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Note

Emission Spectrum of Zinc Oxide between 6000 and 5000 Å

D. S. Pešić

The Boris Kidrič Institute of Nuclear Sciences, Belgrade, Serbia, Yugoslavia

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Mohler and Moor[1] observed in the region between 3000 and 2500 Å a suite of absorption bands emitted from zinc vapour, which they ascribed to zinc oxide. The spectrum of zinc vapour in the same region was found by Walter and Barrott[2]. On the basis of the experimental conditions they suggested Zn_2, ZnCl and ZnO as emitters of these bands. Since it has not been confirmed that ZnO is responsible for some of these bands, the results are not reliable and they are not included in Pearse and Gaydon's table[3]. Egerton and Rudrakanchana[4] obtained one red-degraded ZnO band at 3435.3 Å in diffusion zinc dimethyl flame with oxygen, and in an arc between pure zinc electrodes in air and in a mixture of $N_2 + O_2$. The band was visible only when oxygen was present, and authors considered it to belong to ZnO rather than to Zn_2 or ZnN. Parkinson[5] observed a band of the same wave-length in emission when zinc oxide was subjected to shock excitation in argon, and he suggested a polyatomic oxide of zinc as the emitter in view of the analogy with polyatomic oxides of earth alkaline metals. To determine zinc by flame photometry[6-8] a continuum with a maximum at 5000 Å is used. However, no report on the emitter of this continuum has been given so far.

The purpose of the present investigation was to identify a group of new bands in the greenish-yellow region obtained in zinc arc in an atmosphere of oxygen. The experimental procedure and the results of the examination of this spectrum are presented.

EXPERIMENTAL

The emission bands were excited in a vacuum arc using water-cooled spectrographic pure zinc electrodes in an atmosphere of ordinary oxygen and in 98.4% oxygen 18. The arc was maintained with a 220 volt D. C. and a current of 0.8 Amps. The pressure of 15 mm. Hg was found to be favourable for the arc running. The discharge is of medium intensity and of a blue color. The spectrum was obtained using Hilger medium and large Littrow quartz prism instruments with a dispersion at 5600 Å of 88 Å/mm. and 30 Å/mm. respectively. The investigated region was photographed on Ilford HP 3 and Astra III plates. Exposures of 15 minutes on the medium and 1 hour on the large spectrograph were sufficient. The bands were measured against iron arc standard lines.

RESULTS

The bands started at 5200 Å and extended up to nearly 6000 Å. The strongest part of the spectrum lay between 5570 and 5800 Å. The appearance

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of the spectrum obtained with ordinary oxygen under low and medium dispersion is shown in Fig. 1. The mean of several measurements of the main heads with average precision of 0.2 Å, are given in Table 1. A great number of bands are degraded to the red, but some of bands on the short-wave side, either barely degraded to the red or show only a broad maximum. Bands appear diffuse with small dispersion, while under large dispersion they show a line-like structure, and it is difficult to localize the position of the heads.

TABLE I

Wavelengths of Outstanding Bands of Zinc in Oxygen 16

λ, Å	ν, cm.$^{-1}$	I*	Deg.	λ, Å	ν, cm.$^{-1}$	I	Deg.
5774.0	17314	4	R	5437.3	18386	7	R
5678.9	17604	10	R	5369.4	18619	8	R
5619.3	17791	4	R	5326.9	18768	8	R
5581.2	17912	7	R	5312.3	18819	3	R
5523.5	18099	4	R	5264.7	18989	3	M
5461.6	18305	4	R	5224.6	19135	3	M

* Intensities in the table are estimated visually on a scale of ten.

With the vacuum arc in oxygen 18, the spectrum in the same region was obtained (Fig. 1. *a*, *b*). Table 2 shows measured wavelengths of outstanding bands. The general appearance of the spectrum is similar to that obtained in ordinary oxygen, but with definite isotope shift. A correlation between bands obtained in ordinary and isotopic oxygen can be made with certainty only for intense bands. The strongest bands in ordinary oxygen are at 17604, 17791 and 17912 cm.$^{-1}$ The corresponding bands in oxygen 18 are shifted to the red and lie at 17529, 17725 and 17838 cm.$^{-1}$ This is a shift of 75.66 and 74 cm.$^{-1}$ For weaker bands shifts are also observed, but they are irregular and attempts to establish the correlation between the two systems have had little success.

TABLE II

Wavelengths of Outstanding Bands of Zinc in Oxygen 18

λ, Å	ν, cm.$^{-1}$	I	Deg.	λ, Å	ν, cm.$^{-1}$	I	Deg.
5703.3	17529	10	R	5370	18616	4	M
5640.2	17725	4	R	5258	19013	4	M
5604.4	17838	7	R	5225	19133	3	M
5578.7	17920	3	M	5006	19970	1	M
5546.3	18025	3	M	4958	20163	2	R
5512	18137	3	M	4892.2	20435	5	R

The spectrum described can be with considerable certainty assigned to a molecule containing only oxygen and zinc atoms. Experiments have shown that oxygen and zinc had to be present for the bands to appear. Measured well-marked isotope shifts when ordinary oxygen was replaced with oxygen 18, show that oxygen is present in the emitting species. When running zinc arc in an atmosphere of argon, nitrogen, hydrogen and water, no spectra which

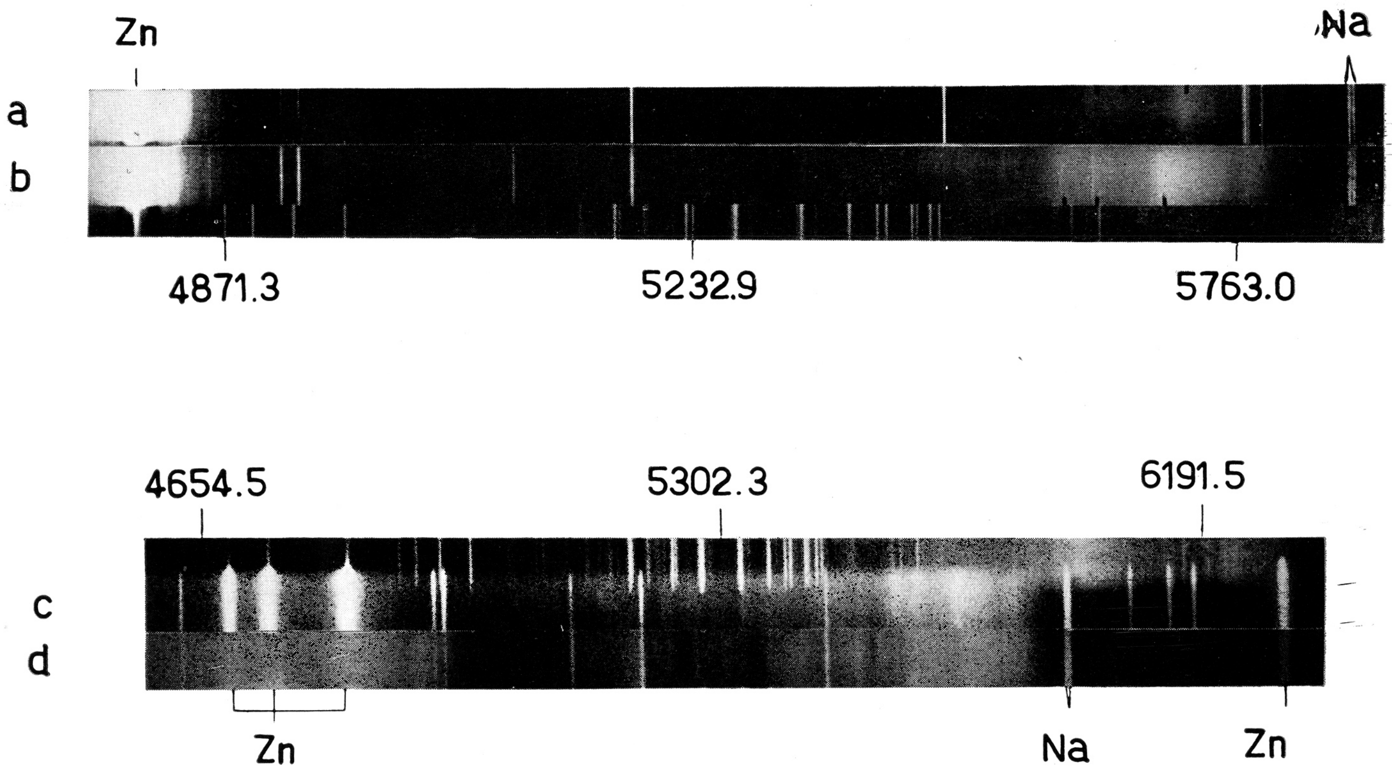

Fig. 1. Part of the spectrum showing diffuse zinc oxide bands. Spectra *a* and *d* — Zinc metal in vacuum arc in oxygen 18. Spetra *b* and *c* — Zinc metal in vacuum arc in oxygen 16. Strips *a* and *b* show spectra taken with a large quartz Littrow spectrograph, and *c* and *d* with a medium quartz spectrograph.

could be identified with an observed spectrum were found in the examined region. Absence of the spectra is interpreted as a proof that Zn_2, ZnN, ZnH and ZnOH are not emitters of these bands.

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IZVOD

Emisioni spektar cink-oksida između 6000 i 5000 Å

D. S. Pešić

Korišćenjem vakuumskog luka sa cink-elektrodama dobijena je grupa novih emisionih traka u žuto-zelenom delu spektra. Trake se proređuju prema crvenom delu spektra, ili pokazuju samo maksimume, i imaju difuznu strukturu pri srednjoj disperziji. Spektar je snimljen u atmosferi oksigena 16 i oksigena 18 pri sniženom pritisku. Kod većine izmerenih traka utvrđeno je izotopsko pomeranje, pri zameni običnog oksigena njegovim izotopom 18. Na osnovu dobijenih rezultata spektar je pripisan cink-oksidu.

INSTITUT ZA NUKLEARNE NAUKE
»BORIS KIDRIČ«
BEOGRAD

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