Formation of deuterated "chiral" glycine by low-temperature surface reactions via quantum tunneling

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Glycine is not positively identified in interstallr molecular clouds [1], although laboratory experiments predict that it can be formed on interstellar grains [2]. If this is the case, the formed glycine could become enriched in deuterium (D) by surface reactions on grains, as is the case for well-known D-enriched interstellar molecules such as methanol and formadehyde [3]. In the present study, we experimentally investigated hydrogen (H)-D substitution of solid glycine through the reaction with D atoms at low temperatures.

Solid glycine (NH_2CH_2COOH, d_0-Gly) was codeposited with D atoms, which were produced in a microwave-induced D_2 plasma, onto a cold substrate at 12 K in a vacuum chamber. After the codeposition, the sample was warmed to room temperature and dissolved in distilled and deionized H_2O, and the extracted aqueous sample was analyzed by high-resolution mass spectromtry with mass resolution 70,000 at $m/z = 200$.

The formation of mono- (d_1-Gly) and di-deuterated glycines (d_2-Gly) were confirmed in the mass spectra of the codeposition sample. The abundance of d_1- and d_2-Gly relative to d_0-Gly reached to 2.4×10^{-1} and 6.3×10^{-2}, respectively, in the present study. Since glycine should exchange its labile hydrogens (carboxyl and amino groups) with H_2O when extracted from the reaction substrate, their D/H ratio should be terrestrial value, $\sim 10^{-4}$. We therefore conclude that one- or two carbon-bound hydrogen in glycine was replaced with D after codeposition with D atoms at 12 K and the reaction proceeds through quantum-tunneling.

It should be noted that the formed d_1-Gly, $NH_2CHDCOOH$, is a chiral molecule. Since any chiral molecules have never been observed in molecular clouds, d_1-Gly could be a possible candidate for the origin of whole chiral molecules during the evolution from molecular clouds to planetary systems.

[1] Snyder et al. (2005) *Astrophys. J.*, **619**, 914–930. [2] Bernstein et al. (2002) *Nature*, **416**, 401–403. [3] Watanabe and Kouchi (2008) *Prog. Surf. Sci.*, **83**, 439–489.