OPTICAL AND PHOTOELECTRIC PROPERTIES OF MATERIALS OF ASTROPHYSICAL INTEREST

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ABSTRACT. The charge of cosmic grains can be calculated if the optical constants, the photoelectric yields and the photoelectron energy distributions for a large range of energy of incident photons are known. Our measurements are made on several materials which are possible constituents of interstellar and interplanetary dusts. We present here our results for fused quartz, iron and carbon.

1. INTRODUCTION

The electric charge of interstellar or interplanetary grains depends on their optical and photoelectric properties. We present here our results for several materials which are considered as the more common components of grains. The reflectivity has been measured for silica, iron and carbon in the energy range 3-27 eV and the photoelectric measurements were extended to 40.8 eV. The photoelectron energy distribution curves show the importance of secondary electrons.

2. EXPERIMENTAL METHODS.

All experiments were performed under ultra high vacuum conditions ($p < 10^{-9}$ torr). The optical constants were obtained by reflectivity measurements under various incidences. The real and imaginary parts of the refractive index are calculated by Kramers-Krönig analysis and multiangle method. The quantum yield was measured by using a calibrated photodiode and the energy distributions of photoelectrons were obtained by means of a retarding potential, the photocurrent being amplified by microchannel plates (Priol et al., 1980). The wavelengths given by the specially realized monochromator cover the photon energy range from 3 to 50 eV. The acquisition, the treatment of the data and the control of the apparatus were realized by a computer.

3. EXPERIMENTAL RESULTS.

For our sample of fused silica, the reflectivity (Fig.1 was found

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larger than the values given by Philipp)1971) and Lamy (1977). The resulting complex index of refraction is given in Fig. 2.

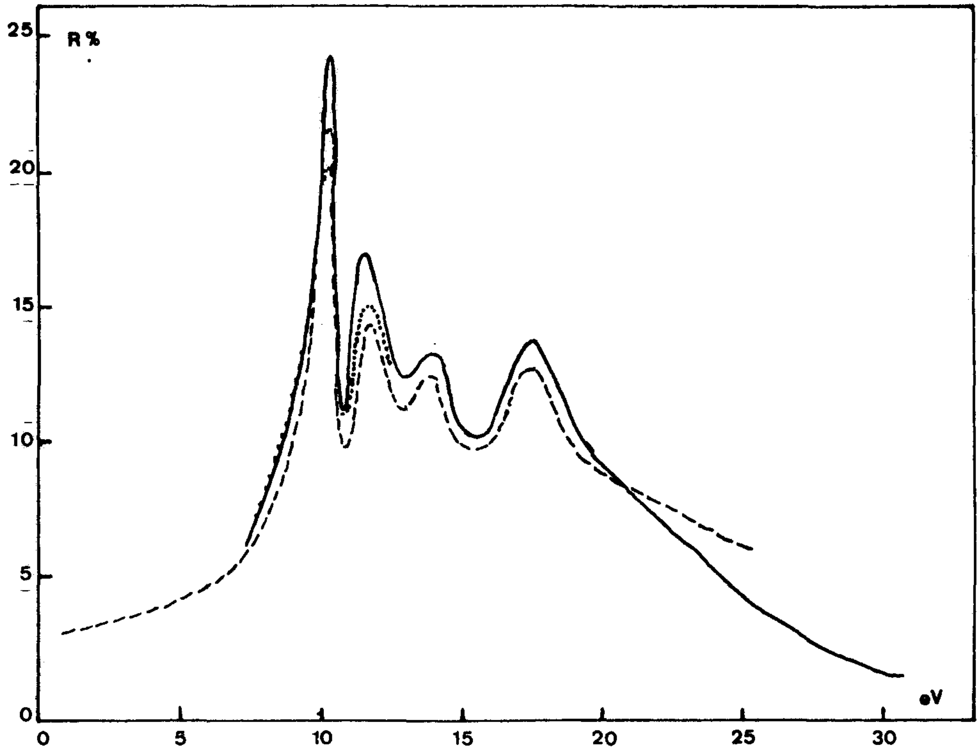

Fig. 1. Reflectivity of fused silica. - : our results ; --- : Philipp (1971) ; .... : Lamy (1977).

The photoelectric yield per absorbed photon (Fig. 3) was obtained with a thin film of SiO_2 on a silicon (111) substrate. A small thickness was necessary (220 A°) to keep a fixed value of the electric potential of the target.

The photoelectron energy distribution curves have been plotted (Fig.4) for three different photon energies (16.8, 21.2, 26.8 eV). Results are also available for other energies. The maximum at low energies is due to secondary electrons.

Finally we present the reflectivity (Fig. 5) and the quantum yield (Fig. 6) of iron thin films and of polished glassy carbon. A pronounced minimum at 7 eV for glassy carbon is due to interband transitions. For iron, the shoulder at about 8 eV is related to the surface plasmon.

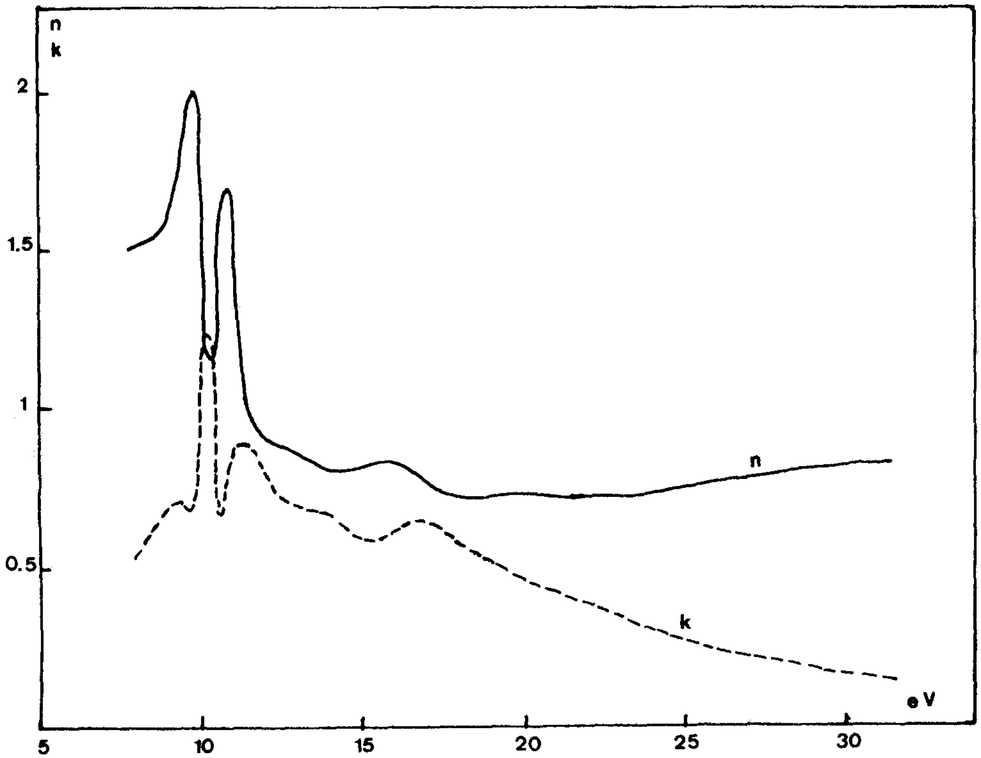

Fig. 2. Refractive index of fused silica. – : real part ;
---- : imaginary part.

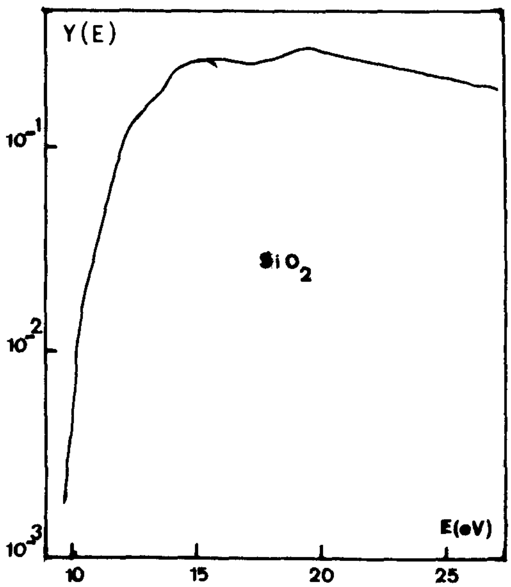

Fig. 3. Photoelectric yield per absorbed photon for silica.

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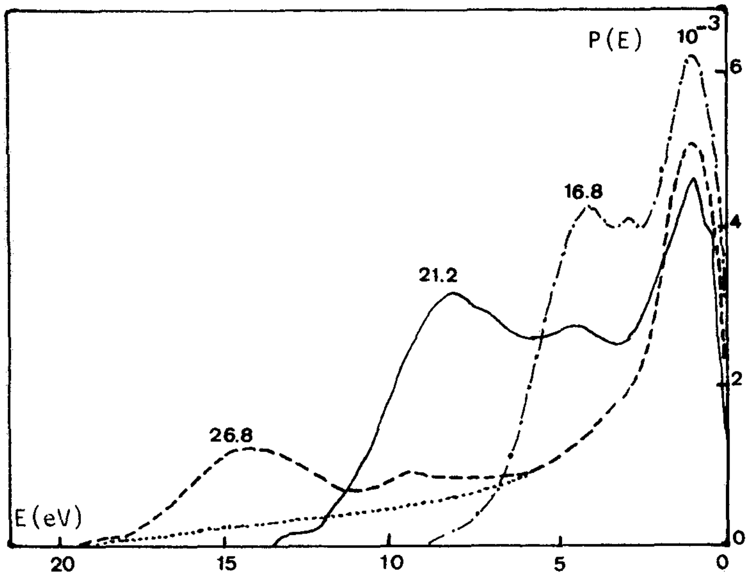

Fig. 4. Photoelectron energy distribution curves for silica at different photon energies. The ordinate is the number of emitted electrons per incident photons and the abscissa is the energy of photoelectrons. Each curveis labelled with the energy of incident photons. On the 26.8eV curve the relative importance of primary and secondary electrons is shown.

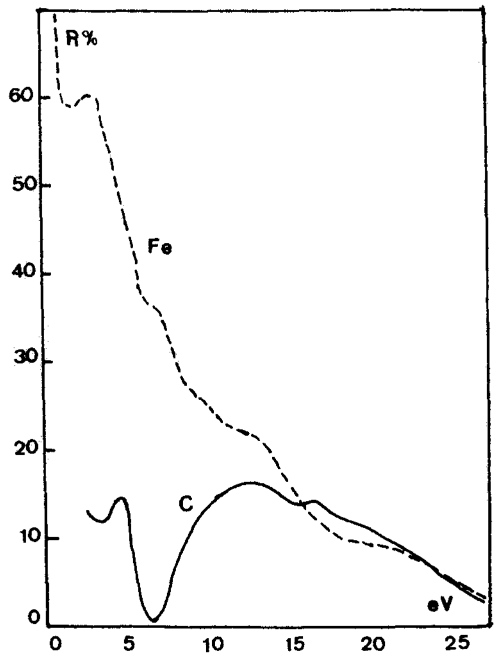

Fig. 5. Reflectivity for iron thin film (—) and polished glassy carbon (---)

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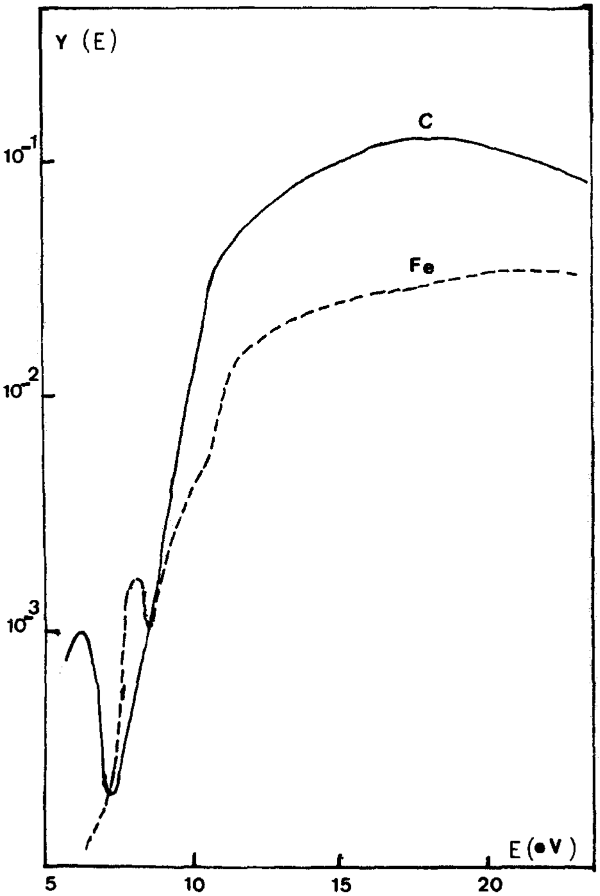

Fig. 6. Photoelectric yield per absorbed photon for iron and carbon.

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