Submitted to Review of Scientific Instruments

LBL-3513
Preprint c.1

SUPERCONDUCTING Pb TO Nb UNIONS

Michael L. Rappaport

October, 1974

Prepared for the U. S. Atomic Energy Commission
under Contract W-7405-ENG-48

Superconducting Pb to Nb Unions

Michael L. Rappaport

Department of Physics, University of California
and
Inorganic Materials Research Division,
Lawrence Berkeley Laboratory,
Berkeley, California 94720

ABSTRACT

Two simple methods of making superconducting unions which can be soldered to Pb and spotwelded to Nb are described.

Because niobium oxidizes so rapidly and forms such a tenacious oxide, it is not possible to solder to it by conventional methods. It has therefore been inconvenient to make small, robust superconducting connections between Nb wires and Pb leads, e.g., in circuits with SQUIDs. Described here are two methods of fabricating unions which are only ~ 1 × 1 × 4 mm and weigh ~ .1 gm, yet have critical currents of ~ 10 mA at 4.2K and > 100 mA at the λ-point.

The first method requires an electron beam gun. A short length (~ 5 mm) of 1.6 mm diameter 5N- grade Sn wire is placed on a water-cooled copper plate in a vacuum system. The middle of a rectangle (~ 6 × 20 mm) of technical grade .125 mm Ta foil (T_c = 4.5K) is then set on top of the wire.

After evacuating to ~ 10^{-6} Torr, the foil is heated to incandescence with an electron beam gun. Near the melting point of Ta_2O_5 (1800°C), the Sn melts and wets the foil. Because the area of the Sn in contact with the water-cooled plate is increased, it immediately cools below its melting point and the process stops. The beam gun[1] power required is ~ 3 kW.

The Ta foil, with Sn covering the center, can then be cut with a scissors into strips ~ 1 mm wide and with Sn on one end. Pb wires can be soldered to the Sn and Nb wires spotwelded to the Ta.

The second method requires the fashioning of a shallow boat out of the Ta foil similar to that used in evaporation. A short length of 5N-grade Sn wire is melted in the boat in a vacuum of ~ 10^{-5} Torr. When the boat is hot enough, the Sn will wet the surface. The unions can then be cut as in the first method.

Although the T_c of Sn is 3.7K, the solder used to attach the Pb wires penetrates down to the $SnTa_3$ (T_c = 6.0K) interface which is presumably formed, and the Pb wire-union-.125 mm Nb wire system has a critical current of ~ 10 mA at 4.2K.[2]

Similar results were obtained with the second method when fluxless 60/40 Sn/Pb solder was substituted for the pure Sn. It should also be possible to substitute Nb foil for the Ta. Then the unions should be usable up to ~ 7K, the critical temperature for Sn/Pb solder.[3]

FOOTNOTES

* This work was supported by the U.S. Atomic Energy Commission.

1. A Veeco VeB-6.

2. 10 mA is the critical current for the spotweld. The Sn-Ta interface has $I_c \sim 1$ A at 4.2K.

3. W. H. Warren and W. G. Bader, Rev. Sci. Instr. 40, 180 (1969).