Fast H(2S) *Atoms from Electron-beam Excitation of Polyethylene*

IT IS known that electron bombardment of molecules such as H_2[1–3], H_2O[3], NH_3[3] and hydrocarbons[3] in the gas phase gives excited H(2S) atoms with several eV of kinetic energy. In a general search for abundant sources of H(2S) atoms, electron bombardment of H atoms chemisorbed on metals was carried out but with little success. Ions and excited atoms formed on metal surfaces will be ejected with considerable kinetic energy due to the repulsive force of interaction. However, most of these so formed are neutralized or de-excited by resonance processes during the ejection period[4]. The chance of escape of an H(2S) atom depends in part on the density distribution of electrons in the *d*-band of the metal. Such neutralization processes will not be present in insulators which are therefore expected to give a higher yield of ions and excited atoms than metals. With an insulator such as polyethylene, rupture of the C—H bond can also occur giving rise to H(2S) atoms in a similar way to the ethylene molecule[3]. The depth at which these electronically excited (10·20 eV) atoms are generated in the polymer will depend on the bombarding electron energy. At the energies used in the present work (< 50 eV), excited atoms will be formed in the surface layer and some may be ejected from it. This note records the detection and time-of-flight resolution of H(2S) atoms ejected from

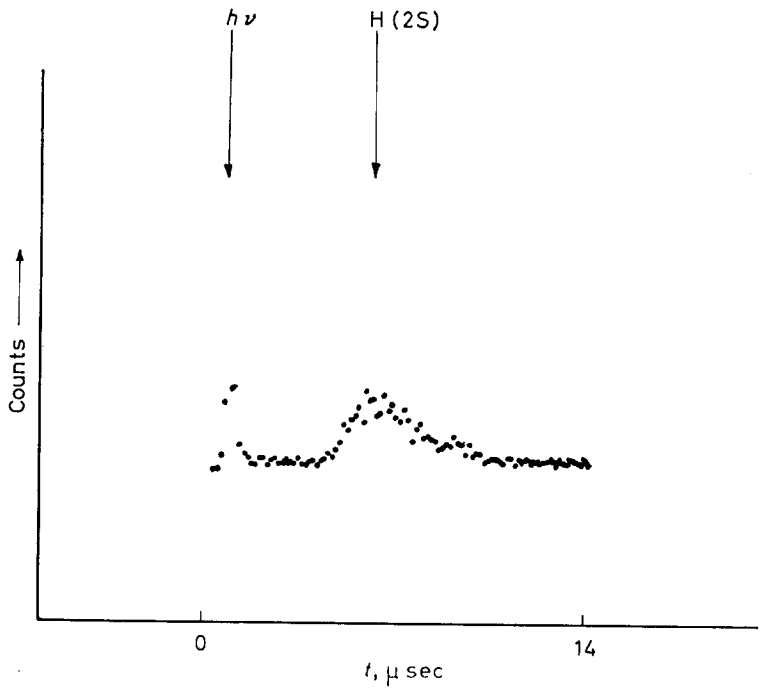

Figure 1—Time-of-flight resolution of H (2S) atoms from polyethylene

polyethylene by low energy electron impact. The experimental technique has been reported in detail previously[2,3]. A pulsed electron beam ($\sim 10\mu$A) of 200 ns duration and 5 kHz repetition rate impinges on to a piece of polyethylene which is covered with a wire mesh to minimize electrical charging during the experiment. Excited atoms ejected from the target traverse a 10 cm drift space and are detected by electron ejection from the earthed cathode of an 18-stage electron multiplier. Charged particles are removed from the drift space by a combination of weak electric and magnetic fields. Pulses from the anode, operating at $+3$ kV, are amplified and processed by a time-to-height converter and pulse-height analyser to produce a time-of-flight spectrum of neutral excited particles shown in *Figure 1*. In this way photons produced in the excitation are separated from excited atoms. The mean kinetic energy of the ejected H(2S) atom was $1{\cdot}5 \pm 0{\cdot}2$ eV which is very close to that for H(2S) atoms from gaseous ethylene, $1{\cdot}6 \pm 0{\cdot}2$ eV. The threshold electron energy for H(2S) production from polyethylene, obtained by a delayed coincidence method[2], was estimated to be ~ 15 eV by comparison with known thresholds for metastable H_2 ($c^3\pi$) molecules and He(^{3}S) atoms.

The implications of the present observation to the interaction of radiation with polymers can be seen. The fast, electronically-excited and long-lived atoms, produced by low-energy electrons, may subsequently dissociate neighbouring C—H bonds with considerably higher efficiency than an electron of the same energy.

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REFERENCES

[1] LEVENTHAL, M., ROBISCOE, R. T. and LEA, K. R. *Phys. Rev.* 1967, **158**, 49
[2] CLAMPITT, R. and NEWTON, A. S. *J. chem. Phys.* 1969, **50**, 1997
[3] CLAMPITT, R. *Physics Letters*, 1969, **28A**, 581
[4] HAGSTRUM, H. D. *Phys. Rev.* 1954, **96**, 336