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STRUCTURE AND SUPERCONDUCTIVITY OF $Mg_{1-x}Li_xB_2$ *

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The effects of the substitution of Li for Mg in $Mg_{1-x}Li_xB_2$(x=0, 0.1, 0.2) on their structure and superconductivity have been investigated. It has been found by X-ray diffraction that the substitution of Li for Mg with x=0.1 and 0.2 does not cause phase transformation in these samples. However, the measurements of temperature-dependent normalized magnetization indicate the loss of superconductivity with the increase of the Li content in these samples.

Keywords: superconductivity, magnesium diboride, lithium substitution
PACC: 7400

I. INTRODUCTION

Recently, the discovery of superconductivity at about 39 K in MgB_2 has attracted much attention due to its physical properties and applications.[1] Its superconducting transition temperature seems to be either above or at the limit of BCS theory.[2] The study of the effects of substitution on the structure and superconductivity of MgB_2 is of interest from an application point of view and in understanding fundamental physics. Slusky *et al.*[3] have reported the structural transition and superconductivity of $Mg_{1-x}Al_xB_2$. It was found that the superconducting transition temperature decreases with increasing Al concentration, and the superconductivity disappears at x >0.4. Zhang *el al.*[4] have investigated the effect of carbon substitution on the superconductivity of MgB_2 and found that the addition of carbon leads to the decrease of superconducting transition temperature. In this paper, we report on the effects of the substitution of Mg by Li on the structure and superconductivity of $Mg_{1-x}Li_xB$.

II. EXPERIMENTAL DETAILS

The samples were prepared from Mg(98.5%), LiB(99.9%) and B(99.999%) powders. The powders with the composition $Mg_{1-x}Li_xB$(x=0,0.1,0.2) were weighed and mixed in a high-purity, argon-filled glove box. The mixed powders were then pressed into pellets and heated in a high-purity argon gas at 950°C for 2 h. Powder X-ray diffraction (XRD) was carried out with an X-ray spectrometer, using Cu$K\alpha$ radiation over a 2θ angle ranging from 20° to 90°. The temperature dependence of magnetization of the samples was measured in a Quantum Design MPMS-7 SQUID magnetometer in an applied field of 1600 A/m.

III. RESULTS AND DISCUSSION

Figure 1 illustrates the XRD patterns of $Mg_{1-x}Li_xB_2$(x=0,0.1,0.2). The XRD patterns indicate that the main diffraction peaks can be indexed with a hexagonal structure of MgB_2. A small amount of impurity phase MgO is observed in all samples. No other phase is detected by XRD after the introduction of Li, indicating that the addition of Li does not lead to the phase transformation in these samples.

Figure 2 shows the temperature-dependent normalized magnetization at low temperatures of $Mg_{1-x}Li_xB_2$ measured by SQUID at 1600A/m under the condition of zero-field cooling (ZFC). A sharp superconducting transition is observed in MgB_2. Its superconducting transition temperature determined from the onset temperature of 2% of the full diamagnetic signal at low temperatures is about 36.0K, which is lower than the sample reported in Ref.[1]. This possibly results from the low purity of Mg powders (98.5% in purity).[4] For the sample x=0.1, the superconducting transition remains very sharp. However, its superconducting transition temperature (33.4K) becomes lower than the Li-free sample (36.0K). For the sample x=0.2, its superconducting transition temperature drops to 31.6K. In addition, its superconducting tran-

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sition width increases significantly in comparison with samples x=0 and 0.1. It is concluded from the analysis above that the introduction of Li in MgB_2 leads to the loss of superconductivity.

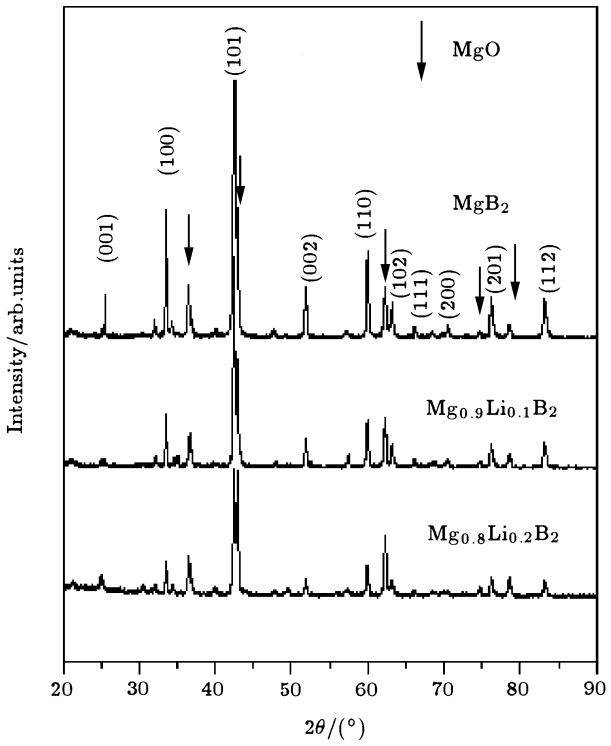


Fig.1. XRD patterns of $Mg_{1-x}Li_xB_2$ (x=0,0.1,0.2).

The addition of Li will lead to a deficiency of Mg in our $Mg_{1-x}Li_xB_2$(x=0.1,0.2) samples. Probably, it is the non-stoichiometry of MgB_2 that causes the loss of superconductivity in these samples. Some our experiments, however, have proved that the non-stoichiometry of MgB_2 has no influence on the superconducting transition temperature of MgB_2 prepared by our experimental method.[4] Therefore, it can be concluded that the loss of superconductivity in our samples is certainly a result of the introduction of Li.

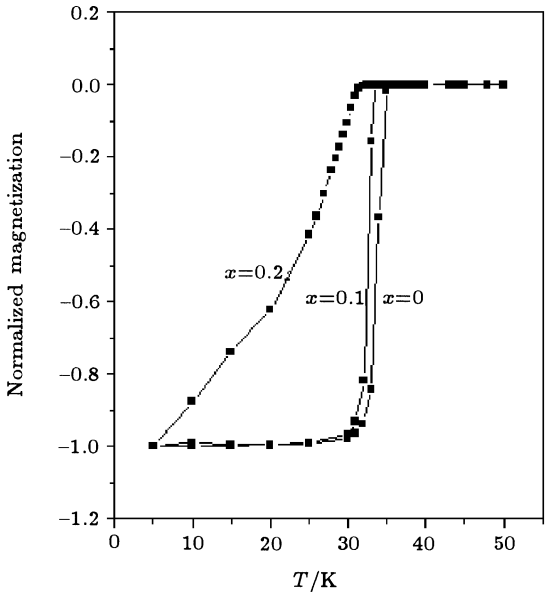


Fig.2. The temperature-dependent normalized magnetization at low temperatures of $Mg_{1-x}Li_xB_2$ at a field of 1600 A/m. The samples were cooled down to 5 K in ZFC.

IV. CONCLUSION

The structure and superconductivity of $Mg_{1-x}Li_xB$ (x=0,0.1,0.2) have been investigated by means of powder XRD patterns and magnetization measurements. It has been found that with the increase of the Li content in the samples, the superconducting transition temperature drops rapidly. No phase transformations were discovered by XRD with the increase of the Li content in these samples.

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