Synthesis and X-ray Absorption Study of $Mg_{1-x}Ta_xB_2$

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Samples of Ta –doped MgB_2 were prepared by the method of rapid metathesis reactions. Mg-rich MgB_2 and $TaCl_5$ were mixed and calcined at 500°C for 30 minutes in an argon-filled quartz tube. The chemical reaction formula may be written as MgB_2 +3/2xMg +x$TaCl_5$ →$Mg_{1-x}Ta_xB_2$ + 5/2x$MgCl_2$, $MgCl_2$ can be removed by immersing the products in ethanol. The sample of ST1 was produced by set x = 0.05 while ST2 was made for 0.15. Their X-ray powder diffraction (XRD) patterns along with that of MgB_2 powders (denoted as MBA) are shown in Fig.1. The lattice constants deduced from XRD are shown in table 1. The actual stoichiometry of each sample was calculated by using Vegard's law and listed in table 2.

No substantial degradation of the superconductivity transition temperature was found for the Ta-doped samples as indicated in the magnetization curves measured by a SQUID (Fig.2), although the superconducting volume was reduced.

Nevertheless, the sequential decrease of the threshold peak intensity of the X-ray near-edge absorption spectrum (XANES) of boron K edge is apparent (peak A in Fig.3). Our observations suggest that the doping of Ta in MgB_2 will decrease the number of holes in the valence band at the Fermi level. The B_2O_3 peak (peak C in Fig.3) indicates that the oxidation existed in the synthesis process. The oxidation of Ta into Ta_2O_5 has already appeared in the XRD pattern in Fig.1.

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Table 1

samples	a (Å)	b (Å)
MBA	3.084(1)	3.520(2)
ST1	3.084(2)	3.518(2)
ST2	3.084(2)	3.517(2)

Table 2

samples	Expected stoichiometry	Actual stoichiometry
ST1	$Mg_{0.95}Ta_{0.05}B_2$	$Mg_{0.984}Ta_{0.016}B_2$
ST2	$Mg_{0.85}Ta_{0.15}B_2$	$Mg_{0.974}Ta_{0.026}B_2$

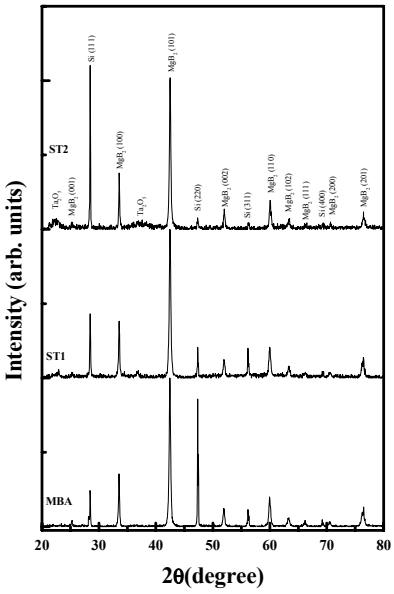

Figure 1. XRD of samples of MBA, ST1, and ST2

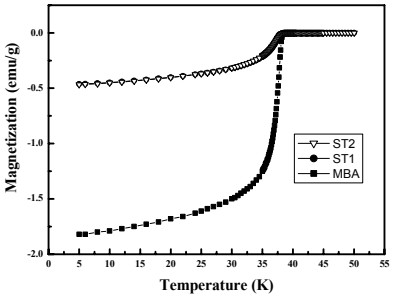

Figure 2. Magnetization curves measured by a SQUID.

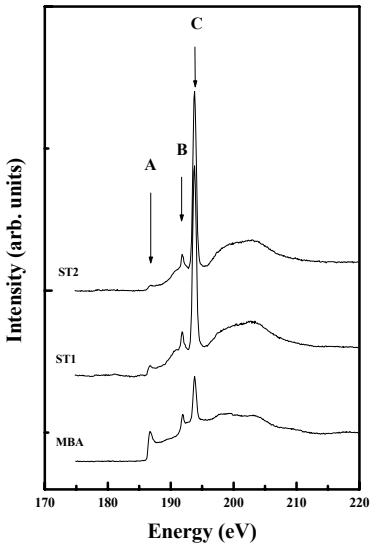

Figure 3. The XANES of boron K-edge for MBA, ST1 and ST2.