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Electron Attachment to Excited Molecules[1]

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The interactions of slow electrons with molecules --especially the processes of electr attachment-- depend rather strongly on the internal energy content of the molecules themselv As a rule, excited molecules interact with slow electrons with substantially larger cross secti than do ground-state molecules.[1-5] Studies of electron attachment to vibrationally/rotationally excited, "hot", molecules[1,3,5-18] and especially to electronically excited molecules[1,3,5,19-24] a rather recent, in contrast to the extensive studies on electron attachment to ground-state molecules which cover many decades.[6,25,26]

Recent studies on electron attachment to vibrationally/rotationally excited (thermall by infrared laser radiation) molecules, showed that the effect of internal energy of a molecu its electron attachment properties depends on the mode --dissociative or nondissociative-- o electron attachment. They quantified the effect of the internal energy of the molecule on the of destruction (by autodissociation or by autodetachment) of its parent transient anion. Gen increases in ro-vibrational molecular energy increase the cross section for dissociative attac (mainly due to faster dissociation and the capturing of lower-energy electrons)[3,6,8,9,10] and decrease the effective cross section for parent anion formation (mainly due to increased autodetachment).[3,13-15] These findings will be discussed.

Recent studies of electron attachment to electronically excited molecules, especiall photoenhanced dissociative electron attachment to short- and long-lived excited electronic of molecules produced directly or indirectly by laser irradiation[3,20-24] will be discussed als

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These studies show that the cross sections for dissociative electron attachment to electronical excited molecules can be orders of magnitude larger than those for the ground-state molecules The larger polarizabilities of the excited states are believed to be partly responsible for these large cross sections, as is indicated by the data on electron scattering from excited atoms[1,2,4,5] and molecules.[1,5]

The new techniques that have been developed for such studies will be briefly describe and the implications[23,26,27] of this new knowledge for new technologies (e.g., ultrasensitive analytical methods, plasma processing of materials, negative ion sources) will be indicated.

REFERENCES

1. L. G. Christophorou, In XXth Intern. Conf. on Phenomena in Ionized Gases, V. Palleschi P. Singh, and M. Vaselli (Eds.), (Pisa: Instituto di Fisica Atomica e Molecolare), Invited Pa 1991, p.3.

2. S. Trajmar and J.C. Nickel, In Adv. Atom. Mol. Opt. Phys., D. R. Bates and B. Bederson (Eds.), Academic, Orlando, FA, Vol. 30, 1993, p. 45.

3. L. G. Christophorou, L. A. Pinnaduwage, and P. G. Datskos, In Linking the Gaseous and Condensed Phases of Matter, L. G. Christophorou, E. Illenberger, and W. F. Schmidt (Eds Plenum, New York, 1994, p. 415.

4. L. G. Christophorou and E. Illenberger, Phys. Lett. A 173, 78 (1993).

5. L. G. Christophorou, R. J. Van Brunt, and J. K. Olthoff, In 11th Intern. Conf. Gas Disc and their Applications, (Tokyo, 11-15,1995) (in press).

6. L. G. Christophorou, D. L. McCorkle, and A. A. Christodoulides, In Electron-Molecule Interactions and their Applications, L. G. Christophorou (Ed.), Academic, Orlando, FA, V Chapter 6, 1984.

7. D. Smith and P. Spanel, In Adv. Atom. Mol. Opt. Phys., D. R. Bates and B. Bederson Academic, Orlando, FA, Vol. 32, 1994, p. 307.

8. A Chutjian, A. Garscadden, and J. M. Wadehra, "Electron Attachment to Molecules a

Electron Energies" . To be published in Repts. Prog. Phys.

9. T. F. O'Malley, Phys. Rev. 155, 59 (1967).

10. J. N. Bardsley and J. M. Wadehra, Phys. Rev. A20, 1398 (1979).

11. C. L. Chen and P. J. Chantry, J. Chem. Phys. 71, 3897 (1979).

12. D. Spence and G. J. Schulz, J. Chem. Phys. 58, 1800 (1973).

13. S. M. Spyrou and L. G. Christophorou, J. Chem Phys. 83, 2829 (1985).

14. P. G. Datskos, L. G. Christophorou, and J. G. Carter, J. Chem. Phys. 97, 9031 (1992).

15 P. G. Datskos, L. G. Christophorou, and J. G. Carter, J. Chem. Phys. 99, 8607 (1993); 9
7875 (1993).

16. I. M. Beterov and N. V. Fateyev, J. Phys. (Paris), Colloq. C7-447 (1983).

17. M. J. Rossi, H. Helm, and D. C. Lorents, Appl. Phys. Lett. 47, 576 (1985).

18. M. Kulz, A. Kortyna, M. Keil, B. Schellhass, and K. Bergmann, Phys. Rev. A 48, R401
(1993).

19. L. G. Christophorou, S. R. Hunter, L. A. Pinnaduwage, J. G. Carter, A. A. Christodouli
and S. M. Spyrou, Phys. Rev. Lett. 58, 1316 (1887).

20. R. S. Mock and E. P. Grimsrud, J. Phys. Chem. 94, 3550 (1990).

21. L. A. Pinnaduwage, L. G. Christophorou and S. R. Hunter, J. Chem. Phys. 90, 6275 (1

22 L. A. Pinnaduwage, L. G. Christophorou, and A. P. Bitouni, J. Chem. Phys. 95, 274 (1

23. L. A. Pinnaduwage and L. G. Christophorou, J. Appl. Phys. 76, 46 (1994).

24. T. Jaffke, R. Hashemi, L. G. Christophorou, E. Illenberger, H. Baumgartel, and L. A.
Pinnaduwage, Chem. Phys. Lett. 203, 21 (1993).

25. L. G. Christophorou, Atomic and Molecular Radiation Physics, Wiley-Interscience, N
York, 1971.

26. H.S. W. Massey, Negative Ions, Cambridge University Press, London, 1976.

27. J. F. Kielkopf, L. A. Pinnaduwage, and L. G. Christophorou, Phys. Rev. A 49, 2675 (

28. A. Garscadden and R. Nagpal, Plasma Source Sci. Technol. (Preprint, 1994).