<table>
<thead>
<tr>
<th>項目</th>
<th>内容</th>
</tr>
</thead>
<tbody>
<tr>
<td>概要</td>
<td>Arc temperature at breaking of Au contact</td>
</tr>
<tr>
<td>著者</td>
<td>Itoyama, Kagehiro</td>
</tr>
<tr>
<td>引用</td>
<td>長崎大学教育学部自然科学研究報告. vol.25, p.99-104; 1974</td>
</tr>
<tr>
<td>発行日</td>
<td>1974-02-28</td>
</tr>
<tr>
<td>URL</td>
<td><a href="http://hdl.handle.net/10069/32969">http://hdl.handle.net/10069/32969</a></td>
</tr>
</tbody>
</table>

NAOSITE: Nagasaki University's Academic Output SITE
http://naosite.lb.nagasaki-u.ac.jp
Arc Temperature at Breaking of Au Contact

Kagehiro ITOYAMA

Faculty of Education, Nagasaki University, Nagasaki

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°C to 7500°C. The temperature of contact arc was independent for the change of current through the contact. In this case, the current density of the anode spot on Au contact is about 10⁴A/cm² 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 AuI 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 occurred 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 name 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 AgI spectra versus the excitation potential for each line(2). Let us name Method 2 for this. In the present paper, 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 AuI 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 5φ×(3~5)mm.

The experimental circuit consists of the serial contacts, c₁ and c₂. The circuit is adjusted so that the arc at c₁ will arise only when c₁ breaks, and that at c₂ will do so only when c₂ 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 ± 1°C.

3. principle of Measurement

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

\[ I = N \frac{G}{u} Ah \nu \exp\left( - \frac{E}{kT} \right) \]  

(1)

where \( N \) is the particle density of the ground state and \( u \) is the partition function for any particular 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 \( \nu \) 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 \( \lambda \) the wavelength of the line, and changing into logarithmic form (base 10), equation (1) becomes

\[ \log \frac{I\lambda}{gA} = \log Nhc - \frac{0.434E}{kT} \]  

(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 \( k \),

\[ T = - \frac{625 E}{\log \frac{I\lambda}{gA} - C} \]  

(3)

where \( T \) is in °K and \( E \) is in units of 10⁹ 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 AuI 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

<table>
<thead>
<tr>
<th>Wavelength (Å)</th>
<th>Spectrum</th>
<th>Energy Levels (K)</th>
<th>( gA ) value (10/sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4515.09</td>
<td>Au I</td>
<td>46537–68705</td>
<td>1.3</td>
</tr>
<tr>
<td>4437.27</td>
<td>Au I</td>
<td>46174–68705</td>
<td>0.78</td>
</tr>
<tr>
<td>4488.25</td>
<td>Au I</td>
<td>45537–67812</td>
<td>1.6</td>
</tr>
<tr>
<td>4607.34</td>
<td>Au I</td>
<td>47007–68705</td>
<td>6.1</td>
</tr>
<tr>
<td>4792.60</td>
<td>Au I</td>
<td>41174–62034</td>
<td>2.9</td>
</tr>
<tr>
<td>5839.40</td>
<td>Au I</td>
<td>37359–54485</td>
<td>1.0</td>
</tr>
<tr>
<td>6278.18</td>
<td>Au I</td>
<td>21455–37359</td>
<td>0.048</td>
</tr>
</tbody>
</table>

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 cases of 2, 3 and 5 amperes at DC 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 $I_A$ to $g_A$ for lines of Au in the contact arc plotted versus upper level. An arc temperature of 7300$^0$ K is derived from the slope of the line of best fit.

Fig. 3. Log ratio of intensity $I_A$ to $g_A$ for lines of Au in the contact arc plotted versus upper level. An arc temperature of 6600$^0$ 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.

<table>
<thead>
<tr>
<th>Experimental condition</th>
<th>DC 60V, 2 A</th>
<th>DC 60V, 3 A</th>
<th>DC 60V, 5 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual determination</td>
<td>6900°K</td>
<td>7300°K</td>
<td>6600°K</td>
</tr>
<tr>
<td></td>
<td>7500°K</td>
<td>7100°K</td>
<td>6800°K</td>
</tr>
<tr>
<td>mean value</td>
<td>6900°K</td>
<td>7300°K</td>
<td>6850°K</td>
</tr>
</tbody>
</table>

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-

![Graph]

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/cm².

6. Conclusion

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

(1) The values of arc temperature of Au contact are 6500ºK to 7500ºK.
(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/cm² and is constant.

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

References

(2) T. Aida : Simpo. of elect. and mechani. parts of IECE, EMC 72-8, (1972).