TECH MEMO

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SURFACE EFFECTS IN ALKALI-HALIDE CRYSTALS RESULTING FROM IRRADIATION BY X-RAYS

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FOREWORD

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ROY F. POTTER
Head, Infrared Division

ABSTRACT

The spectral emittance at 373°K of some alkali-halide crystals was measured before and after irradiation by 50-kilovolt 50-milliampere x-rays.

INTRODUCTION

Chemical reactions occur at room temperature between crystalline NaCl and some components of the atmosphere.[1,2] In addition to the formation of carbonates, unpublished data obtained at the Lewis Research Center show that nitrate (NO^-_3) or nitrite (NO^-_2) ions are produced on a surface of NaCl crystals exposed to air in the presence of an electric spark, X-irradiation, or α bombardment.

This report, without attempting to differentiate between the above chemical reactions, shows some of the results of exposing a series of alkali-halides to X-irradiation and measuring a resulting change in the absorptance spectra of the crystals. The technique employed to examine the crystals is the measurement of their spectral emittance before and after their exposure to X-irradiation.

The theory, techniques and experimental apparatus used in acquiring the spectral emittance (spectral absorptance) of a transparent solid, in the infrared region of the spectrum, have been discussed in detail in previous reports.[3,4] It should be noted that the spectral emittance measurement technique represents a direct measure of absorptance. A transmittance measurement would need a supplementary reflectance measurement to determine the spectral absorptance.

The crystals measured are KCl (t = 2.10 mm), RbBr (t = 5.31 mm), NaCl (t = 6.56 mm) and KBr (t - 4.65 mm).

RESULTS

Figures 1a, 2a, 3a, and 4a show the spectral emittances at 373°K of curves NaCl, KBr, RbBr, and KCl respectively.

Figures 1b, 2b, 3b, and 4b show respectively the spectral emittances at 373°K of NaCl after two hours of x-ray irradiation, KBr after six hours irradiation, RbBr after three hours irradiation and KCl after two hours irradiation. Samples were irradiated in the atmosphere at 25°C with a Macklet AEG50S tungsten target, unfiltered. An additional sample of NaCl crystal, enclosed in a nitrogen atmosphere was irradiated. At the completion of the emittance measurements, a surface layer of 0.04 mm was removed from the face of NaCl, 0.05 mm from the face of the KCl and 0.1 mm removed from the face of RbBr. The spectral emittances of these three samples, which had been irradiated in the atmosphere, were measured again, with the result that all the structure in the 7.0 - 7.3 micron region, which appeared after irradiation, had disappeared. The sample irradiated in the nitrogen atmosphere showed no change in structure due to irradiation. Because of the deterioration of the crystal, the KBr sample was not remeasured after removal of the surface layer.

CONCLUSIONS

No attempt is made here to quantitatively establish the exact mechanism, or to identify the resulting surface changes. It is evident, however, that X-irradiation of the sample in a pure nitrogen atmosphere does not produce this effect in the 7.0 - 7.3 micron region. It does not exclude the possibility, however, that nitrogen

in combination with other atmospheric gases may produce this surface change. There is evidence[5], however, which points to the possibility that the formation of carbonates takes place at/and near the surface of the crystal during X-irradiation in the presence of atmospheric CO_2.

This, the initial experiment using the spectral emittance technique at low temperatures to observe these surface changes in the alkali-halide crystals, provides an excellent tool for correlating the results of measurements made by mass spectrometric and microchemical analysis techniques.[1,2]

DISCUSSION

The following experiments, using the "spectral emittance techniques", should be considered for future development of surface effect studies of the type described in this report.

1. The quantitative measurement of depth of penetration of chemical change as a function of irradiation time, intensity and energy.
2. Effects of ultra violet and gamma radiation.
3. Irradiation effect in the presence of atmospheric gases individually and in combination.
4. Correlate emittance measurements with mass spectrometer studies in a program for identifying the chemical species.

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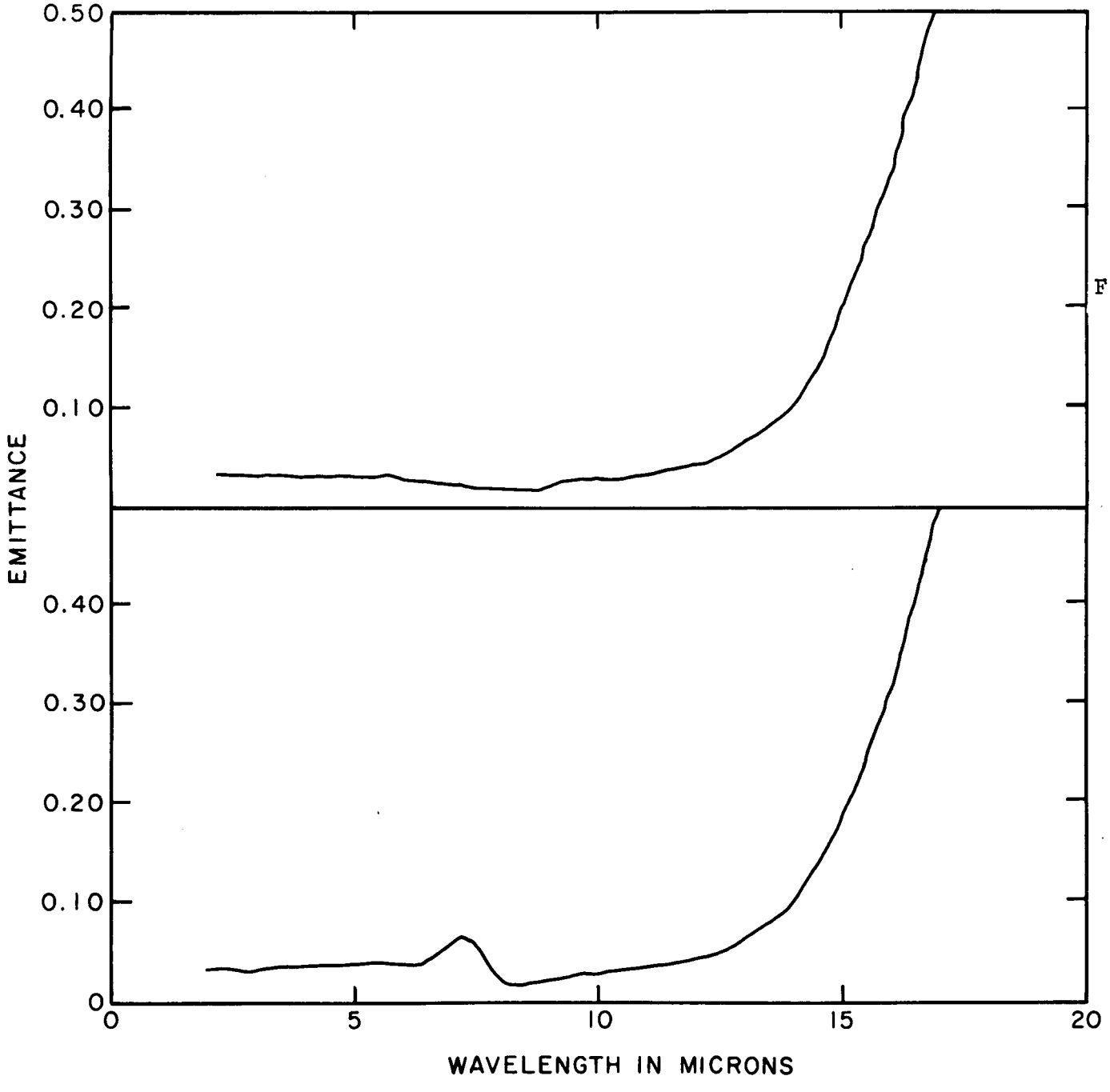
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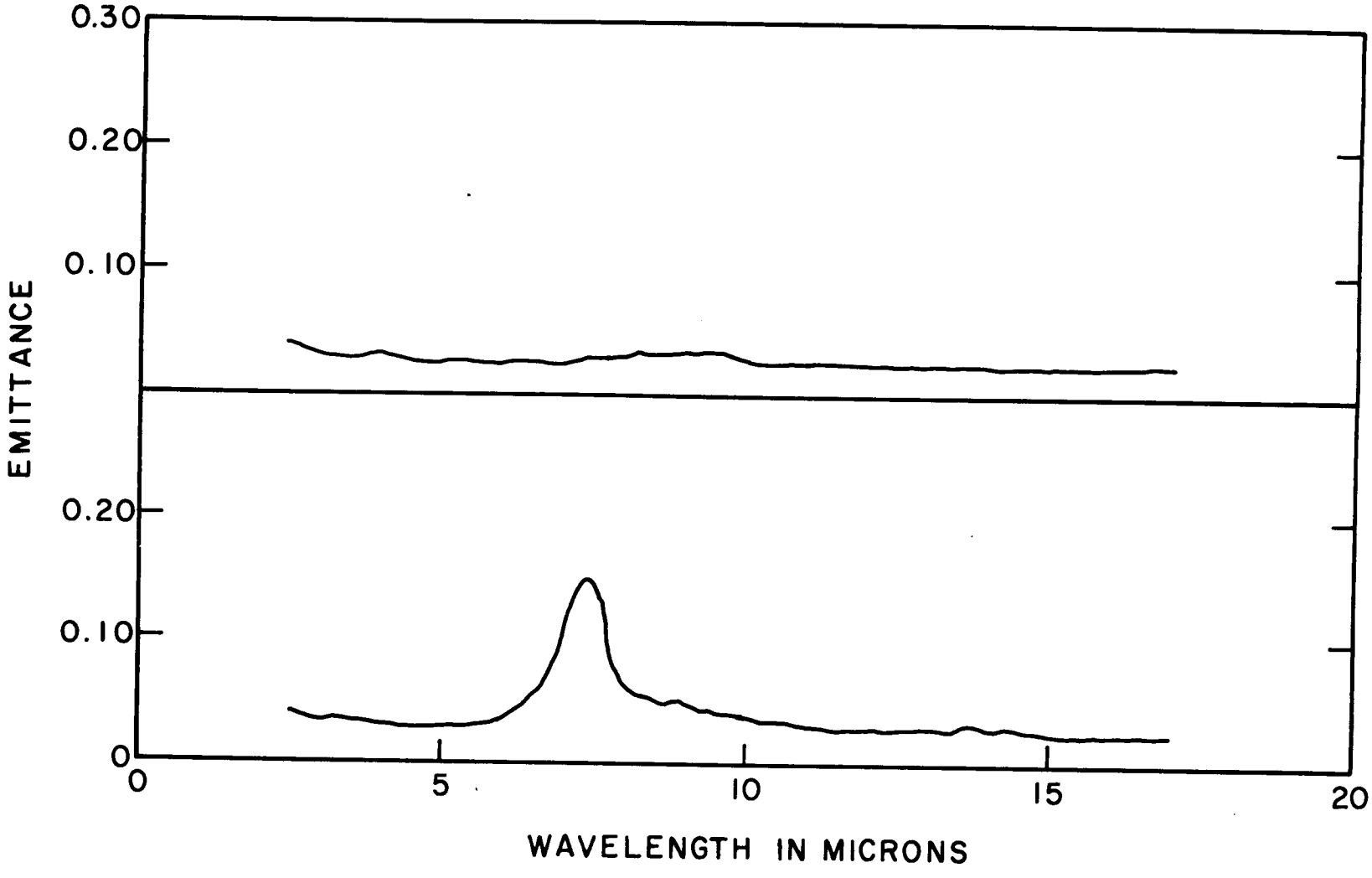
WAVELENGTH IN MICRONS

Fig.1a

Fig.1b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WAVELENGTH IN MICRONS

Fig.2a

Fig. 2b

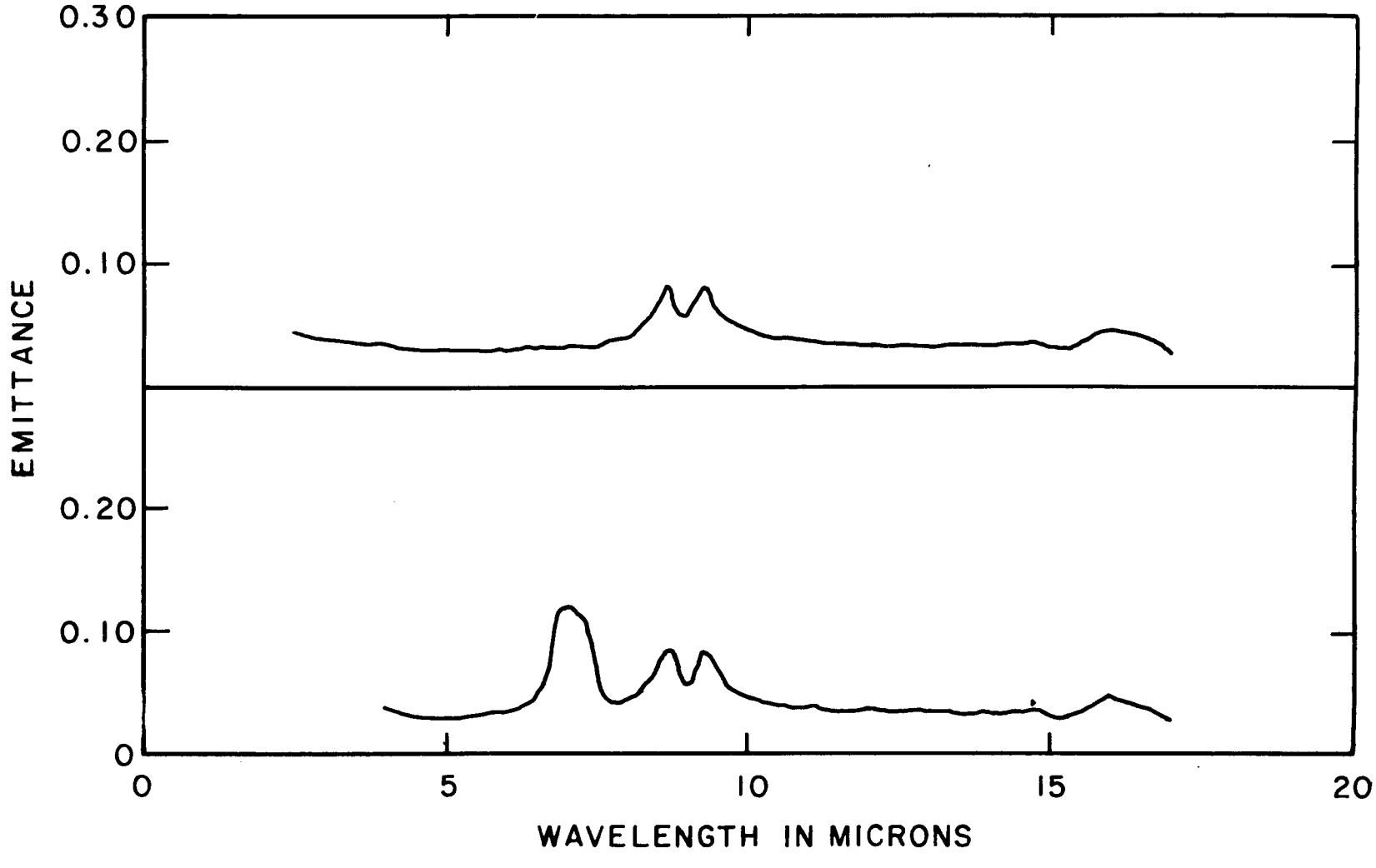
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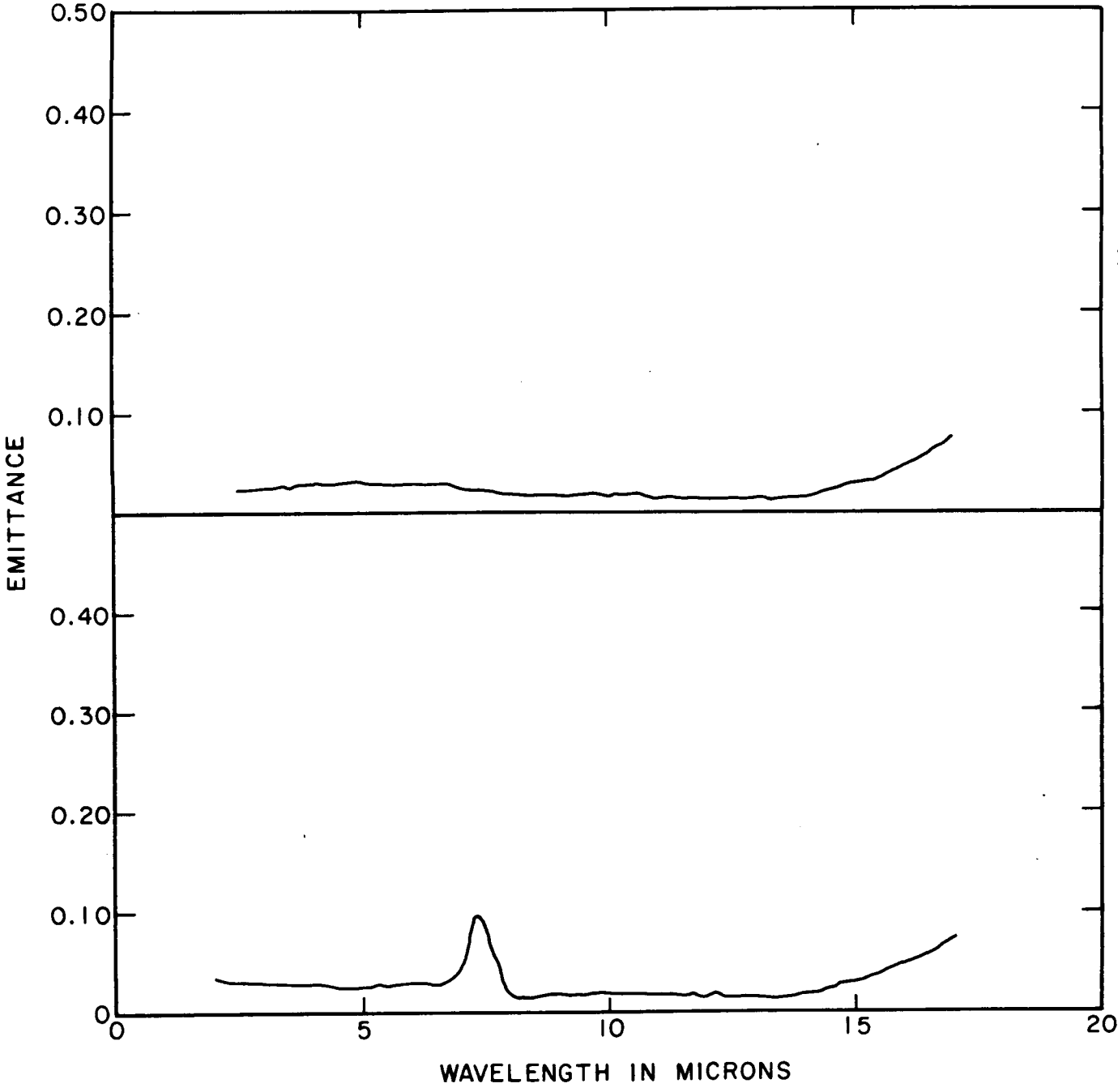
Fig. 3a

Fig.3b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WAVELENGTH IN MICRONS

Fig.4a

Fig. 4b

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