Carbon and hydrogen isotope fractionation of acetic acid accompanied with UV photolysis.

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Meteoritic organic matter is of importance because it may have provided the building blocks of life to the early Earth during the heavy-bombardment period 4.3-4.0 Ga (Bada 2004). Meteoritic organic matter are enriched in heavy isotopes, so generally considered to be generated by ion-molecule reaction in interstellar environments, following to the incorporation into a meteorite parent body, and ultimately fall in the Earth as a meteorite (Cronin and Chang 1993; Pizzarello 2004). Meteoritic organic compounds would have been exposed to extensive ultraviolet (UV) and cosmic ray, which are ubiquitous energy sources until the incorporation into a meteorite, and experienced thermal processes by accretions on the meteorite parent body. These energy sources could have affected the generation and destruction of organic compounds, accordingly the isotopic compositions of them.

Acetic acid (CH3COOH) is one of the most abundant organic compounds in carbonaceous chondrites (Cronin and Chang 1993) and also identified in interstellar medium (Mehringer et al. 1997). So acetic acid may also be the heritage of interstellar cloud, however, the half of acetic acid that originally existed would be photolyzed in only 100 yr in diffuse interstellar medium (Bernstein et al. 2004). The carbon isotopic ratio of acetic acid in the Murchison carbonaceous chondrite has been reported previously (Yuen et al. 1984), revealing that the carbon isotopic ratio of acetic acid is higher than that of carboxylic acids having longer carbon chains. On the other hand, the hydrogen isotopic ratio of acetic acid in the Murchison is depleted in deuterium relative to other meteoritic organic compounds (Haung et al. 2005), being opposite to the characteristic of organic matter produced in interstellar environments (Geiss and Reeves 1981). Consequently, whether the acetic acid in the Murchison is the heritage of interstellar chemistry or a secondary altered product before an analysis in a laboratory is unknown.

In this report, we present laboratory data examining the carbon and hydrogen isotopic fractionations of acetic acid accompanied with an UV photolysis, and also compare our results with the isotopic values of the meteoritic acetic acid.