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LOW-PRESSURE ARC AS A SOURCE FOR MOLECULAR SPECTRA

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The arc discharge, besides the flames, discharge tubes and high temperature furnaces, is an important source of emission molecular spectra[1, 2]. The arc burning between metal electrodes in different atmospheres at reduced pressure, provides the useful source for the production of molecular spectra of oxides, hydrides and halides of different metals[3, 4, 5]. The present paper describes the construction, and some results obtained in the study of the low-pressure arc used as a source of electronic molecular spectra.

A shematic diagram of the low-pressure arc chamber is given in Fig. 1. The cylindrical vessel is made of quartz glass, having an outer diameter of 100 mm, and hight of 150 mm. The outer wall consists of water-jacketed aluminium cylinder. Water cooled electrode holders with ground glass joins, allow easy removal of the electrodes for replacement and cleaning. The arc chamber is connected to a vacuum line, and a silicon manometer was used for measuring the oxygen pressure.

The current from 0.5 to 1.8 A, and potential of $U = 650 - 700$ V have been used with cobalt, nickel and iron electrodes and the pressures between 30 and 250 mm Hg of oxygen. The arc is ignited by a sparc discharge from an-auxiliary circuit.

The low-pressure arc produces a plasma, which could be devided in to two zones. The central »blue« zone between electrodes about 5 mm in diameter, surrounded by a large transparent low-temperature zone roughly conical in shape. The predominant color of the low-temperature zone is gray. By increasing the amount of dry oxygen, the diameter and the length of this zone is increased also. The increase of the electrode gap to 50 mm was followed by the increase of the diameter and the length of the gray zone.

The emission spectra obtained by the low-pressure arc with iron, nickel and cobalt electrodes look different from those of the ordinary arc. In the blue zone, the oxide spectra are poor, with large number of atomic lines on a continuous background. The low-temperature zone, which was used as the source, is characterized by a strong molecular spectra of oxides, and a few weak atomic lines. The detected lines belong to neutral atoms, with the intensities much smaller than those of the arc in air. In the iron arc spectra all lines with upper level more than $E_{Fe} \simeq 32000$ cm^{-1} are of a very low intensity or completely absent, which is in agreement with Dhumvord's

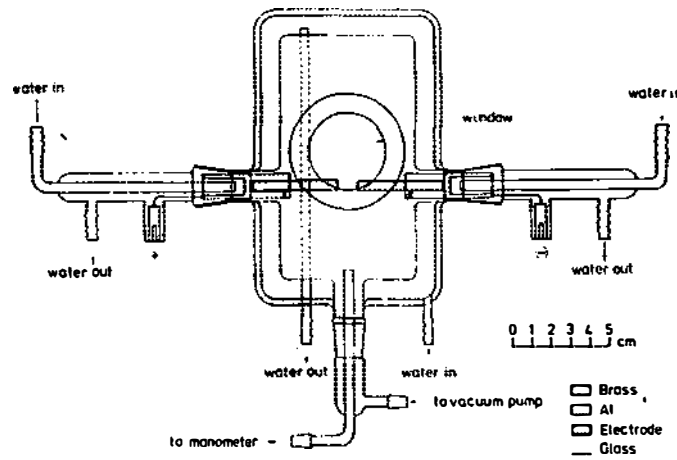

Fig. 1. Schematic diagram of the low-pressure arc chamber.

results[6]. Molecular spectra show orange bands (Systems A and B) and infra red system D of FeO molecule[1]. Using nickel electrodes red-degrading complex bands in the region between 4300 and 8500 A assigned to NiO molecule by Malet and Rosen[7], have been detected. The band spectrum was accompanied by few lines of NiI with the excitation energy $E_{Ni} \simeq 37000$ cm^{-1}. The lines with the upper level more than this value are very weak or absent.

The same procedure with cobalt electrodes has been used for obtaining cobalt oxide spectra in the visible and near infra-red region[7]. In this case, similar to nickel and iron arc, only a few cobalt lines which belong to neutral CoI atom, with the upper level up to $E_{Co} \simeq 34500$ cm^{-1} have been detected.

Apart from the oxide spectra in the oxygen atmosphere without special care, N_2, CN and OH as well as metal oxides were present. The weak OH bands, specialy 3064 A, were present in spite of dry oxygen used in the chamber. The most careful drying is necessary to reduce their intensity.

By using the rotational lines from OH 3064 A band (3068.28, 3069.18, 3069.67, 3071.14, 3073.03, 3074.37, 3077. 03 A) and procedure given in Ref.[8, 9], the temperature of the source was measured. The temperature was measured in the

Fig. 2. The portion of the spectrum obtained on a 2 m grating spectrograph;

a) Low-pressure arc spectrum of NiO (Ni electrodes, pO_2 — 160 mm Hg, U — 680 V, I — 1.2 A),

b) Nickel ordinary arc spectrum,

c) Iron arc spectrum.

low-temperature zone 5 mm above the electrodes. Under experimental conditions used for obtaining well developed molecular spectra, the measurements indicated the rotational temperature of 3100 ± 150 K.

Our experience with this source is that the low-pressure arc is very simple to operate, has a high degree of stablity which allows as long as 5 hours continuous operation. The particular advantage of the source is the lack of the line spectra which make its very convenient source of the electronic spectra of quite different molecules.

References

1) R. W. Pearse and A. G. Gaydon, The identification of molecular spectra 3 rd. Ed. Chapman Hall London 1963;
2) B. Rosen, Données spectroscopiques relatives aux molécules diatomiques. Pergamon press. Oxford, 1970;
3) A. G. Gaydon, Proc. Roy. Soc. **231A**, (1955) 437;
4) S. Trojmar, UCRL-9773 (1961);
5) B. K. Dhumword and A. M. Bass, Appl. Opt. **2**, (1963) 1335;
6) R. K. Dhumward and N. A. Norasimham, Proc. Ind. Acad. Sci. **64** (1966) 283;
7) L. Malet and B. Rosen, Bull. Soc. Roy. Sc. Liege **14**, (1945) 382;
8) C. Feldman, Spectrohim. Acta **9**, (1957) 19;
9) R. A. Tourin, Spectroscopic gas Temperature Measurements, Elsevier, Amsterdam, 1966.