RESISTIVE MEASUREMENTS ON AN IMPROVED Nb-Al-Ge SUPERCONDUCTING RIBBON*

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An improved version of the Nb-Al-Ge ribbon which was developed in our laboratory[1] has been produced. This ribbon is considerably less porous and more flexible than its predecessor. Resistive measurements at 4.2° - 16°K in steady transverse magnetic fields up to 150 kOe are presented. Preliminary results on other Nb_3Al-based compounds in ribbon form will also be presented.

Introduction

Because Nb_3Al and Nb_3Al-based ternary materials have been shown to be capable in principle of carrying large currents at temperatures above 12°K and fields up to 15T [1-3], we have directed some recent efforts[1,4,5] at producing ribbons with desirable technical properties. This task has been difficult, and improvement comes in a series of small steps, one of which is reported here.

Experimental

The basic fabrication steps are as reported previously[1], with the exception that annealing was performed in argon gas at 1/2 atmospheres. Compositions used were Nb_3Al, $Nb_3Al_{.75}Ge_{.25}$, $Nb_3Al_{.9}Si_{.1}$ and $Nb_3Al_{.7}Si_{.3}$. The large amounts of porosity noted in the previous work[1] were not present, and although quantitative measurements of bendability were not made, there was an obvious increase in flexibility and resilience. Measurements of J_c vs. H were made in transverse fields in a manner identical to our previous work[1], at the Francis Bitter National Magnet Laboratory.

Results

Figures 1 and 2 give the results for $Nb_3(Al,Si)$ alloys. As can be seen the critical current drops off rapidly. Figure 3 shows the $Nb_3Al_{.75}Ge_{.25}$

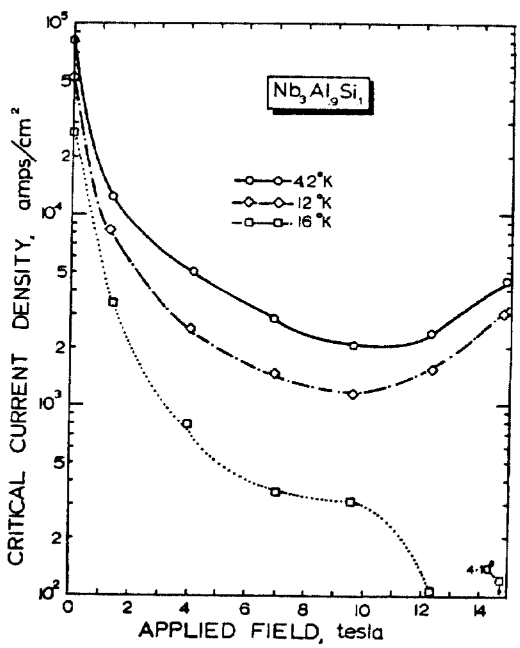

Figure 1 J_c vs. H for $Nb_3(Al_{.9}Si_{.1})$ ribbon; H transverse to J, parallel to plane of ribbon; at 4.2°, 12° and 16°, in He gas.

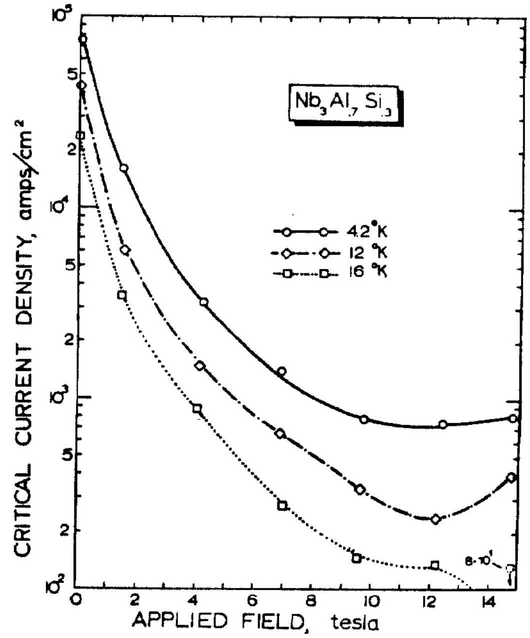

Figure 2 J_c vs. H for $Nb_3(Al_{.7}Si_{.3})$ ribbon; H transverse to J, parallel to plane of ribbon; at 4.2°, 12° and 16°, in He gas.

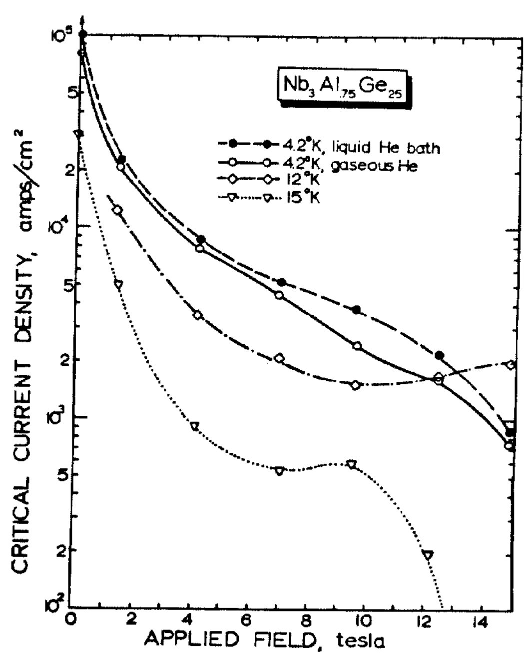

Figure 3 J_c vs. H for $Nb_3Al_{.75}Ge_{.25}$ ribbon; H as in Figs. 1 and 2; at 4.2°, 12° and 15° in He gas and 4.2° in He liquid. Note that the liquid environment increases J_c by ca. 30%.

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sample. This sample differed from that previously reported[1] only in the heat treatment under one half atmosphere pressure and subsequent reduced porosity. The critical current at low fields is similar to the previous $Nb_3Al_{.75}Ge_{.25}$ ribbons but greatly reduced at 4.2°K at higher fields (>10T); it is possible that the J_c peak has simply moved to fields well in excess of 15T, out of the range of our measurements. All samples were tested in a helium gas environment except the dashed line of 4.2°K in Figure 3. In this case the sample, after testing at 4.2, 12 and 15°K in He gas, was uncovered and replaced without change in liquid helium at 4.2°K. As can be seen, the improved heat transfer has raised J_c by about 30%. Figure 4 shows the results for Nb_3Al. In this instance, J_c was found to be the highest of all samples at all fields. In the sample heat treated 24 hours at 750°C J_c(4.2°K) is $>10^4$ A/cm^2 at all fields to 15T than any other Nb_3Al alloy tested.

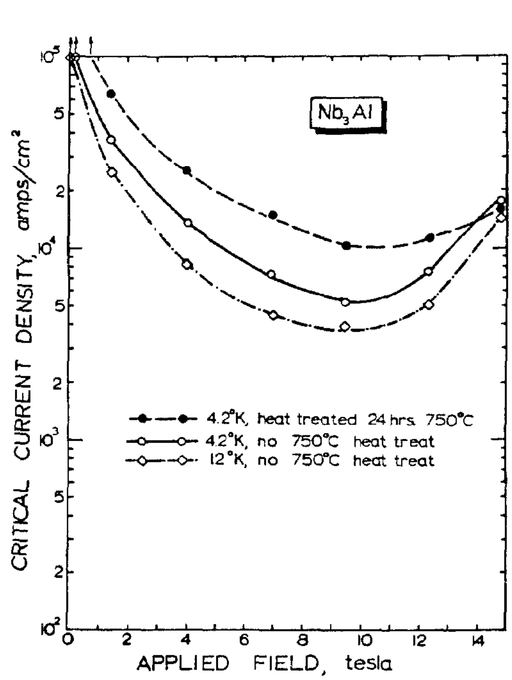

Figure 4 J_c vs. H for Nb_3Al ribbon; H as in Figures 1 and 2; at 4.2°K and 12°K for ribbon without 750°C ordering anneal, and 4.2°K with 24 hour anneal at 750°C.

Since longer times *up to 48 hours) at 750°C will improve the transition temperature even further[5] it would be worthwhile to test such samples in the future. Not only would they have higher J_c but a higher T_c also, which is opposite to the $Nb_3(Al_{.75}Ge_{.25})$ samples previously reported[1], where higher T_c meant lower J_c.

In conclusion, it should be pointed out that while these ribbons have very interesting properties up to 12 to 14°K, the critical currents are still too small for practical application. Further Nb_3Al alloys are no more ductile than Nb_3Sn which presents serious engineering disadvantages. However, Nb_3Al is not any worse than Nb_3Sn in so far as mechanical properties are concerned and provided that its critical current properties can be improved, it could one day become the successor to Nb_3Sn until something better than both is found.

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