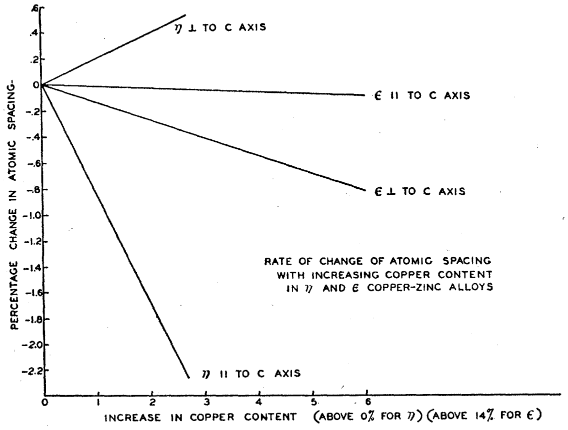

FIG. 1. Rate of change of atomic spacing with increasing copper content in eta and epsilon copper-zinc alloys.

in zinc content) causes a large decrease in atomic spacing in the directions of greatest atomic vibration in each of the two crystal lattices.

The pronounced anisotropy of zinc is demonstrated by these two alloy phases. Although both phases are hexagonal close-packed with the same coordination number, a complete series of solid solutions is not formed. There exists a gap in axial ratio and in composition between eta and epsilon within which no hexagonal close-packed copper-zinc phase exists. In eta the influence of the zinc atom is evidently in the shape of a prolate spheroid and in epsilon, in the shape of an oblate spheroid, without the intermediate spherical condition at axial ratio 1.633.

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[1] Robert A. Howard, Phys. Rev. **53**, 966 (1938).

The Internal Friction of Metallic Crystals

Several investigators have studied the internal friction of polycrystalline metals,[1] but as far as the writer is aware the only observations on single metal crystals are those of Zacharias on nickel,[2] and these deal entirely with the ferromagnetic contribution. Accordingly the following results, obtained in the course of a systematic investigation of internal friction in single and polycrystalline metals, seem worth reporting at this time. The experimental method is that devised by Cooke and Brown.[3]

Observations have been made on single crystals of copper, lead and tin. The vibration frequency is 38.9 kilocycles in each case, and the temperature is about 25°C. The observed longitudinal decrements of the crystals are 3.6×10^{-5}, 2.8×10^{-4}, and 6.9×10^{-5}, respectively. These values may be compared with those of the corresponding polycrystalline substances obtained by Forster and Korster,[1] namely, 3.5×10^{-3}, 4.6×10^{-3}, and 5.4×10^{-3}. It thus appears that the internal friction of a single metal crystal is substantially less than that of the polycrystalline material. The decrement of crystalline quartz is 3×10^{-6}, and it is suggested that the decrement of a pure and strain free metal crystal might approach this value.

The effect of internal strain on the internal friction of crystalline copper is noteworthy. The decrement of a crystal, on removal from the furnace in which it is grown, is of the same order as that of the polycrystalline material. The low value here reported is obtained by annealing the crystal in a vacuum. Lead and tin crystals, on the other hand, remain unaffected by annealing.

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[1] See for example, Wegel and Walther, Physics **6**, 141 (1935); Forster and Korster, Zeits. f. Metallkunde **29**, 116 (1937).

[2] Zacharias, Phys. Rev. **44**, 116 (1933).

[3] Cooke and Brown, Phys. Rev. **50**, 1158 (1936).

Ignition Potential in a Low Pressure Neon Tube

In an article by Lindenhovius[1] an expression is derived and experimentally verified for the relation between the voltage at which ignition of a low pressure irradiated neon glow occurs and the frequency of the applied sinusoidal voltage. The expression was based on the determination of the time constant of an assumed exponential current rise,[2] and this time constant was shown to depend upon the magnitude of the overvoltage applied to the discharge. The time required for ignition can be computed from the relation

$$\log\frac{i_1}{i_0}=a\int_{t_0}^{t_1}(v-V_0)dt, \tag{1}$$

where v is the instantaneous electrode voltage, V_0 is the minimum ignition voltage, i_0 and t_0 are the current and time when $v=V_0$, i_1 is the current at time t_1 when ignition takes place and a is a constant depending upon the ionization coefficient, mobility of the ions, and number of electrons ejected from the cathode per ion pair formed. It is assumed that space charge does not distort the electric field.

If an exponentially increasing voltage, obtained from the plates of a condenser C charged through a resistance R by a battery V_m, is placed across the electrodes Eq. (1) may be conveniently tested. The term $[V_m(1-\epsilon^{t/RC})-V_0]$ may be substituted for $(v-V_0)$ in Eq. (1) and the solution of the resulting equation may be written

$$\log\frac{i_1}{i_0}=a\bigg[(V_m-V_0)(t_1-t_0)+RCV_m\bigg\{\exp\Big(-\frac{t_1}{RC}\Big)-\exp\Big(-\frac{t_0}{RC}\Big)\bigg\}\bigg]. \tag{2}$$

A neon discharge tube with parallel-plane iron electrodes was used. The transient visualizer[3] was used to apply the exponential voltage to the electrodes at a very low frequency, and at the same time to sweep the beam of a

TABLE I. *Calculated and observed values of ignition voltage in a neon tube as a function of the time constant of an exponentially increasing voltage.*

RC (SEC.)	V_m (VOLTS)	V_{calc} (VOLTS)	V_{obs} (VOLTS)
2.37×10^{-2}	250	195	197
	295	204	205
	340	209	206
	385	222	219
	420	236	231
1.33×10^{-2}	250	209	202
	295	211	210
	340	213	212
	385	228	223
	420	245	250
0.59×10^{-2}	250	218	217
	295	219	218
	340	222	222
	385	232	231

cathode-ray oscillograph. The voltage across the discharge was measured by the oscillograph, the persistence of vision providing a means of determining the maximum tube voltage. The time for discharge was measured as a check on the voltage measurement. As a criterion for ignition, it was assumed that ignition occurred at the maximum discharge voltage and that immediately after ignition the voltage dropped. This assumption is reasonable from the appearance of oscillograms obtained by Reich and Depp.[4] The condenser discharge current was made large compared with the pre-ignition current of the discharge so that the latter current did not distort the applied voltage shape. The frequency of application of voltage was so low that de-ionization was judged to be complete. The condenser voltage was short-circuited after each discharge to hasten de-ionization.

Table I shows the experimentally determined ignition voltage compared with the value computed from Eq. (2). It is seen that the results are within the experimental error of about 2 percent. Divergences are expected at the higher values of V_m, since in arriving at Eq. (1) only the first term of a Taylor's expansion for a was used.

It is proposed to use the method described with that described by Reich and Depp,[4] with a modification to control time of de-ionization, to study the effect of the application of various voltage wave shapes on the ignition voltage, not only as a check on Eq. (1) for the initial breakdown, but also to determine the effects of change of de-ionizing time.

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[1] H. J. Lindenhovius, Physica **4**, 1212 (1937).

[2] M. Steenbeck, Veröff. a.d. Siemens-Konz. **9**, 83 (1930); A. V. Engel, and M. Steenbeck, *Elektrische Gasentladungen* (Julius Springer, 1934), Vol. II, p. 178.

[3] H. J. Reich, Rev. Sci. Inst. **2**, 164 and 234 (1931).

[4] H. J. Reich, and W. A. Depp, J. App. Phys. **9**, 421 (1938).