

LETTER TO THE EDITOR

JET-PLASMA AS A SOURCE FOR MOLECULAR SPECTRA

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A source for molecular spectra of some metal oxides, based on the fact that such spectra can be obtained in the aureole of an arc is described in the paper. The jet electrode extends the aureole separating the molecular from atomic spectrum. The estimated jet-plasma source temperature is 3100 K.

Studies of molecular spectra require invention of new sources, as well as improvement of the ones already in use. Many different sources have been used so far for producing molecular spectra, such as: flame¹⁾, exploding wire technique²⁾, arc discharge in different atmospheres, at reduced or atmospheric pressure^{3,4)}, high temperature furnace^{5,6,7)}, discharge tube^{8,9)}, etc. A source based on the fact that spectra of some metal oxides are obtained in the aureole of the arc¹⁰⁾ has been described in this paper. The jet electrode, so far used mainly in atomic spectroscopy¹¹⁾, extends the arc aureole, that is, the useful part of the plasma column and increases efficiency of the source.

The jet-plasma source is a particular modification of a d. c. arc burning in oxygen atmosphere. A schematic diagram of that source is given in Fig. 1. The lower, jet electrode, of the vertical arc consists of a metal rod (1), screwed into the massive body (2) of the electrode, in order to provide the oxide spectrum. A gas inlet (3) at the bottom of the massive body completes together with the internal channels (4) compact design of the jet electrode. Precise centering of the rod in the body provides a uniform oxygen stream round the electrode, which expels the plasma column through a ring shaped counter-electrode (5). To facilitate regular flow of oxygen the upper, ring electrode, has a conical cavity (6) on its lower side. Both electrodes are made of the same metal and screwed into water cooled metal holders (7). The arc is ignited mechanically.

The power for this source is supplied from a three-phase rectifier of the available a. c. mains. The voltage at the terminals of the power supply is 550 V, which makes it possible to choose proper current intensity. In our experiments, the current was varied between 0.5 and 6 A, and the oxygen flow rate, which depends on the inter-electrode distance and applied current, about 1.5 l/min. Emission intensity of the source increases with applied current, enabling about ten fold reduction of the exposure time.

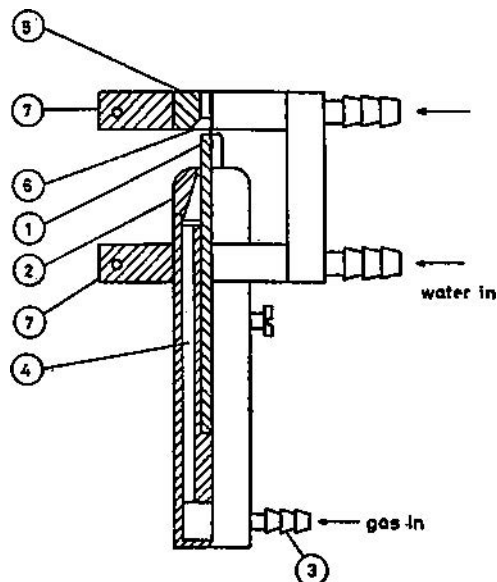


Fig. 1.

Two zones are recognizable in the plasma cone formed above the ring electrode: the internal, »blue« zone in which both atomic and molecular spectra are obtained and the external, »pale orange« zone — the aureole of the arc — in which a strong molecular spectrum and a few weak atomic lines can be seen. The portion of the CoO spectrum obtained on a 3m grating spectrograph is shown in Fig. 2, where (a) is the spectrum obtained in the aureole of the jet-plasma arc, (b) the spectrum obtained in the intense, blue zone of this arc, and (c) is the atomic spectrum of cobalt in air. As can be seen the number of atomic lines, and their intensity, decrease towards the outer parts of the arc.

By comparing excitation potentials of the lines that occur in the spectrum of the jet-plasma source and in the spectrum of the arc at reduced pressure⁴⁾, we can conclude that the temperature of both sources is of the same order of magnitude, 3100 K.

Besides the cobalt electrodes, we also used nickel and iron electrodes in this source. In all cases, we obtained molecular spectra of oxides with the bands consistent with the literature data^{1 2, 1 3)}.

Although open construction of the jet-plasma source makes superfluous the use of, sometimes indispensable, expensive and rare gases, its great advantage is just its simplicity of design, and, as a result, easy handling, in which way rather complex operations of obtaining and maintaining low pressures are avoided. Cleaning and replacement of consumed electrodes are also easier. Simplicity of this source promises easy obtaining of molecular spectra in absorption, with, of course, a minimum of additional external optics. The great stability of the jet-plasma source, which is achieved by correct centering of the jet electrode (i. e. uniform flow of the working gas round the electrode) and by appropriate choice of the working current, makes it especially suitable for the studies of molecular spectra, whereby long exposures are often needed.

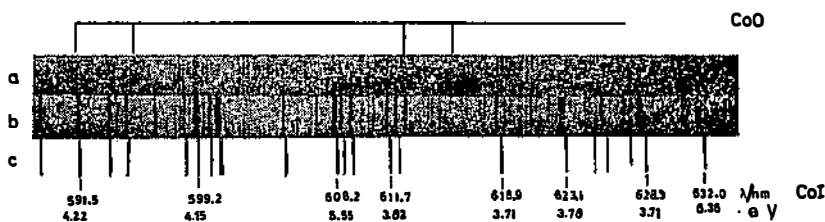


Fig. 2.

References

- 1) A. G. Gaydon, *The Spectroscopy of Flames*, Chapman and Hall, London (1974);
- 2) B. Rosen, *Nature* **156** (1945) 570;
- 3) A. G. Gaydon, *Proc. Roy. Soc.* **231A** (1955) 437;
- 4) B. R. Vujisić and D. S. Pešić, *Fizika* **4** (1972) 69;
- 5) F. S. Tomkins and B. Ercoli, *Appl. Opt.* **6** (1967) 1299;
- 6) S. M. Chernin and A. A. Malcev, *PTE* no. 1 (1967) 173;
- 7) V. Srdanov, N. Strajin, D. Pešić and J. Janjić, *Zbornik radova PMF*, no. 5, Novi Sad (1975);
- 8) G. Herzberg, *Spektri i strukture prostih slobodnih radikala* (prevod), Građevinska knjiga, Beograd (1982);
- 9) R. Bacis, *J. Phys. E: Sci. Instr.* **9** (1976) 1081;
- 10) L. Malet and B. Rosen, *Bull. Soc. Roy. Sci. Liège* **14** (1945) 382;
- 11) Rank Hilger, Report No B08/E/790901 (1979);
- 12) B. Rosen (Ed.), *Données Spectroscopiques Relatives aux Molécules Diatomiques*, Pergamon Press, Oxford (1970);
- 13) R. W. B. Pearse and A. G. Gaydon, *The Identification of Molecular Spectra*, Chapman and Hall, London (1976).

JET-PLASMA KAO IZVOR ZA MOLEKULSKE SPEKTRE

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U ovom radu opisan je izvor za dobijanje molekulskih spektara oksida nekih metala-zasnovan na činjenici da se takvi spektri mogu dobiti u oreolu luka. Jet elektroda izdužuje oreol luka i na taj način izdvaja molekulski spektar od atomskog. Temperatura izvora jet-plasma procenjena je na 3100 K.