Laboratory Simulation of Chemical Reactions on Pluto

Yu-Jong Wu,[1,2,*] Chih-Hao Chin,[1] Meng-Chen Liu,[1] and Sian-Cong Chen[1]

[1]*Scientific Research Division, National Synchrotron Radiation Research Center, Taiwan*
[2]*Department of Chemistry, National Chiao Tung University, Taiwan*
E-mail:yjwu@nsrrc.org.tw

Stern et al. [1] used the Hubble Space Telescope with the Cosmic Origins Spectrograph (HST-COS) to record ultraviolet reflectance spectra of Pluto at two rotational phases. An absorption feature between 210 and 240 nm with an absorption maximum near 222 nm was found in the 95º longitude of Pluto. Because most nitriles and/or large hydrocarbons have UV absorptions in this spectral region, they suggested that complex molecules may exist on the surface of Pluto. In our previous works, we recorded the UV absorption spectrum of electron-bombarded CH_4 diluted in solid N_2 at 10 K [2]. The observed spectrum revealed a band within the 310–200 nm region, centered at 260 nm and with a shoulder near 220 nm. We further studied the UV spectra of electron-bombarded pure solid N_2 [3], C_2H_2 [4], and C_2H_4 [5] in solid N_2 at 10 K, but all the recorded spectra showed no significant features near 220 nm. The temperature on Pluto's surface ranges from 33 K to 55 K, which means that laboratory simulations of chemical reactions at 10 K might be improper. The current work presents a study of electron irradiated CH_4:N_2 ices during deposition at various temperatures. IR spectra show formation of N_3 and CH_3 radicals at low temperatures while only nitrile species were observed at higher deposition temperatures. This was attributed to radical recombination enabled by diffusion at the higher temperatures. UV absorption spectrum of electron irradiated samples at 44K, depicted in Fig. 1, shows a feature that compares well with the Pluto spectrum observed by Stern et al [1]. This along with the IR based identifications implies that nitriles exist on Pluto's surface [6].

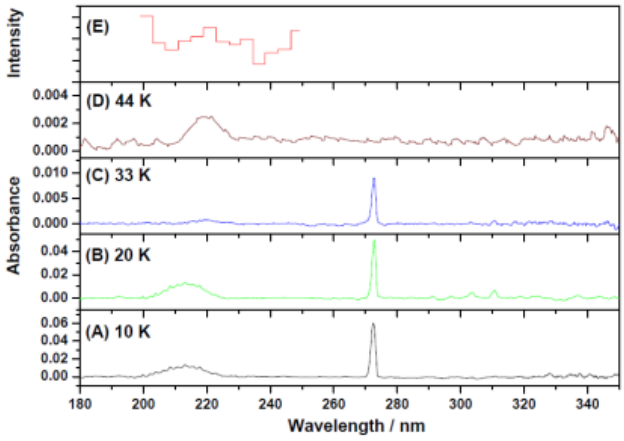

Figure 1: Ultraviolet (UV) absorption spectra of electron-bombarded CH_4/N_2 matrix samples during deposition at (A) 10 K, (B) 20 K, (C) 33 K, (D) 44 K. (E) The inverted HST-COS Pluto spectrum [1].

References

[1] S. A. Stern, et al, 2012, A J, 143, 22.
[2] Y.-J. Wu, H.-F. Chen, S.-J. Chuang, & T.-P. Huang, 2013, ApJ 768, 83.
[3] Y.-J. Wu, H.-F. Chen, S.-J. Chuang, & T.-P. Huang, 2013, ApJ, 779, 40.
[4] Y.-J. Wu, S.-J. Chuang, S.-C. Chen, & T.-P. Huang, 2014, ApJS. 212, 7.
[5] H.-F. Chen, S.-C. Chen, M.-C. Liu, T.-P. Huang, & Y.-J. Wu, 2015, ApJ. 804, 36.
[6] C.-H. Chin, S.-C. Chen, M.-C. Liu, T.-P. Huang, & Y.-J. Wu, 2016, ApJS, 224, 17.