AOGS 2005

Formation of Methanol, Formaldehyde and Hydrocarbons from the Electron Impact on the Thin Film of H_2O/CH_4 at 10K

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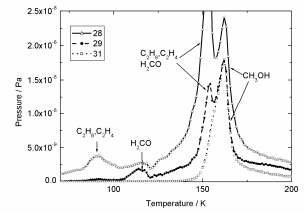
Since the rate of reaction of H with CO is much lower than with paraffins, olefins, H2CO, and CH3OH, the probability that H atoms will react with CO in the mantle of dust grains decreases drastically when contaminated by other molecules, i.e., H atoms adsorbed on the dust grains may be annihilated by reactions with more reactive contaminants and the less reactive CO will be left intact. The importance of CO for formation of CH3OH must decrease as the chemical evolution in the dark clouds proceeds. Thus, another source for the formation of CH3OH in the dirty ice containing some carbon source (e.g., CH4) must be invoked . The interaction of radiation (e.g. cosmic rays) with dust grains is of paramount importance in the chemical evolution. The secondary electrons (i.e. δ rays) carry most of the energy of the fast primaries. Thus the study of interactions between electrons and matter will give fundamental information on the chemical processes induced by cosmic rays in the dust grains. In the present work, the interactions between 30-300 eV electrons with thin films of H2O seeded with various molecules were investigated. The film was irradiated at 10K by an electron beam with a flux of □2×10-7A/cm2. After electron bombardment, reaction products were analyzed by thermal desorption mass spectrometry. The figure shows temperature-programmed selected integral mass traces, showing reaction products formed by the 300 eV electron irradiation on the H2O film containing 10% methane. Methanol as well as C2 hydrocarbons and formaldehyde were formed as major products. This strongly suggests that cosmic rays play an important role for the formation of methanol on dust grains.

Keywords: methanol; formaldehyde; cosmic rays; chemical evolution.



References

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