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Determination of the Range of Slow Electrons in Solid
Polymethylmethacrylate by Means of Fluorescence Measurements

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ABSTRACT

The distance travelled by a photoelectron of low energy in an anthracene-doped polymer is very weakly dependent on its initial kinetic energy.

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DETERMINATION OF THE RANGE OF SLOW ELECTRONS IN SOLID
POLYMETHYLMETHACRYLATE BY MEANS OF FLUORESCENCE MEASUREMENTS

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Experimental data on the range of slow electrons in organic solids are extremely scarce. Transmission measurements through thin films for electrons below 50 eV meet great difficulties⁽¹⁾. These slow electrons, however (as a result of energy degradation) are the agents which produce the effects observed for high energy excitation. It has been predicted⁽²⁾ that below about 60 eV the range of an electron increases markedly with decreasing energy. This means that whatever the initial kinetic energy of an electron in this energy region, the ultimate distance travelled by the electron will be only weakly dependent of the initial energy. The implications of this fact for radiation chemistry and radiation biology amount to the result that very slow electrons will be able to interact with highly diluted impurities provided their excitation energy is sufficiently low.

In the present work a method is described for the determination of the effective attenuation length of photoelectrons in polymethylmethacrylate (PMMA), which is based on the excitation of solid solutions of anthracene in the polymer by radiation in the vacuum ultraviolet. This produces photoelectrons in the sample, which undergo a multitude of elastic and inelastic collisions and ultimately may collide with an anthracene molecule and excite its fluorescence. This latter process requires an energy of 3.1 eV. Hence the emission of a fluorescent photon from anthracene (the polymer is non-

fluorescent and does not transfer excitation energy) indicates that a photoelectron which travelled the distance from its origin to the dissolved anthracene molecule arrived there with an energy which is greater or equal to 3.15 eV. For a random walk model of the photoelectron and the given spatial distribution of the solute molecules, the distance travelled by the electron can be estimated.

The analysis of the results shown in Fig. 1 yields effective attenuation ranges between 18 Å and 22 Å for excitation energies between 20 eV and 36 eV. This result is in accordance with the assumption of a weak dependence of the effective attenuation range on the initial kinetic energy of the photoelectron.

Fig. 1

Fluorescence intensity of varying concentrations of anthracene in PMMA as function of excitation energy.

C_1 : 10^{-2} M/M:

C_2 : 5×10^{-3} M/M:

C_3 : 2.5×10^{-3} M/M:

C_4 : 0.625×10^{-3} M/M.

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