# COMBINED SYSTEM BETWEEN $Nb_3Ge$ MICROBRIDGE AND A PORTABLE-HYDROGEN-LIQUEFIER

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If a Josephson junction can be performed in normal-boiling-liquid-hydrogen the applications of cryo-electronic devices will be greatly expanded. Such a technique has two great advantages. One of those is that it is helpful for the shortages of He gas. The other one is there are no heat spots because of good thermal contact with the liquid. Therefore the sample temperature can very easily be kept constant in contrast with using cold He gas. An examination on the combined systems of a Josephson microbridge and a very small liquefier of hydrogen was carried out. It was necessary that the microbridge had a higher superconductive-critical-temperature than the normal boiling-liquid-hydrogen-temperature. High pressure $H_2$ in a bonbe was used to make the hydrogen liquid using the Joule-Thomson effect. A zero-voltage current of the $Nb_3Ge$ microbridge was observed in the liquefied hydrogen.

## §1. Liquefaction of Hydrogen

As is mentioned above Joule-Thomson effect was used for liquefaction of hydrogen. At room temperature, the pressure (P) and the temperature (T) is out of the Joule-Thomson-inversecurve. Therefore high pressure-hydrogen gas from a bombe was precooled by flowing through 10 meters copper pipe with inner diameter of 1.5 mm immersed in liquid nitrogen ( Fig. 1)

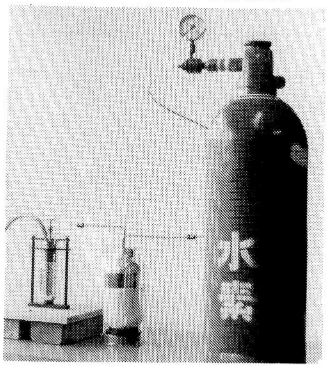


Fig. 1 Coil of the copper pipe to cool $H_2$ by immersing it in liquid nitrogen.

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in the first dewar and was induced into Hampson heat exchanger which is pushed fairly tight into the second dewar. The liquefaction of hydrogen was started by opening slowly Joule-Thomson valve connected at the end of the pipe. Fig. 2 is the external appearance of all the system.

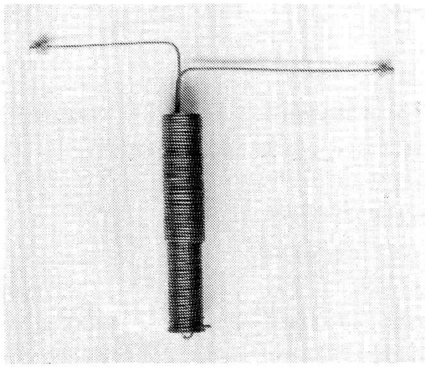

Fig. 2 The external appearance of all the system.

## § 2 . Fabrication of the Microbridge

$Nb_3Ge$ films have been prepared by high rate sputtering in a container full of liquid nitrogen.[1] The films with the superconducting-upper-onset-temperature ( $T_{co}$ ) above 22K and lower onset ( $T_{ce}$ ) above ~21K have been reproducibly obtained. Most of the films are completely superconductive above the liquid hydrogen temperature. However, for some samples with broad transition width, two effective methods were used to improve it. (i) Application of small mechanical shock to prepared $Nb_3Ge$ films at room temperature.[2] (ii) Deposition of $Nb_3Ge$ on the oxidized Nb layer, which is proposed by B. Krevet et al.[3] Moreover chemical-etching-method was taken to form the $Nb_3Ge$ microbridge because the ion-sputter etching brings on the decrease on the superconducting temperature.[4] We have used OMR−83 photoresist and a electron beam accelerated by 20KV in patterning the microbridge.

Fig. 3 shows the schematic pattern of a microbridge of which size is as follows; 2 $\mu$m in length, 2 $\mu$m in width and 2000 Å in thickness.

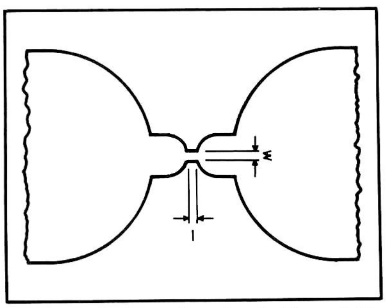


Fig. 3 Schematic pattern of a microbridge of $Nb_3Ge$

Fig. 4 shows the critical-current ( $I_c$ ) versus temperature ( T ) characteristics of this microbridge which was measured in He vapour. There exists a linear relation between $I_c^{2/3}$ and the temperature except a region of temperature close to $T_{ce}$. $T_{co}$ and $T_{ce}$ were 22.0 K and 21.4 K respectively. The decrease of the critical temperature has not been observed in the process in fabricating a microbridge.

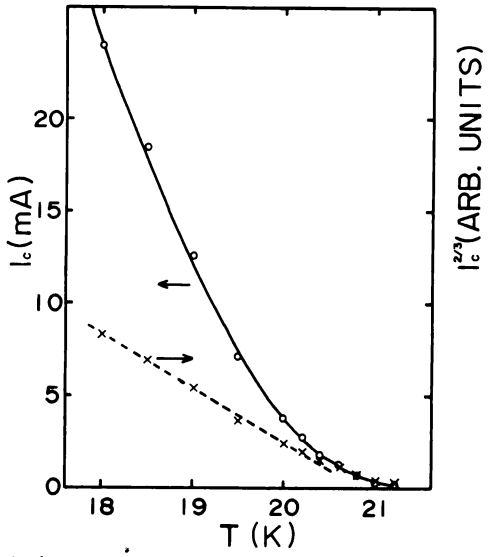


Fig. 4 The critical-current v. s. temperature characteristics of $Nb_3Ge$ microbridge. Mark × belong to $I^{2/3}$ coordinate.

Fig. 5 shows the current ( I )-voltage ( V ) characteristics of $Nb_3Ge$ microbridge in the normal-boiling-liquid-hydrogen which was liquefied in second dewar by using the present system. In this report, the possibility of making very simple and portable SQUID-system has been described by the use of $Nb_3Ge$ microbridge and a very simple liquefier of hydrogen.

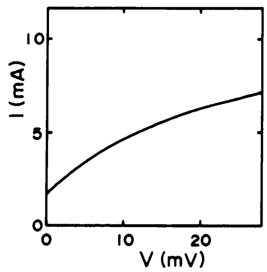


Fig. 5 The current-voltage characteristics of the microbridge in the normal-boiling-liquid-hydrogen liquefied by the present system.

**Acknowledgements**

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**Referances**

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