ANALYSIS OF A DEUTERIUM HOTSPOT IN AN INTERPLANETARY DUST PARTICLE: IMPLICATIONS FOR THE CARRIER OF HYDROGEN ISOTOPIC ANOMALIES IN IDPs. L. P. Keller[1], S, Messenger[2], G. J. Flynn[3], S. Wirick[4] and C. Jacobsen[4]. [1]Mail Code SR, NASA Johnson Space Center, Houston, TX 77058 (Lindsay.P.Keller@jsc.nasa.gov), [2]Physics Dept., Washington Univ., St. Louis, MO 63130, [3]Dept. Physics, SUNY, Plattsburgh, NY 12901, [4]Dept. Physics, SUNY, Stony Brook, NY 11794.

Introduction. Presolar molecular cloud materials are partially preserved in interplanetary dust particles (IDPs). Evidence for these primitive materials comes from ion microprobe measurements of IDPs [1] and cluster particles [2], which exhibit D/H ratios up to 50 times solar, reaching values observed in cold molecular clouds [2]. In some cases, spatial variations in the D/H ratios have been correlated with the local C/H secondary ion signal, suggesting an organic carrier [1, 3]. We have been working to further constrain the identity of the carrier phase(s) of the high D excess observed in these particles through coordinated ion microprobe and transmission electron microscopy (TEM) measurements of the same particles [4,5]. Our sample preparation methods have evolved to the point where we can now also obtain infrared and X-ray absorption spectroscopy data from the same samples (see below). We previously analyzed a cluster particle with a bulk δD of ~+50,000‰ (or 50 times solar) and concluded that the abundant organic matter in the particle was responsible for the high-D excess [4]. X-ray absorption measurements suggested that a carbonyl-rich phase was present in the organic carbon although we were unable to obtain confirming infrared data. In this paper, we discuss our chemical and petrographic studies of an IDP with a pronounced deuterium "hotspot".

Methods. The IDP that we studied is L2009D11 (a fragment from a cluster particle nicknamed "Taz" [2]) that showed a bulk δD of +5600‰ although subsequent ion imaging shows the the D is concentrated in a 2-3 μm diameter hotspot with an estimated δD of at least twice the bulk value. We now use a modified sample preparation technique to prepare microtome thin sections of IDPs that have been pressed into gold and previously analyzed in the ion probe. Following the ion probe measurement, we extract the IDP undisturbed along with a portion of the Au substrate and then embed the Au+IDP in sulfur for ultramicrotomy. For the TEM studies and FTIR measurements, we placed sections on TEM grids with amorphous carbon substrates. For the XANES analysis, thin sections were analyzed on SiO substrates. This procedure allows for a direct one-to-one comparison of features in ion images to TEM images, XANES (X-ray absorption near-edge structure) maps, and FTIR (Fourier transform infrared) maps. We used synchrotron-based XANES and FTIR instruments at Beamlines X1A and U10B, repectively at Brookhaven National Lab to further characterize the material in the D hotspot.

Results and Discussion. TEM observation of the ultramicotome thin sections of L2009D11 (20-30 nm thick) show that the particle is dominated by coarse-grained Fe-Ni sulfides and lesser crystalline silicates including enstatite, forsterite and anorthite. Solar flare tracks are observed in both the enstatite and anorthite, with track densities of ~$5x10^{10}/cm^2$. Because of the way the sample was prepared, there is no ambiguity about the location of the D hotspot for the subsequent analyses. The hotspot region is dominated by poorly ordered carbonaceous material with embedded GEMS and fine-grained sulfides. Electron energy-loss spectroscopy measurements on the carbonaceous phase are in progress.

For the FTIR analyses, we used a small field-limiting aperture to confine the region of interest to the D hotspot. The FTIR spectra show solid- state features for the silicate species in and around the hotspot and more importantly, reproducible features which correspond to the CH_2 and CH_3 stretching vibrations in aliphatic hydrocarbons (Figure 1). FTIR spectra from the D-hotspot are similar (with repect to peak positions and relative band strengths) to the aliphatic hydrocarbons identified in other primitive anhydrous IDPs using IR techniques [6].

XANES spectra taken at the C k-edge show three major absorptions (Figure 2) similar to those observed in previous analyses of D-rich material in IDPs [4]. The ~285 eV peak results from the carbon ring structure and the feature at ~288.5 eV is attributed to carbonyl (C=O). The carbonyl peak at 288.5 eV is not as intense as observed in Dragonfly [4], and the 285 eV peak is systematically broader in the L2009D11 hotspot spectra, which suggests that multiple carbon ring species are present.

Conclusions. A consistent picture is emerging from our analyses of D-rich IDPs. The TEM evidence shows that the D-rich areas identified in the ion probe are correlated with the carbonaceous materials seen in microtome thin sections. Based on the spectroscopic evidence from the FTIR and XANES analyses, the carrier phase is associated with the aliphatic and aromatic hydrocarbons in these particles, however, we do not know at his time the specific molecular species that are D-rich. We do know that these types of organic materials common in primitive chondritic porous (cometary) IDPs.

Acknowledgements. This work was supported in part by NASA RTOP 344-31-40-07 (LPK). We thank L. Miller and G. L. Carr at the National Synchrotron Light Source at Brookhaven Nat'l Lab for assistance with the FTIR.

References. [1] McKeegan, K. D. *et al*. (1985) *GCA*, **49**, 1971. [2] Messenger, S. (2000) *Nature*, **404**, 968. [3] Aleon, J. *et al.* (2001) *GCA*, **65**, 4399. [4]

Keller, L. P. *et al*. (2000) *MPS*, **35**, A86. [5] Keller, L. P. *et al.* (2000) *JGR – Space Phys*., **105**, 10397. [6] Flynn *et al*. (1998) *LPSC 29*, #1157.

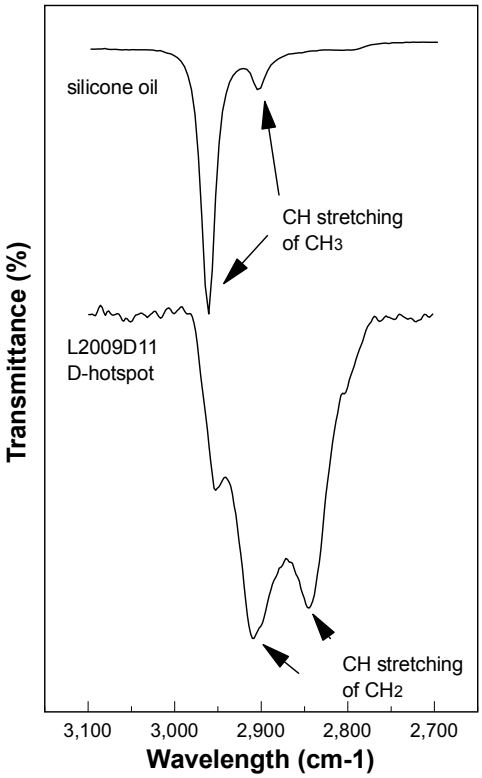

Figure 1. FTIR transmission spectra of the CH stretching region obtained from the D-hotspot in L2009D11 (bottom spectrum) and a reference spectrum from the silicone oil (top) used in the JSC Curatorial facility to coat the IDP collection surfaces.

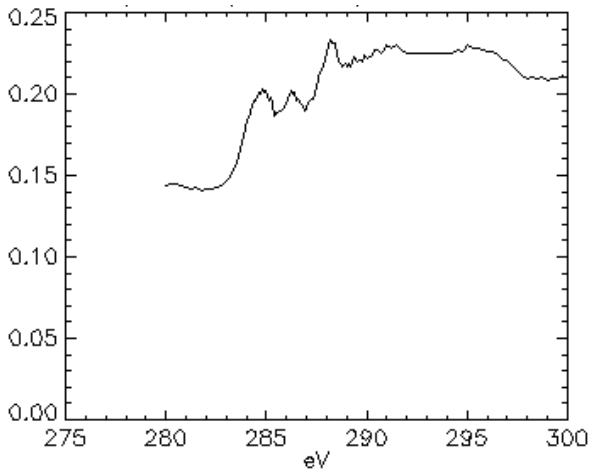

Figure 2. XANES spectrum for the carbon k-edge in the D-hotspot region in L2009D11.

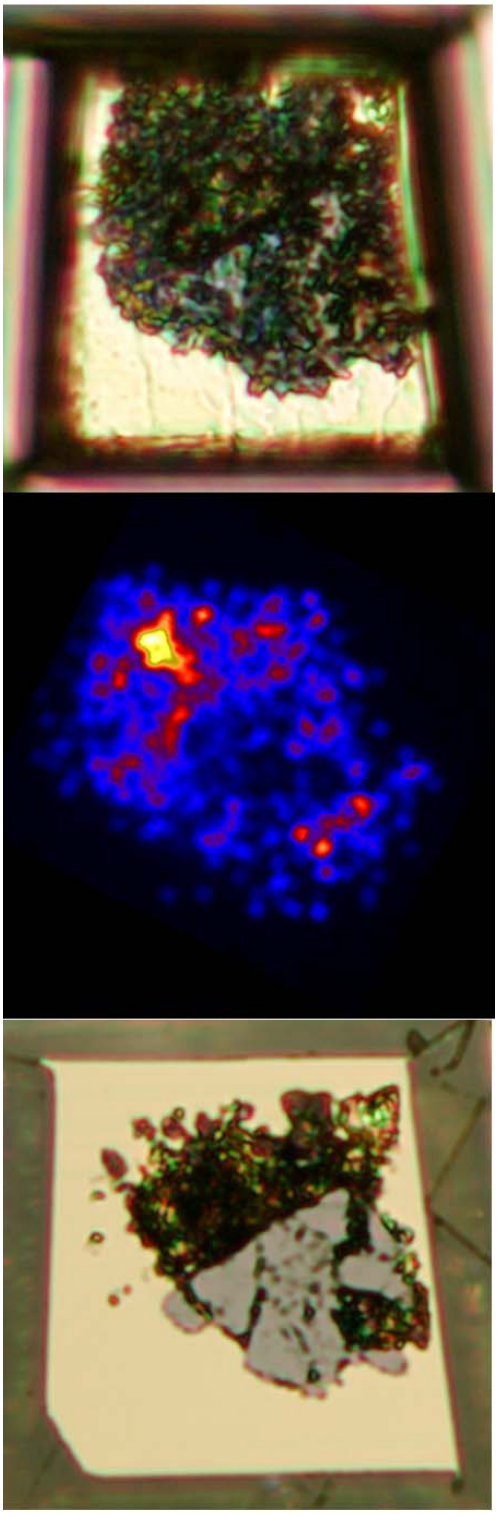

Figure 3. a) L2009D11 prior to sulfur embedding (top), b) D ion image of D11 showing location of the D hotspot (middle), c) L2009D11 after ultramicrotomy (bottom). The field-of-view is ~50 micrometers.