Prevention of Reversal in Mercury-198 Lamps

THE green emission line 5461 A. of mercury-198 has been proposed by Meggers[1] as a primary standard of wave-length, and is one of the lines being considered as the basis for a redefined international metre. The line has much to recommend it in its sharpness, isolation from other lines, convenience of excitation, etc.

However, as the line is excited at present in an electrodeless lamp with argon as a carrier gas, there is the serious disadvantage that it very easily suffers reversal which is unsymmetrical, thereby becoming broadened and shifted in wave-length. As a consequence the lamp must be operated and observed very carefully. The temperature must be maintained below about 10° C., although the intensity of the line is reduced and the lamp will not operate at much below 0° C.

To overcome this difficulty an attempt has been made to use the well-known property of molecular gases of reducing the tendency to reversal by depopulation of metastable levels[2]. Lamps have been made and observed which contain as carrier gases respectively hydrogen, nitrogen and mixtures of these gases with argon.

The results are illustrated by Fig. 1. At the right is seen the profile of the 5461 A. mercury-198 line emitted by a small electrodeless argon-filled lamp run in air without special cooling and viewed end on; at the left is the profile of the same line excited and viewed under identical conditions except that the carrier gas was nitrogen instead of argon. A similar improvement was found with hydrogen. In both cases the intensity at peak was considerably enhanced. The argon–hydrogen and argon–nitrogen mixtures showed improvement which was somewhat less but nevertheless great; on the other hand the excitation of the mercury lines compared with the background due to nitrogen and hydrogen was somewhat better with the mixtures.

The wave-length shift due to the presence of nitrogen was measured and found to be less than for argon[3]; that due to hydrogen would also be expected to be small on the basis of measurements made at high pressure[4]. The nitrogen tends to form Hg_3N_2 which, however, under the discharge conditions is in equilibrium with N_2 at sufficient pressure for useful operation of the lamp.

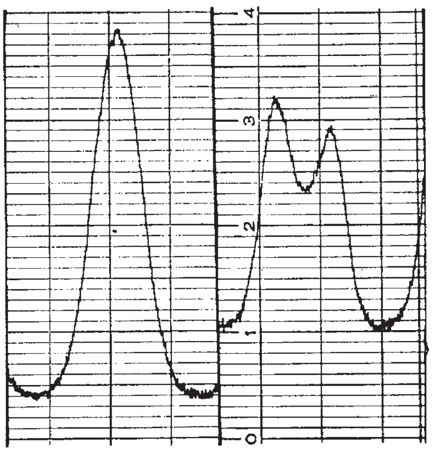

Fig. 1

So far as the experiments have gone it appears that the usefulness of the mercury-198 green line as a standard or for length measurement would be greatly increased by the method of preventing reversal described. A study of such matters as the life of the lamp, the importance of the slight background, the exact wave-length emitted, etc., is in progress.

K. M. BAIRD
D. S. SMITH

Division of Applied Physics,
National Research Council,
Ottawa.
Aug. 27.

[1] Meggers, W. F., and Kessler, K. G., *J. Opt. Soc. Amer.*, **40**, 737 (1950).
[2] Pringsheim, "Fluorescence and Phosphorescence" (Interscience Publishers, Ltd., London, 1949).
[3] Baird, K. M., and Smith, D. S., *Canad., J. Phys.*, **35**, 455 (1957).
[4] Margenau, H., and Watson, W. W., *Rev. Mod. Phys.*, **8**, 44 (1936).

Unloading Effects in Copper Single Crystals

Haasen and Kelly[1] have observed a small yield point on retesting previously strained single crystals of aluminium and nickel at the same or lower temperatures than the initial deformation. The effect occurred only when the crystals were unloaded between tests, and no yield point was found at low stresses. Annealing at 300° K., between tests at 90° K., increased the magnitude of the yield phenomenon and much larger yield points were observed when the second deformation was carried out at a lower temperature than the first. Haasen and Kelly attributed the effect to the rearrangement of dislocations during unloading.

The present work was undertaken to investigate further the phenomenon in copper single crystals, and, in particular, to determine in more detail the effect on the magnitude of the yield point of (*a*) partial unloading and (*b*) annealing between tests.

Single crystals of copper were prepared in a split graphite mould by the Bridgman technique from spectroscopically pure wire. After electropolishing, tensile tests were carried out in a motor-driven hard beam machine at a variety of temperatures between −195° C. and 200° C.

Experiments were first performed in which frequent unloading tests were made at small strain increments during the whole stress–strain curve at various temperatures. The overall shape of the curve was identical with that of specimens tested continuously at the various temperatures; in detail, however, the two curves were different in that a yield point was observed on retesting after unloading during the linear and parabolic hardening regions. The stress–strain curve after the yield point returns to the extrapolation of the curve obtained prior to unloading. No yield points were observed at any temperature on retesting during the easy glide stage of deformation. The magnitude of the yield point was directly proportional to the flow stress and independent of the temperature of testing, a constant value of (stress before unloading/stress on retesting) of 0·986 being obtained between −195° C. and +100° C. There was no dependence of the ratio on the time for which the specimen was unloaded at any temperature. During experiments in which the load was only partially removed a linear relationship was found between the amount of unloading and the ratio of the flow stresses, indicating that the