EUV-VUV Photolysis of Molecular Ice Systems of Astronomical Interest

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Abstract

We wish to report laboratory simulation results obtained from extreme ultraviolet (EUV) and vacuum ultraviolet (VUV) photolysis of molecular ices relevant to the cometary-type ices and icy satellites of planetary systems. Specifically, we identify the type of molecules that form in the ices and/or those that come off the ice surfaces, quantify their production yields and destruction yields, understand their production mechanisms, and ascertain their significance in astronomical environments.

A FTIR spectrometer was employed to identify IR absorption features of the *in-situ* ice samples. We have recently installed a Quadrupole Mass Spectrometer in the experimental apparatus which will allow us to carry out simultaneous measurements of fragments ejected by EUV photon sputtering. A tunable intense synchrotron radiation light source available at the National Synchrotron Radiation Research Center, Hsinchu, Taiwan, was employed to provide the required photons from the soft x-ray region on through the VUV. However, we have mainly selected the photon wavelengths to center at the prominent solar lines, namely, the 121.6 nm, 58.4 nm, 30.4 nm, and other photon wavelengths of interest.

So far, we have studied the following ice systems using the FTIR spectrometer: (1) pure ices such as pure CH_4, CO, N_2, and NH_3 ices. (2) Mixtures of two molecules such as H_2O+CH_4, H_2O+C_2H_2, H_2O+CO, H_2O+CO_2, CH_4+NH_3, CO+NH_3, H_2O+NH_3. (3) Mixtures of three or more molecules such as H_2O+CO+NH_3, CO+CH_4+NH_3, H_2O+CO+CH_4+NH_3.

New molecular species were produced in the ice samples at 10 K as a result of EUV photon irradiation. The photon-induced chemical products that have been observed in the above studies include radicals, such as CH_2, CH_3, C_2H_3, C_2H_5, light hydrocarbons, such as, C_2H_2, C_2H_4, C_2H_6, C_3H_8, carbon-containing compounds, such as C_3O_2, C_2O, CO, CO_2, CO_3, alcohols, such as CH_3OH, C_2H_5OH, and others such as HCO, H_2CO, HCOOH, HCN, XCN, CN^-, CH_2N_2. While new molecular species were formed, the original parent molecules were depleted due to their conversion to other species. The production yields of the products and the

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destruction yields (or lifetime) of the parent molecules in the ices, and the typical reaction mechanisms will be presented.