CONCERNING THE DEPENDENCE OF THE QUANTUM YIELD OF THE PHOTOEFFECT IN InSb ON THE PHOTON ENERGY

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Photons of energy $h\nu > E_g + (3/2)kT$ generate in a semiconductor hot carriers capable of producing new electron-hole pairs. The question of the threshold energy (TE) starting with which the quantum yield η exceeds unity has been under discussion for the last few years [1 - 8], in view of its practical importance and the ambiguity of the conclusions of the performed quantum-mechanical calculations.

Thus, according to the calculations of [1], the TE for InSb is $h\nu \approx 2(1 + m_e/m_h)E_g$, i.e., practically equal to $2E_g$. In [4, 5] the importance of energy scattering by optical phonons is emphasized and it is assumed that TE >> $2E_g$. A Monte Carlo calculation [2, 3] shows that the probability of ionization by the carriers differs from zero even at energies close to $2E_g$, but there is doubt in the literature concerning this conclusion [2, 6].

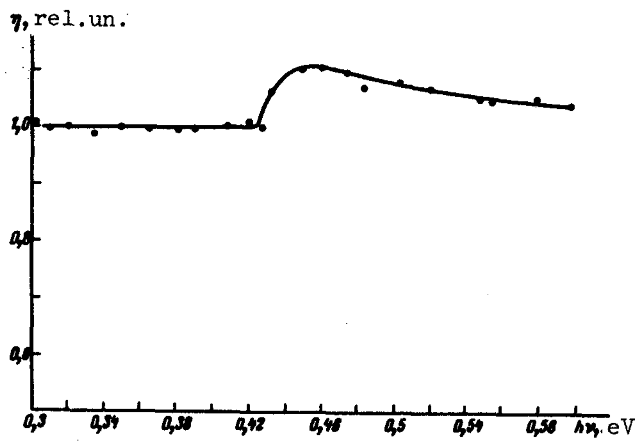
We have already reported on the fine structure of the quantum yield for InSb [7]. These investigations were continued and principal attention was focused on the determination of the value of the TE, which according to [7] is close to $2E_g$.

The photon source was an IKS-14 spectrophotometer with CaF_2 prism, placed in a vacuum-tight chamber with continuous drying of the atmosphere. This eliminated completely the atmosphere lines in the 1 - 5 μ region. The results were recorded simultaneously with the aid of the bolometer of the IKS-14 and the investigated photocell. We used only mirror optics; the p-n junction was in the short-circuited mode, when the relation $I_{pn} \sim \eta$ is valid.

It can be seen from the figure that η begins to grow at $h\nu \approx 0.43$ eV. This means that, within the limits of experimental accuracy, the TE equals $2E_g$ if account is taken of the fact that $E_g = 0.22$ eV at 90°K. For $h\nu \geq 0.48$ eV we have $\partial\eta/\partial(h\nu) < 0$, which is unexpected and should be investigated further.

Similar results were obtained by us in an investigation of the photoconductivity and the photomagnetic effect in InSb.

It is possible that the relation observed by us for $\eta = f(h\nu)$ holds also for other semiconductors having a band



Quantum yield vs. photon energy in InSb. The data are normalized to $h\nu = 0.35$ eV; the reflection coefficient is assumed constant.

structure similar to that of InSb. We could state then that intense ionization by hot carriers, capable of raising the quantum efficiency, takes place in semiconducting crystals already at photon energies close to $2E_g$.

In light of the foregoing, it seems to us also that calculations of energy scattering by hot carriers, carried out by the Monte Carlo methods, apparently agree with the actual facts.

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CONCERNING ONE EXPERIMENTAL POSSIBILITY IN NEUTRINO ASTRONOMY

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In spite of the fact that the potential feasibility of obtaining information concerning the sun by means of neutrino astronomy has become evident a long time ago [1], there exists so far only one setup capable, in principle, of registering solar neutrinos [2]. We have in mind the $Cl^{37} \to A^{37}$ radiochemical method [3]. This setup has already yielded significant information concerning the sun, although it has not yet been possible to record solar neutrinos with its aid [2].

Other radiochemical methods [4] proposed to date can yield, in principle, important additional information, but they are much more difficult to realize.

Various electronic methods [5] proposed for the registrations of neutrinos from the sun have not yet been realized and do not satisfy many important requirements.

What are the desirable properties of a solar-neutrino detector based on electronic registration methods?

1. The apparatus should register electrons from the ν-e scattering process or electrons from the inverse β process, with energy on the order of several MeV (and possibly lower).

2. The sensitive part of the detector should amount to not less than 10 t.

3. The apparatus should yield information on the direction of arrival of the registered neutrinos.

4. The apparatus should yield some information concerning the energy spectrum of the electrons produced by the neutrinos.

5. It is desirable that the apparatus distinguish quite strongly between electrons having a "neutrino nature" and background electrons.

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