Low-Energy Electron-Induced Oligomerization of Condensed Carbon Tetrachloride

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The low-energy electron-induced chemistry of condensed CCl_4 has been investigated with use of post-irradiation temperature-programmed desorption. These experiments were partly motivated by the growing interest in developing facile and economical methods for decomposing CCl_4 and other halocarbons which through widespread use in industry have become potent environmental pollutants. The experimental procedure involves low-energy (50 eV) electron irradiation (fluence ≤ 2×10^{16} electrons cm^{-2}) of nanoscale thin films (5 monolayers) of CCl_4 grown at 100 K on a Mo(110) single crystal under ultrahigh vacuum (UHV) conditions. Results of post-irradiation temperature-programmed desorption experiments were used to identify C_2Cl_4, C_2Cl_6, C_3Cl_6, C_4Cl_6, and C_5Cl_x as low-energy electron-induced reaction products of condensed CCl_4. Two longer chain chlorocarbon oligomers with six or more carbons were also detected but not identified. Although low-energy electron-induced oligomerization reactions have been previously reported for molecules such as thiophene and cyclopropane, the results presented herein represent the first study to specifically identify the products of such reactions, demonstrating the utility of post-irradiation temperature-programmed desorption experiments to study the radiation chemistry of condensed matter.