observed in the $Fe_3O_2BO_3$. In addition, in low temperatures, the saturation magnetization of the $Co_3O_2BO_3$ is at least a order of magnitude larger than that of the $Fe_3O_2BO_3$[1]. The understanding of the differences in physical behavior of these ludwigites can throw light on the nature of the several competing mechanisms which determine the physical properties of mixed valence materials[1-2]. Classically, the synthesis of $Co_3O_2BO_3$ involves the solid state reaction between boron and cobalt oxides at temperatures above 900 °C for many hours[1-5]. The homogeneity of the oxides mixture is crucial to good quality of the solid state reaction[5]. Borohydride reduction of Co^{2+} ions in nonaqueous medium produce a amorphous powder containing metallic cobalt and boron homogeneously mixed at nanometric level[6]. The use of this amorphous powder in the preparation of $Co_3O_2BO_3$ was never studied, to the best of our knowledge. In this work, we studied the formation of $Co_3O_2BO_3$ during the oxidation of amorphous Co-B powder prepared by chemical reduction of Co^{2+} ions. Thermogravimetric analysis (TGA) was used to monitor the $Co_3O_2BO_3$ formation during the oxidation of the amorphous Co-B powder (figure 1). The oxidation products at temperatures between 500 and 1000 °C was characterized by X-ray diffractometry (XRD) (figure 2) and the XRD patterns were fitted using the Rietveld method. These results will be used to optimize the preparation of $Co_3O_2BO_3$.

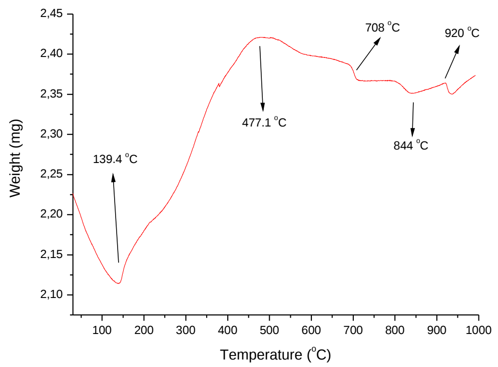

Figure 1: TGA of amorphous Co-B powder

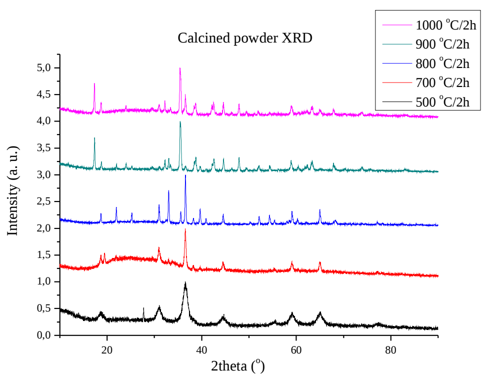

Figure 2: XRD of amorphous Co-B powder calcined at different temperatures.

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