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SYNTHESIS OF ORGANIC MOLECULES AND THE BUILDING BLOCKS FOR LIFE BY LOW ENERGY ELECTRON IRRADIATION OF ASTROPHYSICAL ICES

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Molecular seeds for life on earth were provided *via* meteorite or cometary impacts. Given the fact that both ionizing radiation and matter exist throughout the universe, the existence of this panoply of bio/organic molecules in space suggests that life's building blocks can be synthesized via space-radiation processing of molecular ices in cold regions of the interstellar medium, or on solar system bodies. This radiation processing, or synthesis, can be studied in the laboratory, but to date, most efforts focus on stellar UV radiation, or high energy particles (stellar wind, cosmic rays, etc.). The latter produce abundant low energy electrons (LEEs) below 100 eV in matter, however the role of LEEs in the synthesis of life's building blocks in space has, until recently, been rather assumed than studied. In this thesis, I describe an extended and detailed investigation in which bio-organic molecules, including amino acids, may be formed by LEE in simulated space environments: thin films of differing molecular composition (e.g., O¬$_2$, CH_4, NH_3, and mixtures thereof) are condensed under ultra-high vacuum upon a metallic substrate at ~20 K, and exposed to low energy (0-100 eV) electron irradiation. Multiple in situ surface-analysis methods, namely electron stimulated desorption (ESD) of ions, X-ray photoelectron spectroscopy (XPS), and temperature programmed desorption (TPD), have been employed to investigate the LEE-driven chemistry and to observe the formation of new complex chemical species. Among these, we identify acetylene (C_2H_2), ethane (C_2H_6), propylene (C_3H_6), and ethanol (C_2H_5OH), as well as glycine (NH_2CH_2COOH), the simplest building block of proteins, formed in CH4:CO2:NH3 ices by LEEs down to 9.5eV; still unidentified are molecules containing C_2O_2, C_2O_3, N2, and NO moieties, or CN and HCN subunits, the basic building blocks of adenine. LEEs induce the production of new chemical species containing both C-O and C=O, as well as O-C=O, N-O, N=O, and multiple C-C bonds.

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