Journal of Physics: Conference Series

Dissociative electron attachment to formamide

To cite this article: E Szymanska *et al* 2012 *J. Phys.: Conf. Ser.* **388** 052085

Dissociative electron attachment to formamide

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Synopsis: Investigation of dissociative electron attachment to formamide using Velocity Map Imaging.

Formamide ($CHONH_2$) is the smallest molecule with a peptide bond and has recently been observed in the interstellar medium (ISM) [1], suggesting that it may be ubiquitous in star-forming regions. Therefore there is considerable interest in determining the mechanisms by which this molecule may form and subsequently play a role in the formation of larger biomolecules.

One method for the formation of such molecules is electron-induced chemistry, starting with dissociative electron attachment (DEA) within icy mantles on the surface of dust grains. In addition there in considerable interest in exploring DEA to small organic molecules since the functional group dependence property of DEA leads to site selective fragmentation of molecules at the C-H, O-H and N-H bondsat energies well below the direct impact threshold for the breaking of any of these bonds [2].

We have used a Velocity Map Imaging (VMI) spectrometer [3] consisting of a magnetically collimated and low energy pulsed electron gun, a Faraday cup, an effusive molecular beam, a pulsed field ion extraction, a time of flight analyser, a two-dimensional position sensitive detector consisting of microchannel plates and a phosphor screen.

We observe H^- and another ion at mass 16, which could be either O^- or NH_2^-. The ion yield curve for H^- shows two resonance peaks at electron energies of 6.3 eV and 10.5 eV respectively, while that for mass 16 shows two broad resonance peaks at 5.8 eV and 11 eV respectively. In contrast, the calculations of Goumans *et al* [4] on DEA to formamide show resonances leading to NH_2^- formation at 3.77 eV and 14.9 eV. However, the appearance energies (AE) of O^- and NH_2^- were found to be 4.0 eV and 3.5 eV, respectively and correlate with our results.

Velocity Map Images were measured close to resonance energy peaks for H^- and mass 16 and are shown in Figure 3. The radius of the image represents the magnitude of the velocity of the ions with which they are formed. The most probable kinetic energy of the mass 16 fragment from the image at 5.6 eV is found to be 0.5 eV, giving a total kinetic energy release of 0.79 eV. The excess energy is expected to be transferred into the internal excitation of the fragments.

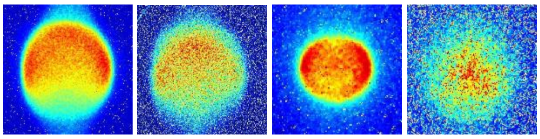

Figure 1. The VMI of negative ions of formamide. The electron beam direction is vertically downwards and in the plane of the image. From left: H^- at 6.0 eV, H^- at 11.0 eV, O^- or NH_2^- at 5.6 eV, O^- or NH_2^- at 10.6 eV.

The images also show distinct anisotropy in the angular distributions. Detailed analysis of the images leading to angular distribution and kinetic energy distribution are being carried out. It is expected such an analysis will provide information on the symmetry of the resonances as well as providing greater insight into the molecular dynamics of low energy electron interactions with formamide.

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