CHAPTER 4
EXCITATION OF THO BANDS AND THEIR
CHARACTERISTIC FEATURES

4.1. Source.

As stated in previous chapters, ThO bands were excited using a d.c. arc source. A d.c. arc between copper electrodes fed with Thorium salts served as a source. Copper electrodes were preferred to carbon electrodes as the latter give CN bands in the region under investigation. Secondly, the consumption of copper electrodes is much less than that of carbon electrodes. This source was used to excite VO, TiO and ZrO by Leud and Kalsulkar. Copper electrodes 0.8 cm in diameter and approximately 10 cm in length were tapered to 0.3 cm. A hole 3 mm deep was drilled in them and fed with Thorium salts. Lower electrode served as the cathode. Arc was made to run at 1.5 to 2 amps and 110 volts.

Thorium Nitrate was found suitable for excitation. But in rainy season it becomes moist due to humidity and so Thorium Nitrate was converted to Thorium Oxide by heating it in a crucible till the brown fumes of Nitrous Oxide completely disappeared. Thorium Oxide thus obtained, was stored in a dessicator. The blue glow from the arc, which appears intermittently contains ThO bands. The arc unit was kept in the source room and the glow was focussed on the slit of the spectrograph (Fig. 4.1).
4.2. Recording of the spectrum.

4.2.1. Low resolution picture.

Spectra were first taken on Orwo films using Hilger constant deviation glass spectrograph, dispersion of which is approximately 40 Å/mm in the 4500 Å region. A few seconds exposure was found sufficient to record the spectrum.

4.2.2. High resolution picture.

The spectra were recorded with the fabricated 10.6 meter concave grating spectrograph to cover the range from 3000 Å to 5000 Å. Ilford special rapid and Ilford N-30 plates of 10" x 2" size were used. The first order spectrum was recorded after filtering away the ultra violet radiations from second order by using a glass condensing lens.

The dispersion in the first order for the above regions varies from 0.765 to 0.735 Å/mm.

For second order pictures around 4100 Å, a 8200 Å region from first order may interfere but the sensitivity of the emulsions used dies down at 5000 Å only. Thus inavailability of a predisperser or order sorter was automatically overcome without any preabsorbing assemblies.
Slit widths and exposure were adjusted according to the intensity of the bands in a particular region. Factors such as exposure time etc., have been discussed in the relevant sections.

4.3. Measurements.

As stated in the earlier chapter on "Error analysis" an ordinary screw driven comparator of .001 mm least count was used. Internal standards were preferred since Thorium atomic lines appear along with ThO band spectra. Standard wavelengths were taken from MIT wavelength tables.

A desk calculator having one memory was utilized for reducing the results. Professor T. Wentink from Fairbanks Alaska was kind enough to process the data and provide computer programms for Deslandres tables, for polynomial fits etc. for vibrational and rotational studies. The accuracy attained varies from 0.05 cm\(^{-1}\) to 0.1 cm\(^{-1}\) as the source used has a considerable line width.

4.4. Description of the spectrum.

A spectrogram of ThO taken on constant deviation Hilger spectrograph and reproduced in Fig. 4.2 gives an idea regarding the prominent band systems appearing in the spectrum. All bands are shaded to the red. Most intense bands are from the O–O sequence of 4115 Å system.
A cluster around 4340 Å also is fairly intense. A band in the 4024 Å region is poorly developed; besides, the atomic lines mask this region. Due to low resolution of the spectrograph the doublets in the 4670 Å are not clearly seen but still the doublets appear on the film with fairly good intensity. Few bands of the two mutually interacting systems \( \Sigma^1 - X^1 \Sigma \) and \( \Pi^1 - X^1 \Sigma \) fall in this region but they are very faint.

The 3340 Å system not seen in Fig. 4.2 was also observed on our spectrograms taken with the concave grating spectrograph.

It must be mentioned here that although some of these bands were reported by earlier investigators; no detailed study of the bands was carried out.

We have carried out in the present investigations a systematic study of these bands on the lines indicated below:

a) Vibrational analysis of the 4115 Å system.
b) Rotational analysis of the 4115 Å band.
c) Rotational analysis of 4024 Å band.
d) A study of 3340 Å system.
e) A discussion of 4670 Å doublets.
A corner of the dark room

Excitation set-up →

Fig. 4.1
$M'\Pi - X'\Sigma$ and $K'\Pi - X'\Sigma$

Systems reported by
Edvinsson →

Low dispersion picture of TiO spectrum photographed on constant deviation Hilger Spectrograph.

Fig 4.2
"What we call results are beginnings".

Emerson.