Experimental Dissociative Electron Attachment Investigations

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An experimental project to investigate dissociative electron attachment to molecules in Belfast is described and opportunities to extend it towards radiation damage of biological systems will be considered.

The process of dissociative electron attachment to a general molecule, AB, can be represented by

$$AB + e^- \rightarrow AB^{-*} \rightarrow A^- + B$$

Where AB^{-*} is a superexcited state of the molecular anion that can dissociate to form anionic and neutral fragments A^- and B. Recent work by Sanche and co-workers has shown that dissociative electron attachment can be potent mechanism for the damage of DNA molecules.[1] To date, low energy electron collisions with molecules of 2 to 20 atoms has been investigated in Belfast – the investigation of larger biological molecules poses various experimental challenges. Sanche solved these challenges by investigation of electron attachment to DNA fixed to a surface in a vacuum chamber. Ideally, it would be interesting to investigate electron attachment to DNA and other biomolecules in their native cellular environment, but this would involve many challenges experimentally and computationally.

Dissociative electron experiments in Belfast have focussed on small unstable molecules; CS,[2] S_2O and S_2O_2.[3] Stable molecules such as HCCCN,[4] SF_6 and 2,4-dinitrotoluene ($CH_3.C_6H_3(NO_2)_2$) have also been investigated. The ERIC (electron radical interaction chamber) used to make these observation has been described previously.[3] Briefly, Low energy electrons from a trochoidal monochromator are crossed with the target gas in a differentially pumped interaction region. The electron gun is pulsed. After the electrons have left the interaction region, ions are extracted and detected with a time-of-flight mass spectrometer.

It has been speculated that CS in carbon/sulphur plasmas is responsible for the incorporation of Sulphur into n-type semiconducting diamond like films.[5] Here CS was formed in a microwave discharge of CS_2 and He. Figure 1 shows a two dimensional spectrum of electron energy against negative ion time-of-flight for CS. Figure 2 shows integrated ion intensity as a function of electron energy.

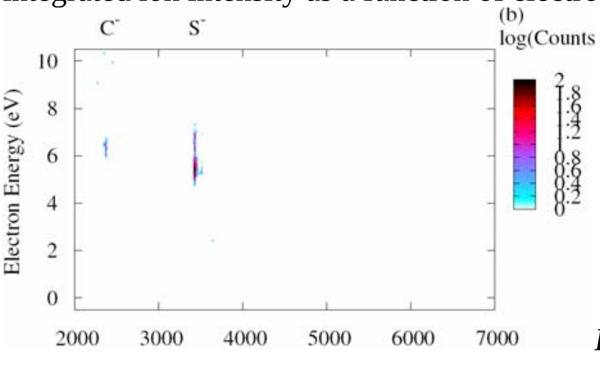

Fig 1

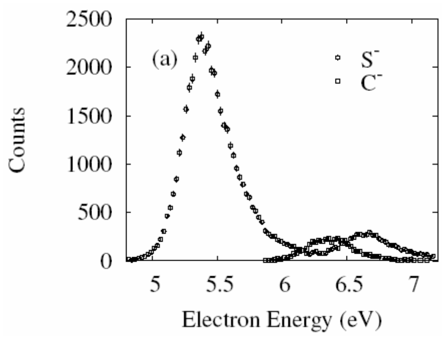

Fig 2

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Rel. Mat. 11 301