An Infrared and Thermal Desorption Study of Amino Acids in Astrophysical Environments

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Alpha amino acids (NH_2-CHR-COOH, where R denotes various side chains) are critical constituents in biochemistry, playing a crucial role in life as we know it. These molecules have been detected in various bodies of the Solar System, including meteorites, comets, and asteroids. Notably, the simplest amino acid, glycine, was detected in comet 67P/Churyumov-Gerasimenko[1]. Additionally, the recent in-situ collection of pristine asteroid Ryugu samples facilitated the analysis of uncontaminated extraterrestrial samples, revealing 15 amino acids[2]. In this context, experimental efforts have demonstrated efficient routes for their formation and those of their precursors under dark cloud conditions[3] or upon irradiation[4]. Such experiments aim to replicate the conditions found in the interstellar medium (ISM) during the early phases of star formation or in the protosolar nebula (PSN) shortly after its formation. To enhance the evaluation of these low-temperature experiments and provide supportive data for *in situ* space missions, understanding the desorption processes of these prebiotic molecules and their temperature-responsive infrared spectra is essential.

In this study, we concentrate on the experimental analysis of desorption kinetics for four amino acids: glycine (-H), alanine (-CH_3), cysteine (-CH_2SH), and serine (-CH_2OH). Utilizing the SURFRESIDE[3] setup and an organic evaporator, we prepared low-temperature (10 K) solid layers by depositing the sublimated vapor of these amino acids onto an inert gold substrate under ultrahigh vacuum conditions (10^{-9} hPa). We employed temperature-programmed desorption techniques to characterize their desorption kinetics and used infrared spectroscopy to analyze their spectral properties.

Our results indicate that amino acids, which are semi-refractory, desorb at relatively high temperatures in these conditions ($T_{sub} > 300$ K). We also monitored the shift from neutral to zwitterionic states in these molecules, providing insights that could help in identifying the presence of amino acids in various astrophysical environments, depending on their physical state, thermal conditions, and chemical makeup.

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