Synthesis of ^{15}N enriched NH_3 through N_2 photolysis: relevance to N-enriched meteoritic organics

S. CHAKRABORTY[1]*, TERESA L. JACKSON[1], H. B. MUSKATEL[2], MUSAHID AHMED[3], BRUCE RUDE[3], R. D. LEVINE[2,4] AND M. H. THIEMENS[1]

[1]University of California, San Diego, Department of Chemistry and Biochemistry, 9500 Gilman Drive, La Jolla, CA 92093-0356 (*correspondence: subrata@ucsd.edu)

[2]The Fritz Haber Research Center, Hebrew University, Jerusalem 91904, Israel

[3]Lawrence Berkeley National Laboratory, 1 Cyclotron Road, Berkeley, CA 94720

[4]Department of Chemistry and Biochemistry, University of California, Los Angeles, CA 90095

Introduction

Nitrogen isotopic analyses ($^{15}N/^{14}N$) of solar system objects [1] advances our understanding of prebiotic processes by defining the volatile inventory of the solar nebula. Bulk meteorite analysis exhibit a variation in the range of few tens to few hundred permil in $\delta^{15}N$ [2]. The N-isotopic composition measured in Solar wind samples (Genesis mission) and in the atmosphere of Jupiter (in NH_3) are nearly equally depleted (~ -400‰) [3]. Conversely, extremely high (up to ~5000‰) ^{15}N enrichments are observed in meteoritic 'hotspots', IDPs, cometary samples and, in insoluble organic matter (IOM) [7-9]. In this abstract, we present N-isotopic fractionations during VUV photolysis of N_2 and discuss the relevance to the solar system. Photochemistry is an important process in solar nebula and, without the measurements of the isotopic fractionations due to photodissociation, no model can be evaluated or theories can be tested.

Results and Discussion

The measured N-isotopic compositions of product NH_3 are enriched by few thousands permil. The wavelength dependent enrichment profile show unprecedented ^{15}N enrichment at 90 nm. This particular wavelength zone is quite unique because of extensive state mixing in highly localized spectral regions leading to perturbations.

Production of ^{15}N enriched amine and nitrile group molecules is plausible at the outer edges of the disk from enriched ^{15}N atom from N_2 photodissociation. Once formed, these functional groups may freeze-out in the ice and possibly synthesize PANHs within the ice with high ^{15}N enrichment under UV exposure and ultimately lead to organic macromolecule formation.

[1] Thiemens *et al* (2012) *Ann. Rev. Phy. Chem.* **63**, 155-177. [2] Marty *et al* (2011) *Science* **332**, 1533-1536. [3] Briani *et al* (2009) ***PNAS*** **106**, 10522-10527. [4] Bernstein *et al* (2002) *ApJ* **576**, 1115. [5] MA and the ALS are supported by DOE (DE-AC02-05CH11231), SC and MHT is supported by NASA Cosmochemistry and Origin programs.