to side in the specimen. However, the magnitude of the displacement is about ten times larger than would be expected from the twinning of one pair of planes. The net volume contraction of the tin as viewed from the quartz is about 10^{-8} cm^3.

Somewhat similar experiments carried out with large aluminum crystals failed to give detectable signals.

On the Mechanism of Electron Emission at the Cathode Spot of an Arc

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April 5, 1948

THE experiments of Smith[1] on the thickness of the mercury arc cathode dark space show that the hypothesis of field emission fails to account for the high current densities (10^4 amp./cm^2) observed at the cathode spot.

The fact that the arc can be extinguished by a current interruption of less than 10^{-8} second,[2] together with evidence indicating a low cathode temperature even at the arc spot itself, shows that thermionic emission is also inadequate.

Smith's[3] theory ascribing the high current density to thermal excitation of the conduction electrons runs into the following difficulty, which applies to thermionic emission as well. Taking the diameter of an arc spot as 10^{-2} cm, the velocity of the spot in a magnetic field as 10^4 cm/sec.[3,4] the arc current as 1 ampere, and the cathode fall as 10 volts, we see that the cathode spot must be excited to full emission in 10^{-6} second by an energy of only 10^{-5} watt second. Furthermore, it is hard to conceive of any plausible mechanism for preventing the "hot" electrons in the cathode spot from losing their energy by interacting with other conduction electrons and even with the atoms of the cathode.

The hypothesis that the entire current is carried by positive ions[5] runs into difficulties such as communicating too much momentum to the cathode, accounting for the high temperature, and inability to explain why an interruption of less than 10^{-8} second should extinguish the arc.

A new theory is proposed that is applicable to the class of arcs characterized by relatively low spot temperature and relatively high spot mobility, e.g., liquid cathodes, Cu, Ag, Au, Fe, Ni. The mechanism may play a partial role in other cases as well. It is assumed that a region possibly 10^{-5} cm thick of very dense metallic vapor exists immediately adjacent the cathode spot. The high density perturbs the atomic fields so that the normally sharp energy levels are spread into bands, including conduction bands. Metallic conduction is then possible from the cathode to this region, which is at a sufficiently high temperature to emit thermionically into the plasma. The ions bombarding the cathode serve to maintain the high local density.

From the work of Birch[6] on the conductivity of Hg in the supercritical region, it appears that a particle density N equal to 10^{22} atoms per cc gives essentially metallic conduction. Consider the arc spot. If n atoms leave it per cm^2 per sec. with a velocity distribution $f(c)$, the particle density in a layer of thickness d outside it is given by

$$p=(1/d)n\int_0^\infty f(c)(\alpha/c)dc=n\int_0^\infty f(c)(dc/c)=N=10^{22}, \text{ say.}$$

To estimate n, we recall a current density of 10^4 amp./cm^2, about 10 percent of which is carried by ions, giving 6×10^{21} ions/cm^2/sec. bombarding the Hg arc spot. This is about ten times the net "evaporative" loss, so somewhat more than this number of atoms leave the cathode. The coefficient of accommodation is probably small, so many of them leave with large velocities giving small contributions to the integral. For want of a better choice at this time, we describe the low velocity fraction by a Maxwellian distribution corresponding to an effective temperature T. We have

$$p=\left[4n\Big/\left(\frac{\pi 2kT}{m}\right)^{\frac{1}{2}}\right]\int_0^\infty xe^{-x^2}dx=N,$$

whence

$$n/(T)^{\frac{1}{2}}\simeq 10^{-4}\ N.$$

Taking $N=10^{22}$, $n=10^{19}$ gives $T=100°K$, $n=10^{20}$ gives $T=10^4$. In view of experimental uncertainties, this can be considered satisfactory.

Additional evidence in favor of the conduction theory is afforded by Smith's[1] observation that a continuous spectrum originates within 10^{-3} cm from the cathode surface. As is well known, continuous spectra can be obtained from high pressure Hg lamps.

Mierdel's[2] work gives an independent estimate of the thickness of the dense region. If the arc conduction atoms are leaving with velocities of 10^4 or 10^5 cm per Mc and the source is cut off for 10^{-8} or 10^{-9} second, they can move 10^{-4} or 10^{-5} cm in this time. The fact that this extinguishes the arc indicates that the dense region is somewhere near this thickness or less.

A more detailed paper working out various refinements and consequences of the theory is in preparation.

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Hyperfine Structure in the Spectrum of Np^{237} *

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April 5, 1948

IN the course of numerous routine spectrographic analyses of very small samples of Np^{237} it was observed that many of tne neptunium lines appeared very broad, even under moderate dispersion (5A/mm), suggesting the presence of wide hyperfine structure.[1] The widest neptunium line in the region investigated, at 3829.15A, was then photographed by use of the third order of a Baird