Formation of Insoluble Organic Material from the Ultraviolet Irradiation of Laboratory Ice Photolysis Residues

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We present preliminary results from the study of ice photolysis residues which were exposed to ultraviolet (UV)/extreme UV (EUV) photon radiation. The residues were produced from the simultaneous deposition and UV irradiation of ice mixtures of astrophysical interest (H_2O, CH_3OH, CO, NH_3, without/with N_2 and/or O_2, and without/with small quantities of aromatic compounds) at 15–20 K using an H_2 lamp, which emits 10.2-eV (121.6 nm) Lyman-α photons and a continuum at 7.5–8 eV (155–165 nm). After warm-up to room temperature and subsequent sublimation of volatile compounds, the refractory materials (residues) recovered at room temperature were analyzed with infrared (IR) microscopy and then further irradiated with UV/EUV photons at a synchrotron facility, on a beamline providing a broad-band photon beam in the 4–45-eV range with a $\sim 10^{16}$ photons s^{-1} flux.[2] The residues were UV/EUV irradiated with increasing photon doses ranging from $\sim 10^{18}$ to $\sim 10^{21}$ photons, i.e., covering 4 orders of magnitude and relevant to those experienced by ice-coated grains in the protosolar nebula.[1]. After UV/EUV irradiation, residues were analyzed with IR microscopy and the data compared to those before irradiation to identify changes in chemical composition as a function of the photon dose. UV/EUV-irradiated residues were also analyzed with other techniques such as nanoscale secondary-ion mass spectrometry (nanoSIMS) to the study the changes in isotopic composition, and scanning transmission electron microscopy to look at variations in structure and C bonding distribution. Results will be compared with data from extraterrestrial materials, in particular, meteoritic insoluble organic material (IOM) and interplanetary dust particles (IDPs).

References

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