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Abstract

Full Text

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PHOTOELECTRIC EMISSION FROM SOLID LAYERS OF PINACYANOL AND PINAKRYPTOL

In a previous work [1] the authors presented data from a study of the external photoeffect from deposited layers of a number of dyes (rhodamine 6G, erythrosin, metal-free phthalocyanine, zinc phthalocyanine, β-carotene). The observed form of the energy distribution of photoelectrons from layers of β-carotene and rhodamine 6G was tentatively explained by the possibility, in them, of scattering of the energy of light quanta into vibrations and electronic transitions within the molecules. As a continuation of this work, on the same apparatus, photoelectric emission was investigated from thin polycrystalline layers of pinacyanol and pinakryptol, prepared by deposition from alcoholic solutions onto nickel disks.

Fig. 1. Spectral distribution of the quantum yield of photoelectron emission from layers of pinacyanol (1) and pinakryptol (2)

The dependence of the photoemission yield on the energy of the incident photons, on a semilogarithmic scale, for pinacyanol and pinakryptol is shown in Fig. 1. In the photon-energy region 7–11 eV the values of the photoemission yield for both dyes differ little and are close to the values for other dyes investigated earlier [2]. In this region of the spectrum the logarithmic dependence of the increase in the photoemission yield with increasing photon energy is obeyed rather accurately. In the region of photon energies below 7 eV, the emission yield from pinakryptol layers decreases sharply, and at a photon energy of 6 eV it becomes approximately an order of magnitude smaller than in pinacyanol. The photoelectric work function, determined from the energy distribution of the photoelectrons (from Einstein' s equation for the photoeffect), is respectively 4.9 and 5.2 eV (Figs. 2 and 3), i.e. it differs little in magnitude. The small photoemission yield for pinakryptol in the indicated spectral region therefore

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[1] Reference as cited on the page.

[2] Reference as cited on the page.

Figure 2 and Figure 3: photoelectron energy-distribution plots

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cannot be explained by a large difference in the work-function values. The reason for the small yield may be explained either by a low density of electrons in the filled band from which the electrons are torn out, or by a low probability of their detachment. The latter may be connected with scattering of the quantum energy into intramolecular vibrations.

The energy distribution of photoelectrons from pinakryptol layers, presented in Fig. 2, is in its general features similar to that observed for β-carotene, investigated earlier [3], i.e. there is a sharply expressed maximum belonging to the group of slow electrons, with a kinetic-energy value of about 0.3–0.4 eV, which remains in place, within the experimental error (of the order of 0.1 eV), up to photon energies of 10 eV.

However, for pinakryptol the number of fast electrons having kinetic energy of 1–3 eV is considerably smaller than in β-carotene, and the photoelectron energy-distribution curves approach the abscissa axis more smoothly. This undoubtedly indicates more substantial energy losses in pinakryptol than in the other dyes.

A completely different character of the photoelectron energy distribution is observed in the case of pinacyanol, Fig. 3. For photon energies below 7.5–7.6 eV, a broad maximum is observed with an almost flat top and a steep falloff in the region of higher kinetic energies; moreover,

Fig. 2. Distribution of photoelectrons by kinetic energies for a layer of pinakryptol at different photon energies.

Fig. 3. Distribution of photoelectrons by kinetic energies for layers of pinacyanol at different photon energies. (The plots for photon energies 10.2 and 11.2 eV are drawn on a reduced scale, respectively 1/10 and 1/15.)

the onset of the falloff shifts linearly toward higher energies as the photon energy increases. At light-quantum energies of 7.8–7.9 eV, the onset of the falloff of the broad maximum occurs at a photoelectron energy of approximately 2 eV, and with further increase in photon energy it practically does not shift toward higher energies. At the same time, a new peak appears in the region of low energies; as the energy increases, this peak broadens, and at an energy of 10.2 eV its base extends to an energy value of 2 eV. The shape of this peak and the course of its change are very reminiscent of the broad peak observed at low photon energies. It should also be noted that, with the appearance of the peak in the region of low energies, the character of the falloff of the curve on the side of higher energies changes. The distribution curves for photon energies greater than 7.9 eV approach the abscissa axis ever more smoothly. This is most clearly manifested for photoelectrons having energies above 4 eV. The character of the

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[3] Reference as cited on the page.

change in the photoelectron energy distribution in pinacyanol with increasing photon energy resembles that observed for a number of inorganic semiconductors (Cs_3Sb, Cs_2Te) ([2]). In the cited works, from comparison of the character of the change in the photoelectron energy distribution with the band scheme of the indicated

the semiconductors, the authors came to the conclusion that there is a discrete loss of energy by the photoelectron, equal to the width of the forbidden band. If one takes into account that for pinacyanol the maximum in the absorption spectrum corresponds to an energy of 2 eV, then the loss of energy by the photoelectrons, equal to this value and to a multiple of it, is in the present case quite possible. A difficulty for such an interpretation is that in the photon-energy region where the peak of slow electrons appears, the increase in the yield of photoemission does not decrease, but even increases somewhat. This rather indicates that what occurs is not a discrete loss of energy by the photoelectron, but the removal of electrons from the next filled band or the excitation of the positive ion being formed. In order to resolve definitively the question of the true mechanism of photoemission from pinacyanol layers, additional data are needed. However, regardless of the final resolution of this question, the results obtained indicate that, in the case of pinacyanol, the scattering of energy into intramolecular vibrations and vibrations of the crystal lattice occurs to a less significant extent than in the case of pinacryptol. Otherwise we would not be able to observe distinctly the processes associated with the excitation by photoelectrons of the electronic transition in the dye molecules. The data obtained show that the dyes considered—pinacryptol and pinacyanol—having close values of the photoelectric work function (5.2 and 4.9 eV), have completely different distributions of photoelectrons with respect to energy.

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[1] F. I. Vilesov, A. N. Terenin, DAN, **133**, No. 5 (1960). [2] L. Apker, E. Taft, J. Dickey, J. Opt. Soc. Am., **43**, 78 (1953); E. Taft, L. Apker, J. Opt. Soc. Am., **43**, 81 (1953).

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