CHINESE PHYS. LETT.
Vol.2, No.2(1985)

CHINESE PHYSICS LETTERS
Science Press,Beijing
Springer-Verlag

NEW EVIDENCE OF STABILIZATION OF HIGH T_c A15 Nb_3Ge PHASE BY Nb_5Ge_3

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(Received 31 October 1984)

Many scientists hypothesized that the presence of oxygen is necessary for the formation and stabilization of the metastable high T_c A15 Nb_3Ge phase in Nb-Ge films. In our previous work we proposed that a certain amount of Nb_5Ge_3 may play a role in stabilizing the high T_c A15 phase. New experimental results of induction measurement on the Nb-Ge films support our proposal.

Since Gavaler in 1973 first obtained high T_c Nb_3Ge film using a d.c. sputtering method[1], there has been a considerable amount of research on the formation and stabilization of the metastable high T_c A15 Nb_3Ge phase. Most of the scientists favored the viewpoint that the presence of oxygen is crucial for forming high T_c A15 Nb_3Ge phase[2,3]. However, from our previous work, it was found that if the sputtered Nb-Ge film is nonstoichiometric and Ge in excess, i.e. contains a certain amount of second phase Nb_5Ge_3, the T_c could be very high. We have proposed that the role of Nb_5Ge_3 is to stabilize the A15 Nb_3Ge phase with small lattice parameter (5.14Å), which contributes to the high T_c of the film[4].

Recently we measured the T_c's on samples prepared in Cambridge, England (in a UHV d.c. getter sputtering apparatus) and the CVD films (prepared by the Institute of Mining and Metallurgy, Changsha) both resistively and inductively, the results are compared with that of the samples prepared by ourselves. The inductive measuring device is shown in fig.1, which is very sensitive to detect the superconductive transition in thin film samples.

From the experimental results obtained, the T_c's of the sputtered samples measured by the inductive method are all lower than that of the resistive method (fig.2). This phenomenon indicates that the volume fraction of the high T_c regions are relatively small in the sputtered samples, while proximity effects will be most apparent in a resistive transition of a one-dimensional percolation path linking proximity coupled with high T_c regions. It was also found that in the sputtered samples with single phase A15, Nb_3Ge had broad transitions and showed several steps in the curves, while the samples containing A15 Nb_3Ge and Nb_5Ge_3 exhibited a smooth and sharp transition(fig.3). This indicates that the so called single A15 phase samples actually contain more than one A15 phase, and only a small

fraction of them has a small lattice parameter with high T_c, but in the samples with A15 Nb_3Ge+Nb_5Ge_3, the A15 phase has a more ordered structure and is near-stoichiometric in composition approaching to that of high T_c A15 Nb_3Ge phase. This experimental result supports the proposal in our previous work, that Nb_5Ge_3 has a stabilization effect on the metastable high T_c A15 Nb_3Ge phase.

As to the CVD Nb_3Ge samples, there is not much difference between the resistive and inductive transitions. It could be that the CVD films are much more homogenous than that of the sputtered films.

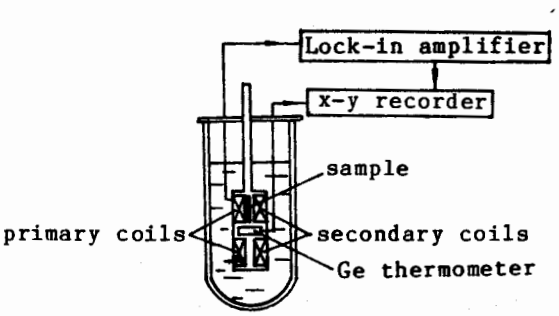

Fig.1 Block diagram of the inductive measuring device.

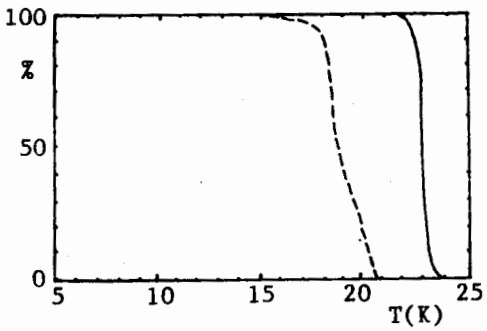

Fig.2 Inductive (dashed) and resistive (full) transition for a two phase sputtered Nb-Ge sample.

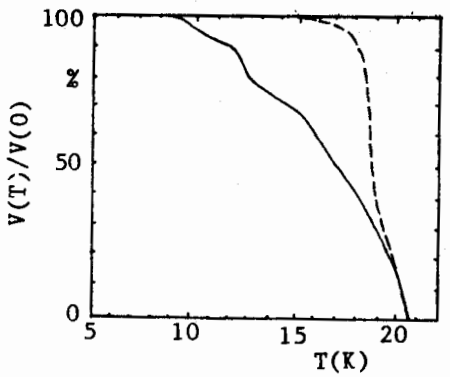

Fig.3 Inductive transition of two phase sample (dashed) and a single phase sample (full).

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