FIZIKA, 2 (1970) 103-104

LETTERS TO THE EDITOR

A POSSIBILITY FOR ELECTRON ENERGY BAND INVESTIGATIONS IN METALS BY PHOTON — ENHANCED FIELD EMISSION

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Received 11 October 1969

The photoelectron energy distribution measurements give valuable results in the energy band determinations, as it is shown in[1]. For lower band investigations a similar technique could be used. Holding a thin film cold cathode[2] at low temperature enough all the electron states above the Fermi

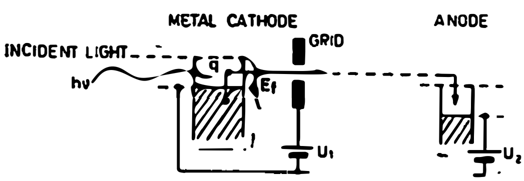

Fig. 1.

level E_F will be empty. In this case and for a certain grid voltage U_1 as it is shown in Fig. 1, there will be no current through the anode. Illuminating now the cathode with a light beam of a certain frequency ν, electron transitions will occur if these transitions are not forbidden for $h\nu$. The nonequilibrium electrons on this level can leave the cathode and be collected in the anode. Measuring the number of these electrons as a function of their energy $\frac{dn}{d\varepsilon}$ for $\nu = \nu_1$ we can determine a characteristic point in the energy band related to the Fermi level, as shown in Fig. 2. The energies ε with $\frac{dn}{d\varepsilon} \to \infty$ for various frequencies $\nu_1, \nu_2 \dots$ of the incident light give the characteristic points in the Brillouin zone with allowed transitions $h\nu_1$, $h\nu_2 \ldots$ Knowing the energies ε_1, $\varepsilon_2 \ldots$ we can calculate the levels from which the transitions occured taking $\varepsilon_1 - h\nu_1$, $\varepsilon_2 - h\nu_2 \ldots$

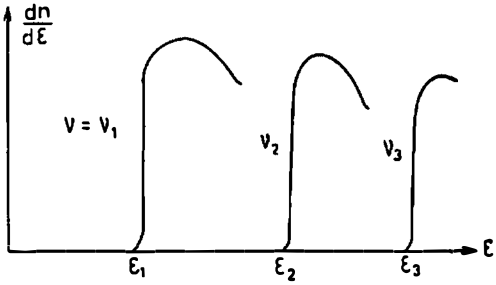

Fig. 2.

It is already shown[3] how the total current depends on the light frequency ν. However, this results the determination of the energy difference between the allowed transition levels and does not give the value of the energy related to the Fermi level. The same results can be obtaind by optical reflection spectra. Measuring however the $\frac{dn}{d\varepsilon}$ for $\nu = \nu_i$ $(i = 1, 2 \ldots)$ we could determine the energies in the characteristic points for which $\frac{dn}{d\varepsilon} \to \infty$ related directly to the Fermi level in the metal.

References

1) Kane E. O. Phys. Rev. **137** (1962) 131;
2) Spindt C. A. J. Appl. Phys. **39** (1968) No 7;
3) Novikov et al., Soviet Phys. Solid State **4** (1962) No 11.