Arc Temperature at Breaking of Au Contact

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Abstract

The arc temperatures at breaking of Au contact were obtained by the spectroscopic measurement. It has been done at DC60V and 2, 3 and 5A. The value of arc temperature obtained was 6500 °K to 7500°K. The temperature of contact arc was indipendent for the change of current through the contact. In this case, the current density of the anode spot on Au contact is about $10^3 A/cm^2$ and is constant. And it was shown that a thermal equilibrium has existed in this arc column from the relation between the relative intensity of Au$_I$ lines and the upper level for each spectrum.

1. Introduction

A phenomena of the thermal ionization of atoms and the re-combination of electron-positive ion have occured too much in an arc column of contact arc. This arc has continued under the condition which the thermal ionization has equilibrated to the re-combination. In order to analyze these phenomena in this arc column, the measurements of the electron density and the arc temperature in an arc column is absolutely necessary. The present paper is touched upon the arc temperature at breaking of Au contact.

Up to the present, the some studies have been taken on it. The present author has estimated the arc temperature of Ag-n%CdO contact by measuring the ratio of the relative intensities of a pair of spectrum[1]. Let us neme Method 1 for this. T. Aida et al. have obtained the arc temperature of Ag-Cd contact from a plot of the relative intensities of Ag$_I$ spectra versus the excitation potential for each line[2]. Let us name Method 2 for this. In the present peper, the arc temperature at breaking of Au contact was obtained from Method 2, and this arc was added the consideration about a thermal equilibrium from a plot of the relative intensities of Au$_I$ spectra versus the excitation potential for each line.

2. Experimental Procedure

The contact material used is Au. and its shape is a flat surface in the

cathode, and a spherical in the anode. Its size is $5\phi \times (3{\sim}5)$mm.

The experimental circut consists of the serial contacts, c_1 and c_2. The circuit is adjusted so that the arc at c_1 will arise only when c_1 breaks, and that at c_2 will do so only when c_2 makes. The current is supplied from batteries, and a water resistance is used as a load to prevent any inductance. The source voltage is DC 60 volts, and the current is 2,3 and 5 amperes.

The contact arc at breaking is gathered on a slit of the spectroscope by using a convex lens and is splitted into some spectral lines on the photograph of arc spectra. After the films were developed, the relative densities of spectral lines were measured with the microphotometer. The film is NEOPAN SSS (PANCHROMATIC), ASA : 200, which is developed for 9 minutes at $21 \pm 1°C$

3. principle of Measurement

The Einstein—Boltzmann equation for the intensity of spectral line can be written in the form[3],

$$I = N\frac{g}{u}Ah\nu \exp\left(-\frac{E}{kT}\right) \tag{1}$$

where N is the particle density of the ground state and u is the partition function for any pairticular atom or ion; h is Planck's constant; k is Boltzmann's constant; E is the energy of the upper level and g is the statistical weight of the upper level; A is Einstein's transition probability, I is the intensity and ν is the frequency of the line; T is the absolute temperature of a source which follows a Boltzmannian distribution of energy.

Substituting $\nu = c/\lambda$, where c is the light velocity and λ the wavelength of the line, and changing into logarithmic form (base 10), equation (1) becomes

$$\log\frac{I\lambda}{gA} = \log\frac{Nhc}{u} - \frac{0.434E}{kT} \tag{2}$$

The first term on the right of (2) is a constant for any particular element in this arc. We set it equal to C and solve for T. Introducing a value for k,

$$T = -\frac{625\,E}{\log\dfrac{I\lambda}{gA} - C} \tag{3}$$

where T is in °K and E is in units of 10^3 cm^{-1} which we will call kilokaysers (1kK=1000cm^{-1}). The value of T is most conveniently obtained from a plot of $\log I\lambda/gA$ versus E for each spectrum in which relative values of gA are known. The constant C does not affect the slope of the line from which T is determined.

In the present measurement, the spectroscope used is able to measure from 4000 Å to 7000Å about the wavelength range. The Au I spectra in this wavelength range are shown in Table 1[4]. As shown in Table 1, the number of lines are 7. The arc temperature of contact is determined by comparison of

Table. 1. Wavelength, spectrum, energy level and
         gA value of Au

Wavelength Å	Spectrum	Energy Levels K	gA value 10/sec.
4315.09	Au I	45537—68705	1.3
4437.27	Au I	46174—68705	0.78
4488.25	Au I	45537—67812	1.6
4607.34	Au I	47007—68705	6.1
4792.60	Au I	41174—62034	2.9
5837.40	Au I	37359—54485	1.0
6278.18	Au I	21435—37359	0.048

intensities of 7 spectral lines with published relative gA-values.

4. Results

The relations between log ratio of intensity $\times \lambda$ to gA-value for lines of Au I in the arc at breaking of Au contact and the upper level for each spectrum are shown in Fig. 1, 2 and 3. These are in cese of 2, 3 and 5 amperes at DC
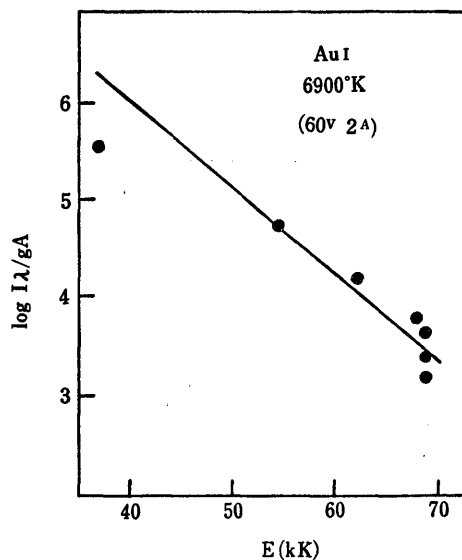

Fig. 1. Log ratio of intensity $\times \lambda$ to gA for lines of Au in the contact are plotted versus upper level. An arc temperature of 6900° K is derived from the slope of the line of best fit.

60 volts, respectively.

The arc temperatures determined from the slope of the plot were given in Table 2. As shown in Table 2, we can not find the differences between the arc temperatures for every current. This result is as well as the result on the arc temperature on Ag-n% CdO contact[1]. The value of arc temperature
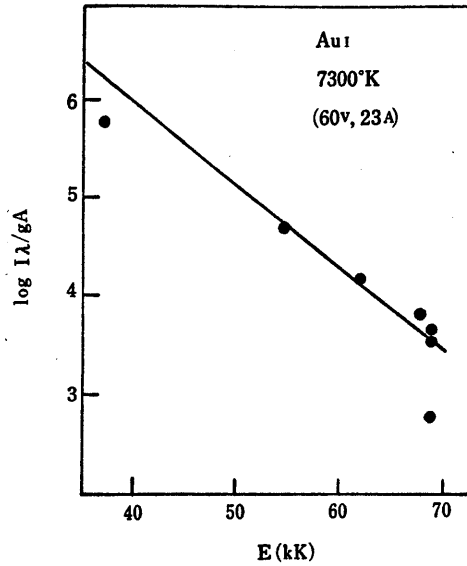
Fig. 2. Log ratio of intensity× λ to gA for lines of Au
in the contact arc plotted versus upper level.
An arc temoerature of 7300₀ K is desived from
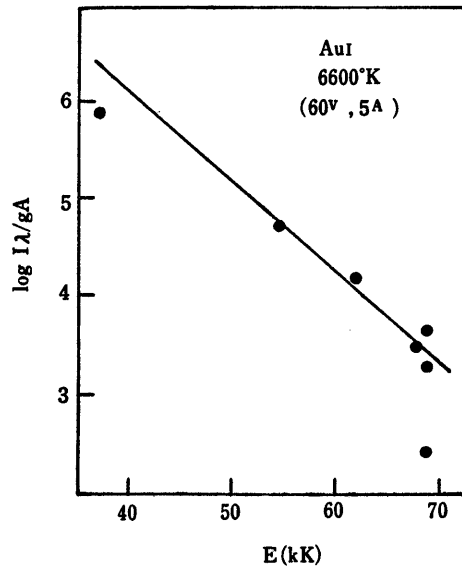the slope of the line of best fit.

Fig. 3. Log ratio of intensity× λ to gA for lines of
Au in the contact arc plotted versus upper
level.
An arc temperature of 6600° K is derived from
the slope of the line of best fit.

Table. 2. Arc temperatures at breaking of Au contact
obtained from each experiment.

Experimental condition	DC 60V, 2 A	DC 60V, 3 A	DC 60V, 5 A
Individual determination	6900°K	7300°K	6600°K
		7500°K	7100°K
		7200°K	6800°K
mean value	6900°K	7330°K	6850°K

was estimated to be 6500°K to 7500°K.

As shown in Fig. 1, 2 and 3, these slope of the lines fits in the measuring point for each line.   From these results, it is considered that the thermal equilibrium has existed in the arc column at breaking of Au contact.

5. Discussion of Results

These plots of Au data from the experiment are long and straight, but show some scatter. And the present measurement covers a long range of E, whose range is between 37kK and 49kK, but it is a small number of lines.

No comparable values find to the results on the arc temperature of Au. It is considered that these arc temperatures are reasonable value from the good plot of Au data.

As the contact arc is a transient phenomenon, so the arc current density is more reasonable than the current through the contacts on the electric con-
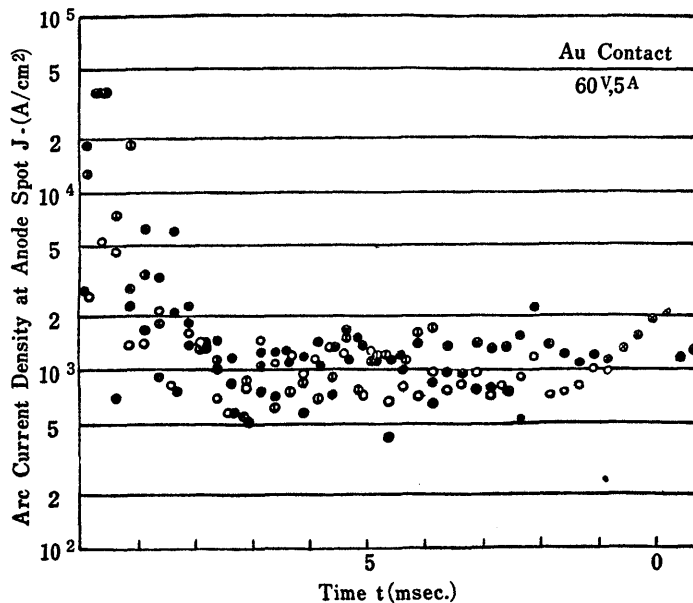
Fig. 4. Change of arc current density at anode spot with the lapse of
time: Au contact, DC 60V, 5A.

dition which prescribes on the arc temperature. The current density at anode spot of Au contact is shown in Fig. 4. As shown in Fig. 4, its value is about 10^3 A/cm^2.

6. Conclusion

The arc temperature at breaking of Au contact was measured photo graphically. The conclusions obtained are as follows.

(1) The values of arc temperature of Au contact are 6500°K to 7500°K.

(2) The plots of Au data are good, and show that the thermal equilibrium exists in this arc column.

(3) The current density at anode spot of Au contact is about 10^3 A/cm^2 and is constant.

More reasonable value of arc temperature may be obtained by using a lerge number of Au$_I$ lines.

Feferences

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