Dissociative electron attachment to molecular chlorine

Journal of Physics: Conference Series **635** (2015) 072024 doi:10.1088/1742-6596/635/7/072024

Dissociative electron attachment to molecular chlorine

Krishnendu Gope[*] [1], Vaibhav S Prabhudesai[*], Nigel Mason[†] and E. Krishnakumar[*] [2]

[*] Dept. Nuclear and Atomic Physics, Tata Institute of Fundamental Research, Colaba, Mumbai 400005, India
[†] Dept. of Physical Sciences, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK

Synopsis We report the study of dissociative electron attachment to molecular chlorine in the energy range of 1 to 20 eV using velocity slice imaging technique. Based on the angular distributions at various electron energies, we identify the partial waves involved in the resonance formation that lead to DEA.

Velocity slice imaging (VSI) is a well-established technique to investigate the molecular dynamics involved in dissociative electron attachment (DEA) to simple molecules [1]. This technique enables one to measure the kinetic energy and angular distribution of the fragment ions produced in the DEA process. The kinetic energy distribution of the fragment ions points to the kinematics of the process leading to DEA. On the other hand the angular distribution of the fragment negative ions with respect to the incoming electron beam indicates the symmetry of the negative ion resonant states involved in the DEA process. This information in combination with the kinetic energy distribution unravels the dynamics of the DEA process.

Due to their high electron affinity, the halogen molecules form a class of interesting diatomic molecules. These molecules are known to show more than one resonances in the DEA channel with very little threshold for the formation of halide anion. This leads to the substantial kinetic energy release in the fragmentation process in DEA.

Particularly for chlorine, the DEA studies are important from the plasma processing point of view. Chlorine is known to affect the properties of electrical plasmas considerably and hence the efficiency of technologies utilizing the plasma, such as those generated in either pure chlorine or mixtures of chlorine with other gases. Chlorine being a highly oxidizing agent much attention has been paid to the investigation of its properties.

Dissociative electron attachment to chlorine has been extensively studied in the past with reports of measurements of absolute cross-section [2] and angular distribution in the limited angular range [3]. However the kinetic energy distribution and the angular distribution for the entire 0-360^{o} angular range have not been reported so far. Here we report the study of DEA using velocity slice imaging at various resonances observed in the DEA to chlorine molecules [1]. The VSI spectrometer was modified with longer flight tube and larger (75mm diameter) phosphor screen based position sensitive detector [4].

In our measurements we measured the ion yield curve up to 90eV electron energy and we found that the chloride anion yield show three resonances at 0eV, 2.5eV and 5.6eV which is consistent with earlier measurements. The velocity slice images obtained at various electron energies across the resonances are shown in Fig. 1. In this poster we will describe the dynamics involved in DEA to chlorine molecule based on the kinetic energies and angular distributions obtained using these velocity slice images.

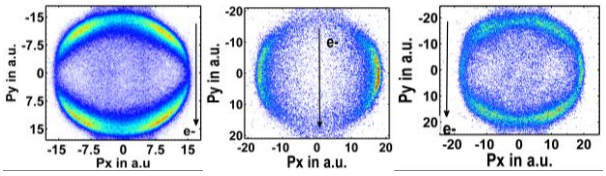

Figure 1. Image of Cl^- from Cl_2 at 2.5eV, 4eV and 6eV electron energy.

References

[1] Dhananjay Nandi, Vaibhav S. Prabhudesai, E. Krishnakumar and A. Chatterjee 2005 *Rev. Sci. Instrum.* **76** 053107
[2] M. V. Kurepa *et al.* 1978 *J. Phys. B: Atom. Mol. Phys.* **11** 3719
[3] R. Azria *et al.* 1982 *J. Phys. B: At. Mol. Phys.* **15** L569
[4] Ewelina Szyman´ska, Vaibhav S. Prabhudesai, Nigel J. Mason and E. Krishnakumar 2013 *Phys. Chem. Chem. Phys.* **15** 998

[1] E-mail: krishnendu@tifr.res.in
[2] E-mail: ekkumar@tifr.res.in