ROTATIONAL ANALYSIS OF SOME OF THE BANDS OF THE ORANGE SYSTEM OF FeO

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Received June 20, 1966

ABSTRACT

The orange bands of FeO are excited in a low pressure arc in oxygen and photographed at dispersions of 0.8 and 0.5 Å/mm. respectively. Rotational analysis of five of the bands shows that they involve a $^1\Sigma - ^1\Sigma$ transition. The vibrational and rotational constants (in cm$^{-1}$) of the upper and lower $\Sigma$ states are found to be

<table>
<thead>
<tr>
<th>Lower state</th>
<th>Upper state</th>
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<tbody>
<tr>
<td>$B_\Sigma$</td>
<td>0.349, 0.306</td>
</tr>
<tr>
<td>$\alpha_\Sigma$</td>
<td>0.002, 0.003</td>
</tr>
<tr>
<td>$\omega_\Sigma$</td>
<td>870.7 ($\Delta G = 770.0$)</td>
</tr>
<tr>
<td>$\omega_\Sigma \chi_\Sigma$</td>
<td>4.3</td>
</tr>
</tbody>
</table>

In the low-pressure arc it is found that highly excited atomic lines appear very much reduced in intensity in contrast to spectra excited in an arc at atmospheric pressure.

INTRODUCTION

Emission spectrum of iron arc in air or oxygen consists of strong bands in the orange and infra-red which are attributed to FeO molecule (Rosen, 1945). A weaker system in the blue is emitted from exploding wires (Malet and Rosen, 1945). The orange bands, in the region 5300–6600 Å, are arranged into two systems, A and B, both involving a common final level. The A
system is found to consist of doublets though an electronic doublet could not arise from a neutral FeO molecule. Recently, Rosen in a compilation (Gatterer, Junkes and Salpeter, 1957) of molecular spectra of metallic oxides revised much of the earlier data on FeO bands and suggested further investigation of the bands be undertaken as the proposed analysis of the band systems was unsatisfactory and some of the bands were of doubtful origin. It is therefore thought worthwhile to investigate the conditions of excitation of the different band systems of FeO and study them under high resolution. The present paper deals with the A bands of the orange system and the results of their rotational analysis.

**Experimental**

The emission spectrum of the Fe arc in air or oxygen is always found to be overlapped heavily by the atomic lines of iron. Several methods of excitation like the hollow cathode discharge have been tried to see which source would favour molecular bands. Of all the sources tried, it is only a low-pressure (~5 cm.) arc that has been found to bring out the molecular bands almost to the exclusion of atomic lines (Dhumwad and Bass, 1963). Spectra resulting from such a low-pressure arc are photographed on the 9·15 m. concave grating spectrograph of the Argonne National Laboratory, U.S.A., in the second and third orders, at dispersions of 0·8 and 0·5 Å/mm. respectively. Eastman Kodak 103-0 plates are used to photograph the spectra. Atomic lines of thorium excited in a microwave discharge through thorium iodide, have been used as wavelength standards. The spectrograms have been measured on a photo-electric comparator and vacuum wave numbers of the spectral lines obtained using an IBM 7090 computer. Measurements of unblended and sharp lines are found to be accurate to ±0·02 cm.⁻¹

**Results**

(i) Vibrational Structure

The gross vibrational structure of the bands could be analysed into Deslandres scheme as shown in Table I. Delsemme and Rosen (1945) had earlier proposed a similar scheme. The band origins (found from the following rotational analysis) are given in italics below the band head data in Table I. As expected, the band origin data give a better fit in the vibrational scheme. It may be pointed out that \( v' \), \( v'' \) numberings are not absolute and may have to be altered when more extensive data become available.