

pressure at the melting point, the affinity of the deposited films for the residual gases in the vacuum system, and the depression of the superconducting transition temperature by the gettered residual gases in the films. Tantalum is a metal in which similar difficulties are encountered; Marchand and Venema⁴ have shown that tantalum films with bulk metal superconducting transition properties can be prepared in vacua of the order of 1×10^{-10} torr by sublimation from a heated tantalum spiral at a deposition-rate of 250 Å./min. We have estimated that in order to produce pure niobium films by vacuum sublimation a vacuum of at least 1×10^{-11} torr would be required.

We are not aware that superconducting films of niobium have been reported previously.

By the use of a vacuum-arc deposition technique^{5,6} developed in this laboratory, we have been able to produce superconducting niobium films with transition temperatures greater than 4.2° K., which is the present upper limit of measurement in our cryostat. Cook, Zemansky, and Boorse⁷ obtained a value of 8.65° K. for the transition temperature of bulk niobium. Our niobium films were deposited on to 25 mm. × 10 mm. glass substrates in vacua of $5-8 \times 10^{-6}$ torr, during deposition the centre of each substrate was placed at a distance of 3 mm. from the point of contact of the two arc electrodes. The electrical resistance of the films range from 0.93 ohms per square to 6.1 ohms per square at 300° K.

In view of the present interest in this type of superconductor, we believe that these preliminary results may be of some use to other workers in this field. No doubt there are other areas where the vacuum-arc deposition technique can be used to obtain similar advantages over contemporary methods. This work was performed under contract with the United States Atomic Energy Commission.

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Search for Light Amplification in a Mixture of Mercury Vapour and Hydrogen

F. A. Butayeva and V. A. Fabrikant have recently reported the discovery of a negative temperature in an excited gaseous mixture of mercury vapour and hydrogen between the levels 7^3S_1 and $6^3P_{0,1,2}$ of mercury¹. They maintain that the populations of the 6^3P levels were reduced below that of the 7^3S_1 level by the well-known quenching action of hydrogen. The populations were investigated by measuring the transmission coefficient of the gas mixture at the wave-lengths 5461 Å., 4358 Å. and 4047 Å., corresponding to the transitions $7^3S_1 - 6^3P_2$, $7^3S_1 - 6^3P_1$ and $7^3S_1 - 6^3P_0$, the mixture being excited by a

d.c. discharge. With a discharge tube of length 36 cm. amplification of about 10 per cent was reported in the λ 5461 Å. and λ 4358 Å. lines for a discharge current of 70 m.amp. with 0.3 mm. mercury hydrogen pressure and saturated mercury vapour at room temperature.

In similar experiments with this mixture, under conditions as nearly as possible identical to those used by Butayeva and Fabrikant, and with a wide variation of hydrogen pressure, we have observed no amplification.

In our apparatus light from a low-pressure mercury lamp was chopped at a low frequency and then passed through the discharge. The line to be investigated was selected with a monochromator, and the light fell on a photomultiplier. A second photomultiplier was used to monitor the light output from the source lamp and the a.c. output from the two photomultipliers was electronically balanced and fed to a phase-sensitive detector. With this arrangement 1 per cent amplification could be detected with ease. The discharge tube was baked at 400° C. for at least 8 hr. before attempting measurements and the final pressure achieved before admitting the gases was 10^{-8} mm. mercury. The hydrogen was admitted by diffusion through hot palladium and the mercury was pre-distilled under vacuum.

With d.c. excitation of the discharge the current was varied continuously from 0 to 150 m.amp. with hydrogen pressures ranging from 0.2 to 0.6 mm. mercury. No absorption or amplification was observed in any of the three lines. At hydrogen pressures below 0.2 mm. mercury, difficulty was experienced in maintaining a d.c. discharge, but it was possible to run a radio-frequency electrodeless discharge at about 10 Mc./s. Investigations were made with the latter form of excitation over the range of hydrogen pressures of 0.0-0.6 mm. mercury. Again no effect was obtained in the λ 4358 Å. line, and a small absorption was observed in the λ 4047 Å. line. Strong absorption was, however, observed at the lowest pressures in the λ 5461 Å. line, being typically about 50 per cent at zero hydrogen pressure, depending on the radiofrequency power used; in this case the absorption fell to, and remained at, zero as the hydrogen pressure was increased up to and beyond about 0.15 mm. mercury. In all cases the mercury vapour was in equilibrium with liquid mercury at a temperature of $20 \pm 2^\circ$ C.

It is difficult to form a convincing theoretical discussion of the conditions in the discharge since the quenching process is not fully understood. However, the experimentally determined cross-section of 8.6×10^{-16} cm.² (ref. 2) for quenching of atoms in the 6^3P_1 state is not large enough for this process alone to create a negative temperature under these conditions, even supposing that the life-time of atoms in the 7^3S_1 state is not affected by the hydrogen. This lends support to our experimental conclusion.

The authors are grateful to Dr. B. A. Lengyel for supplying them with a translation of the Russian report.

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