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CN MOLECULAR BANDS IN A FREE BURNING METAL ELECTRODES ARC

G. Buchet, R. Haug and J. Maftoul.


1. Introduction

The behavior of the arc, the electrode erosion and the stability depend on the material of the electrodes used and on the ambient gas. The knowledge of the arc spectrum is an important tool in order to explain the above mentioned phenomena. We have shown that a temporal correlation exists between spectral lines intensity and arc voltage fluctuations [1]. The molecular bands having a positive correlation coefficient are identified here as well as the origin of the responsible radical.

2. Experimental Techniques and Results

The spectrum of free burning arcs in air, N₂, air + CO₂ and Ar + O₂ mixtures has been studied. The electrodes were of different purity grades of copper. The experimental setup is shown in fig. 1. The voltage used was 250 V with a current of 1.5 A, and a gap spacing of 2-3 mm. Under these conditions the arc is rather stable and the spectrum can be recorded for a relatively long period of time ( ~ 30 min ) which allows the same wavelength interval to be repeated several times. The reproducibility of the spectra is satisfactory. The photomultiplier current and the arc voltage are synchronously sampled with a frequency in the 1 kHz-1 MHz range and recorded in a wave memory recorder (2 x 1024 samples). The samples are then displayed on an X-Y oscilloscope (X for light and Y for voltage). The set of points statistically characterize the mentioned correlation. Fig. 2 refers to a Copper line (5153 Å) - fig. 3 refers to the head of molecular band (3883 Å) for a free burning arc in air. The comparison between figs 2 and 3 shows that the average slopes of the clouds of points are opposite. Precisely, on fig. 2 the light intensity increases which diminishing arc voltage and inversely on fig. 3. Exploring the arc column in air with industrial copper electrodes, the violet system of molecular bands of CN in the region 3850-4216 Å was found.

\[ B^2 \Xi^+ \rightarrow X^2 \Xi^+ \quad \Delta v = 0, \Delta v = 1 \]

To solve the problem of the origin of CN, the electrodes were replaced by ultrapure copper electrodes (99.995 %). The molecular bands were still visible (fig. 4). When arc was burning in air, but they disappeared (for both types of electrodes) when air was replaced by mixtures of Ar and O₂ (both of 99.995 % purity) as it is clear from fig. 5.

For arcs burning in an atmosphere of N₂(99.995%) the molecular bands of nitrogen are so intense that it is impossible to detect the molecular bands of air burning. CN. It is interesting to remark that in an arc with small currents (< 3 A) the molecular bands of nitrogen are not observed. For an arc burning in CO₂ enriched air we observed that the CN molecular bands intensity increased considerably (500-1000 times).

This fact additionally proves an atmospheric origin of CN. The measurements of the CN molecular bands intensity allow to estimate the CO₂-concentration.

It appears [2] that in the system C-O-N the concentration of CN radical increases with increasing gas temperature. For temperatures of T > 6000°K in the free burning arc in air only three types of radicals and atoms exist: CN, N, O.

3. Conclusions

The experiments show that radicals of CN found in the arc burning in air have an atmospheric origin. When metal vapour emission ceases the arc voltage increases due to decreasing conductivity and synchronously the CN band intensity increases.
4. Références

1. M.G. Drouet, R. Haug, M. Goldman,
   31th Annual Gaseous Electronics Conference,
   Buffalo, New York.
2. J. Amouroux,
   Private Communication.

Fig. 1 Experimental setup

M - mirror, W - quartz window
In - inlet for gas injection
B - box, S - spectrometer
PM - photomultiplier, Rg - recorder

Fig. 2 Correlation between light intensity
(λ = 5153 Å - Cu line) and arc voltage.

Fig. 3 Correlation between light intensity
(λ = 3884 Å - head of CN molecular band)
and arc voltage.

Fig. 4 Spectrum of an arc burning in air.

Fig. 5 Spectrum of an arc burning in Ar + O₂ mixtures.