Bare C-ion impact ionization of adenine molecules : DDCS and TCS measurements

S. Bhattacharjee* [1], **C. D. Bagdia***, **M. R. Chowdhury***, **J. Monti**[†] , **R. D. Rivarola**[†], **L. C. Tribedi*** [2]

[*] Tata Institute of Fundamental Research, Homi Bhabha Road, Mumbai 400005
[†] Institute de Fisica Rosario (CONICET-UNR), Universidad Nacional de Rosario, 2000 Rosario, Argentina,

Synopsis Double differential cros sections (DDCS) for vapour phase adenine molecule under the impact of 3.5-MeV/u C^{6+} ions have been measured. The measured DDCS values were compared against the those for other nucleobases, such as, uracil, as well as the CDW-EIS model calculations. An excellent agreement of the experimental result with the theoretical model was observed for both the energy and angular distributions.

Collision of high velocity projectiles with atoms or molecules produces a large number of secondary electrons, near the end of the projectiles trajectory i.e. the Bragg Peak (BP) region. These secondary electrons can further initiate ionization events. Study of energy distribution of these secondary electrons from biological molecules is particularly important, because of its growing importance in radiation damage and radiation therapy[1]. Because of this reason, an increasing number of experimental studies have been devoted recently to study ionization of biological molecules [1-5].

Radiation therapy using proton beam is the most widely used technique. Carbon projectiles are also quite commonly used for this purpose since it offers more confinement of the radiation dose region, thereby minimizing the damage caused to the cells near the infected region.

In present work we have studied the double differential cross sections (DDCS) of the emitted secondary electrons from vapour phase adenine under the impact of 3.5-MeV/u C^{6+} projectile. DDCS study of adenine molecule is extremely important to understand DNA/RNA damage of cells in collisions with high velocity ions. The 3.5-MeV/u C^{6+} beam was generated using the Pelletron Accelerator facility at TIFR, Mumbai. DDCS spectrum was obtained using an electro static hemispherical e-analyzer. A heated oven at a temperature of ~180^0 C was used along with a quartz crystal thickness monitor. To make sure about the steady flow of vapour the oven was heated very slowly i.e. in about 24 hours. Fig 1(a,b) shows a typical absolute DDCS of emitted secondary electrons for two different emission angles. The solid lines in the figure represent the CDW-EIS model calculation for the 3.5-MeV/u C^{6+} projectile. The present results show a fairly good agreement with the theoretical model.

The cross section results for adenine were compared with the results of a previous experiment for uracil [4] target or even a bromouracil target at the same velocity C^{6+} projectile. The ratio of DDCS and TCS (total ionization cross section) values for adenine and uracil were obtained and the ratios were shown to vary from the expected value based on the electron numbers.

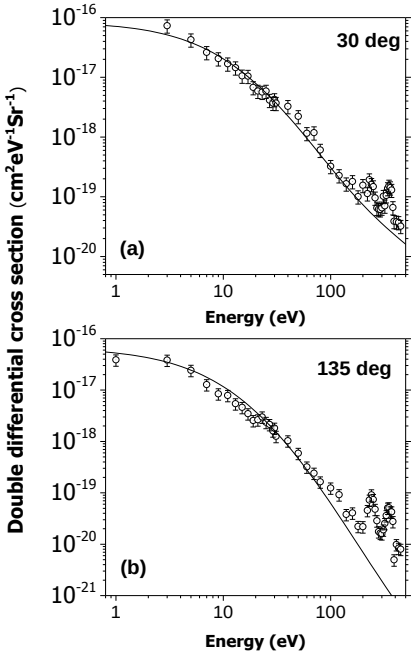

Figure 1. DDCS of emitted e^- for 3.5-MeV/u C^{6+} on adenine target.

References

[1] J. Tabet *et al.* 2010 *Phys. Rev. A* **82** 022703
[2] J. Tabet *et al.* 2010 *Phys. Rev. A* **81** 012711
[3] Y. Iriki *et al.* 2011 *Phys. Rev. A* **84** 032704
[4] Agnihotri *et al.* 2013 *J. Phys. B* **46** 185201
[5] A. Itoh *et al.* 2013 *Phys. Rev. A* **88** 052711

[1] E-mail: shamik127@gmail.com

[2] E-mail: lokesh@tifr.res.in and ltribedi@gmail.com