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Calibration of the hydrogen atom detector in the energy range from 0,2 to 8,0 keV.

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One of the simple methods for determining the intensity of a fast atom beam is measuring the flow of the secondary electrons. But there are only few measurements of the secondary emission coefficient γ^o for metal, gas-covered surface, bombarded by hydrogen atoms with energy up to 10 keV. We measured γ^o for surfaces made of Cu, CuBe, Mo, Al bombarded perpendiculary by the monoenergetic, low intensity (10^{-10} - 10^{-12} A) hydrogen atom beam. The background pressure in the vicinity of the target E (Fig.1) was about 10^{-6} torr and thus the surface was covered with a molecular layer during the measurement.

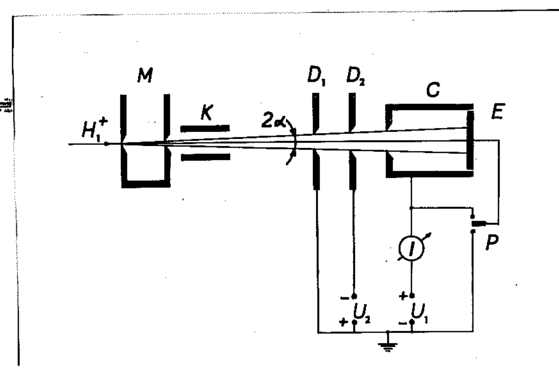

Fig. 1. Experimental arrangement D_1, D_2 - the entrance appertures of the detector. U_1 = 20 V, U_2 = -30 V.

The beam of protons with divergency 0,15° was partially converted to neutral hydrogen by passage through a neutralising cell M, filled with oxygen and went on to the detector. The charged part of the mixed beam was deflected by condenser plates K. The resolution of the detector (α = 2,5°) was sufficient for detection more than 99 % of the scattered atoms in the given energy range [1]. All currents were measured only with one electrometer operating either in "Faraday cup mode" or "secondary emission mode".

The flow of secondary electrons $I_c(o)$ on the collector C depends on the density of the oxygen molecules n in the neutralizing cell and may be expressed as

$$I_c(o) = \gamma^o \cdot I^+ \cdot \sigma_{10} \cdot l \cdot n + K \qquad (1)$$

where I^+ - intensity of the primary proton beam entering the neutralizing cell,

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σ_{10} - proton - molecular oxygen charge transfer cross section [2,3], l - effective length of the neutralizing cell, K - a constant describing a secondary emission current from fast atoms generated in collisions of the primary protons with background molecules. The linearity of (1) was fulfilled up to pressure of oxygen about 1.10^{-3} torr. The coefficient γ^0 was determined from the slope of (1).

To simplify the calibration of neutral detectors, we have also measured directly the ratio γ^0/γ^+, where γ^+ is the secondary electron emission coefficient for protons impinging the metal surface. The ratio was measured using the relation

$$I_c(0) = \gamma^0/\gamma^+ \, I_c(+) \cdot \sigma_{10} \cdot l \cdot n_+ + K \qquad (2)$$

where $I_c^+(+)$ - the flow of the secondary electrons on the collector, when the target is bombarded by the proton beam with intensity I^+.

The accuracy of the measurement for γ^0 and γ^0/γ^+ was better than 25%.

The results of the measurements of γ^0 are shown in Fig. 2 together with the results from [4,5], reduced by cos ϑ to correspond to normal incidence.

The results of the measurements of γ^0/γ^+ are shown in Fig. 3 together with the results from [6]. The difference between both measurements is not clear.

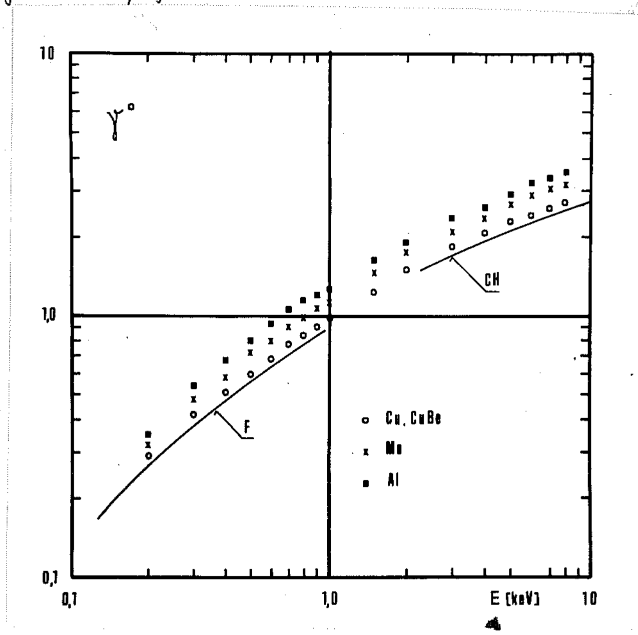

Fig.2. The dependence of γ^0 on the energy of the primary hydrogen atoms. F - [4] (Cu target, ϑ = 45°), CH - [5] (CuBe target, ϑ = 60°).

From Fig. 2 and 3 we can see that in the energy range from 0,2 to 8,0 keV ;

A) the choice of material of the target has little influence on the value of the coefficient γ^0 for the given experimental conditions (gas-covered surface).

B) the ratio γ^0/γ^+ seems to be independent neither on the energy of the primary beams, nor on the target material. The average value of γ^0/γ^+ was found to be 1,18 ± 0,15.

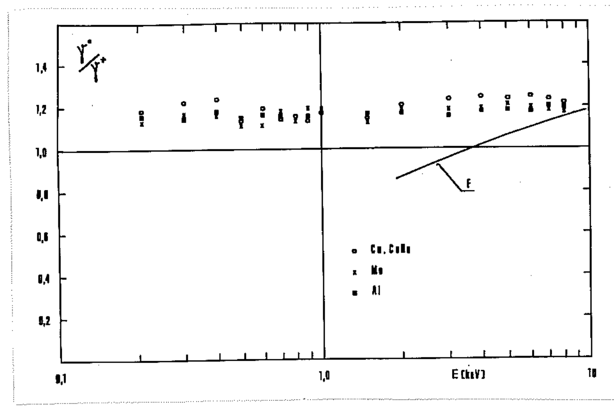

Fig.3. The dependence of γ^0/γ^+ on the energy for H^0 and H^+ impact. F = [6] (Ni target, ϑ = 60°).

References

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