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Short Communication

Resistance increase of discontinuous gold films by substrate absorption of oxygen

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In a prior publication[1] it was shown that the resistance $R(T, t)$ of a discontinuous gold film varies with time, t, when air is admitted to the vacuum system according to

$$\log_{10} R(T, t) = A_1 + A_2 t^{1/2} \cdot \exp[-p/T] \quad (1)$$

provided the film temperature T is constant, where A_1, A_2 and p are constants. The theory is based upon a model of substrate absorption where oxygen modifies the interisland tunneling barrier height. This note is concerned with the measurement of p.

(a) Values of p quoted previously were determined by indirect measurement of the film temperature. Using direct thermocouple monitoring of the film temperature, p has been determined for air as 5640° K (standard deviation 7%) for Corning 7059 glass and as 9380 °K (estimated error ± 10%) for soda-lime glass.

(b) The constant p has been measured for admission of oxygen to a pressure of 0.2 torr. Values of 5500° and 3000 °K (estimated errors ± 10%) have been obtained. It is, therefore, reasonable to attribute the resistance increases in air to oxygen as the active agent, particularly with the result for nitrogen next described.

(c) At a given pressure and temperature the magnitude of change in a nitrogen atmosphere is much less than that in either air or oxygen. Both positive and negative changes have been observed and the Arhenius plot using positive changes only is curved. It is suggested that both tunneling barrier heights and effective mass of the tunneling electrons are affected by the absorbed gas to give a composite effect. This aspect will be considered further in the future.

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REFERENCES

1 J. E. MORRIS, *Thin Solid Films*, *5* (1970) 339–353.