EUV Resonance Fluorescence of the $c_4'(0)$ and $b'(1)$ States of N_2

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To the best of our knowledge this is the first time that an experiment clearly demonstrates resonance fluorescence (RF) in the EUV region. The RF of the (0, v") bands of the $c_4' \, ^1\Sigma_u^+ \rightarrow X \, ^1\Sigma_g^+$ and the (1,v") bands of the $b' \, ^1\Sigma_u^+ \rightarrow X \, ^1\Sigma_g^+$ transitions of N_2 has been observed by photon excitation of N_2 in the vicinity of 95.8 nm. The bandheads of the overlapping $c_4' \, ^1\Sigma_u^+(0)$ and $b' \, ^1\Sigma_u^+(1)$ transitions are only separated by 0.0505 nm [1]. The High Flux CGM monochromator beamline (BL03A) was utilized to provide the primary EUV photons with an instrumental resolution of 0.06 nm. A position sensitive detector (PSD) coupled with a 0.2-m vacuum monochromator was employed to disperse the RF of excited N_2 molecules. The N_2 pressure was regulated to provide a constant flow of 0.04 mTorr, an optically thin condition. The typical fluorescence spectra taken by the 0.2-m vacuum spectrometer and the PSD detector system with a counting time of 1000 seconds are shown in Fig. 1.

The dispersed RF spectra were taken by setting the primary photon wavelength at 95.6, 95.7, 95.8, 95.9, and 96.0 nm, respectively. When the primary photon wavelength is tuned to coincide with the bandhead of the absorption transitions of the excited $b'(1)$ state at 95.7 nm a resonance fluorescence peak is observed with count rates of about 20 counts per pixel per 1000 sec as shown in the blue curve. When the primary photon wavelength is tuned to coincide with the bandhead of the $c_4'(0)$ transition at 95.8 nm very intense resonance fluorescence count rates of about 800 counts per 1000 sec can be seen in the black curve. When tuned away from the center of the absorption transition by 0.2 nm, see the green and the pink curves, the PSD detector system apparently only registers noise counts, which amount to about 10 counts per pixel per 1000 sec counting times.

The $c_4'(0)$ emission intensities become saturated at a N_2 pressure higher than ~0.1 mTorr [2]. The broadband emission features in the 105-130 nm region become progressively significant as the N_2 pressure increases. Many of the broad bands have been assigned to the (1,v") progression for v" up to 11 of the $b' \rightarrow X$ transition and the Lyman-Birge-Hopfield system [2]. The multiple scattering processes significantly reduces the $c_4'(0,0)$ emission rates. The present results may be useful in the explanation of weak $c_4'(0,0)$, but significant $c_4'(0,v")$ features in the dayglow of the Earth observed by the Far Ultraviolet Spectroscopic Explorer. We plan to carry out the above studies at high and low temperature conditions appropriate to that of the upper atmospheres of Earth, Jupiter, Saturn, Titan, and Triton in order to improve our understanding of their atmospheric dayglows.

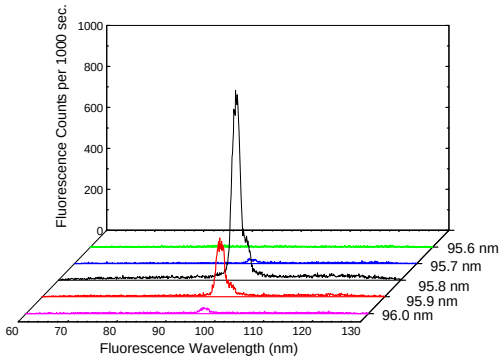

Figure 1. Dispersed fluorescence spectra in the 60-130 nm as a function of primary photon wavelength with an increment of 0.1 nm in the spectral region of the overlapping c_4'-X (0,0) and b'-X (1,0) absorption transitions. The N_2 pressure in the effusive gas flow system was set at 0.04 mtorr.

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Reference:

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