

a pulse passes along a cell containing saturated iodine vapor at room temperature, 80 - 100% of the  $I_2$  molecules dissociated in our case. The 5310-Å radiation falls in the discrete region of the  $I_2$  spectrum, corresponding to a transition of the molecule to the excited state  $B^3\Pi_{0u}$ . According to the latest data [2], this region is overlapped by the continuous absorption region that transfers the molecules to the repulsion state  $^1\Pi_u$ . The high degree of dissociation may in this case be due to the fact that the transition in the continuous absorption region, unlike in the discrete one, does not saturate at any attainable radiation densities. Thus, such a procedure for iodine dissociation results in a high degree of decomposition within a negligibly short time (50 nsec) compared with the characteristic recombination times. To verify the applicability of the method, we determined the recombination constants of iodine atoms in the presence of 551 Torr He and 200 Torr Xe. The concentration was determined using the iodine extinction coefficient for  $\lambda = 495$  nm, which equals  $495 \pm 60$  l/mol-cm and was determined by us experimentally. The appreciable change of the degree of decomposition on the processed sections of the oscillograms (75 - 30%) (see the Figure) makes it necessary to take into account the change in the rate of recombination of iodine atoms into molecular iodine, due to the change of the  $I_2$  concentration. The recombination rate constant  $K_m$  was determined from the differential recombination equation

$$\frac{d[I]}{dt} = -[I]^2(K_{I_2}[I_2] + K_m[m]),$$

where  $d[I_2]/dt$  was determined graphically for different values of  $t$ ,  $[I_2]$  is the  $I_2$  concentration for the corresponding  $t$ ,  $K_{I_2}$  is the rate of recombination<sup>1)</sup> into  $I_2$ . We used the value  $K_{I_2} = 2.35 \times 10^{-30}$  cm<sup>6</sup>sec<sup>-1</sup> given in [3].

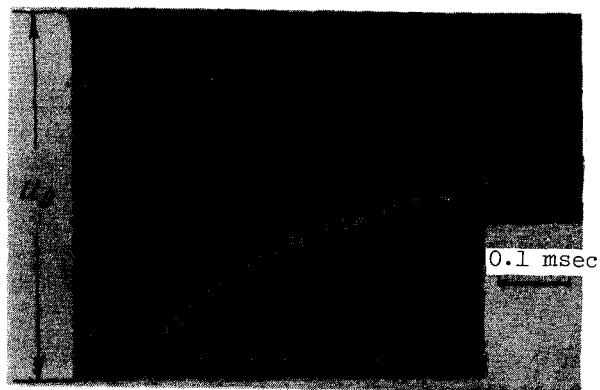
The correction for the expansion of the probed gas column, due both to the heat released upon recombination and to heat released by dissociation does not change the determined constants noticeably at the pressures chosen by us. The obtained values of the recombination rate constants,  $(1.6 \pm 0.25) \times 10^{-32}$  cm<sup>6</sup>sec<sup>-1</sup> for Xe and  $(3.35 \pm 0.5) \times 10^{-33}$  cm<sup>6</sup>sec<sup>-1</sup> for He agree well with the results given in [3]. We believe that the proposed method of iodine molecule dissociation can be used to study those recombination features that are most strongly manifest at high degrees of decomposition [3, 4].

- [1] V. N. Kondrat'ev, *Konstanty skorostei gazofaznykh reaktsii* (Rate Constants of Gas-Phase Reactions), Nauka, 1970, p. 113.
- [2] R. J. Oldman, R. K. Sader, and K. R. Wilson, *J. Chem. Phys.* 54, 4126 (1971).
- [3] M. Christie, *J. Chem. Soc.* 84, 4066 (1962).
- [4] E. E. Nikitin, *Teoriya elementarnykh atomno-molekulyarnykh protsessov v gazakh* (Theory Of Elementary Atomic-Molecular Processes in Gases), Khimiya, 1970, p. 350.

#### DEPENDENCE OF FAST-ION NEUTRALIZATION ON THE EMISSION ANGLE IN SCATTERING BY A METAL SURFACE

S. Yu. Luk'yanov and V. M. Chicherov  
 I. V. Kurchatov Atomic Energy Institute  
 Submitted 11 April 1973  
 ZhETF Pis. Red. 17, No. 10, 560 - 563 (20 May 1973)

It is customary at present to consider ion neutralization on a metal surface by using a model in which the target surface is assumed to be ideally homogeneous and smooth, its electronic properties are described in accord with Sommerfeld-Fermi, and the neutralization is



Typical oscillogram of probing signal ( $15.9 \times 10^{18}$  cm<sup>-3</sup> He +  $0.866 \times 10^{-16}$  cm<sup>-3</sup>  $I_2$ );  $u_0$  - probing-radiation signal corresponding to the absence of iodine.

<sup>1)</sup>The recombination rate constant is defined by us as the number of recombination acts per unit volume per unit time for unit reagent concentration.

effected by the electrons of the solid, which penetrate through the potential barrier (see, e.g., [1]). In this model, the ion neutralization probability is determined by the time of its stay near the target surface or, in the general case when the ion moves at an angle to the surface, by the reciprocal of the normal component of its velocity. Thus, the probability of neutralizing particles of a given kind having identical total velocities should be determined by their emission angles.

In the experiments described below we verified the applicability of this simple model to neutralization of fast argon ions (velocity  $(3 - 5) \times 10^7$  cm/sec) scattered by the atoms of the upper layers of a platinum target. The employed experimental procedure made it possible to measure fluxes of fast scattered particles, ions and neutrals, corresponding to different emission angles, and the total particle velocity was kept constant. A measure of the flux of scattered particles was the height of the single-scattering peak in the energy spectra of the singly-charged argon ions and neutral argon atoms. For an energy analysis of the scattered ions and neutrals, we used the analyzer described in detail in [2]. The fast neutral argon atoms were stripped in helium and in neon. The completeness of the gathering of the fast ions produced by stripping the neutrals was monitored by varying the dimensions of the output slit of the stripping chamber. Additional evidence that the intensity of the fast neutrals was correctly measured was the agreement between the results obtained by stripping in helium and in neon.

The experimental setup is shown in Fig. 1. The target, schematically, was an obliquely cut cylinder, whose axis coincided with the axis of the ion beam bombarding the surface of the cut section. Rotation of the cylinder about its axis leads to a change in the emission angle, and consequently to a change of the normal component  $v_{\perp} = v_0 \sin \psi$  of the velocity of the particles incident on the entrance slit of the analyzer. The scattering angle, and with it the total velocity  $v_0$  of these particles, remain constant. The latter is very important from the point of view of the method chosen to register the neutral component, since measurement of the flux of neutrals whose transverse velocity vary in a wide range requires only the knowledge of the stripping cross section at one value of the total velocity.

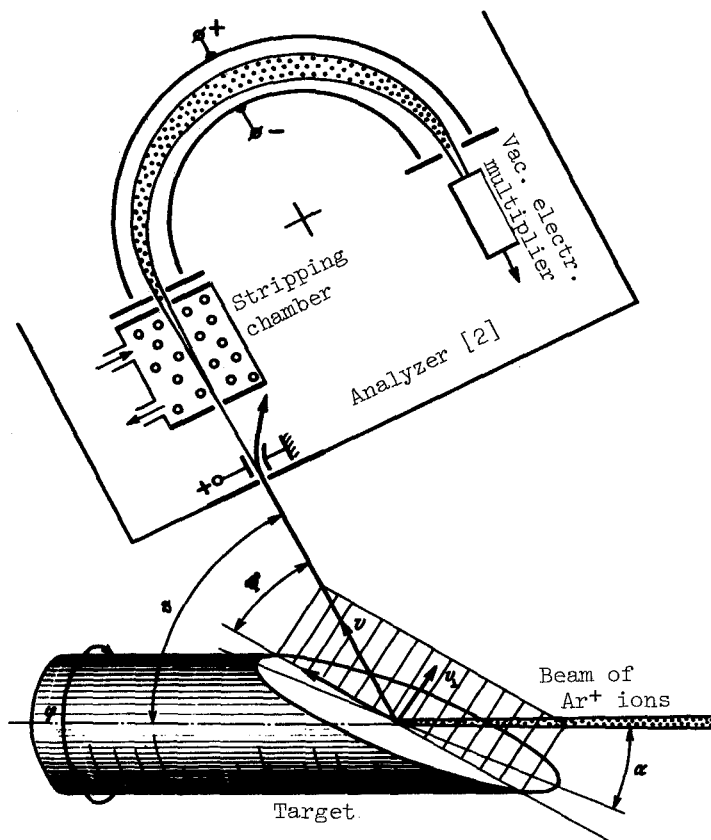


Fig. 1. Diagram of setup

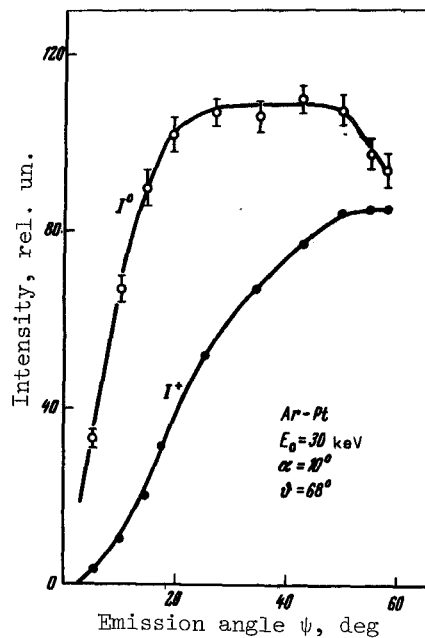


Fig. 2. Intensities  $I^+$  and  $I^0$  of ionic and neutral scattering components vs the emission angle

Figure 2 shows the intensities of the ionic and neutral scattering components as functions of the emission angle  $\psi$ . The curves differ in character: the ion intensity decreases monotonically on going over to smaller emission angles, while the curve for the neutrals has a broad maximum. This difference indicates that the angular distributions obtained for fast ions and for fast neutrals at identical angles of incidence ( $\alpha = \text{const}$ ) and scattering ( $\theta = \text{const}$ ) differ significantly from each other.

Figure 3 shows plots of  $I^+/(I^0 + I^+)$  against  $v_{\perp}$ , measured at bombarding-ion energies 20, 25, and 30 keV. We see that the results corresponding to different energies of the bombarding ions practically coincide. This indicates that the probability of ion neutralization is determined mainly by the normal component of the ion velocity. Figure 3 can thus be regarded as the experimental plot of  $1 - w_0 = f(v)$ , where  $w_0$  is the ion neutralization probability. (The intensity of the scattered-flux components having higher charges did not exceed 10%).

According to the calculations of [3], the share of ionized particles in the scattered flux should depend on the normal component of the velocity like  $\exp(-a/v)$  (the constant  $a$  is not defined by the theory). Yet it is seen that the results of Fig. 3 cannot be described by an exponential function. The quantity  $I^+/(I^0 + I^+)$  increases approximately linearly with  $v_{\perp}$ . It is curious to note that a similar dependence was observed by Veksler (see, e.g., [4]), although in an entirely different velocity region.

The authors thank S. N. Zvonkov for great help with the work, S.A. Evstigneev for constructing a number of parts of the installation, and O. B. Firsov for useful discussions.

- [1] E. S. Parilis, Second All-union Symposium on the Interaction of Atomic Particles with Solids, Moscow, 9 - 11 October 1972, Collected Papers (in Russian), p. 137.
- [2] V. M. Chicherov, ZhETF Pis. Red. 16, 328 (1972) [JETP Lett. 16, 231 (1972)].
- [3] Sh. Sh. Shekhter, Zh. Eksp. Teor. Fiz., 1973, in press.
- [4] V. I. Veksler and B. A. Tsipinyuk, Zh. Eksp. Teor. Fiz. 60, 1393 (1971) [Sov. Phys.-JETP 33, 753 (1971)].

#### RESONANT ABSORPTION IN UNIAXIAL CRYSTALS WITH CYLINDRICAL DOMAIN STRUCTURE

M. A. Sigal  
 Kiev State University  
 Submitted 11 April 1973  
 ZhETF Pis. Red. 17, No. 10, 563 - 566 (20 May 1973)

Resonant absorption due to precession of the magnetization of cylindrical domains was observed experimentally at millimeter wavelengths in the state of residual magnetization of a thin magnetoplumbite crystal.

It is known that in a single-crystal plate of a uniaxial crystal with easy magnetization axis (EMA) perpendicular to the basal plane, in the residual magnetization state (RM), there can occur various types of domain structures (strip, cylindrical), depending on the method of excitation. The so-called honeycomb structure, constituting a hexagonal lattice of cylindrical domains, was observed first in the RM state [1] in a thin magnetoplumbite crystal following the action of a saturating field  $H_{\text{sat}}$  making an angle  $\theta$  close to  $\pi/2$  with the easy axis. In the case  $\theta = 60 - 80^\circ$ , a structure of strip domains is produced, with boundaries parallel to the

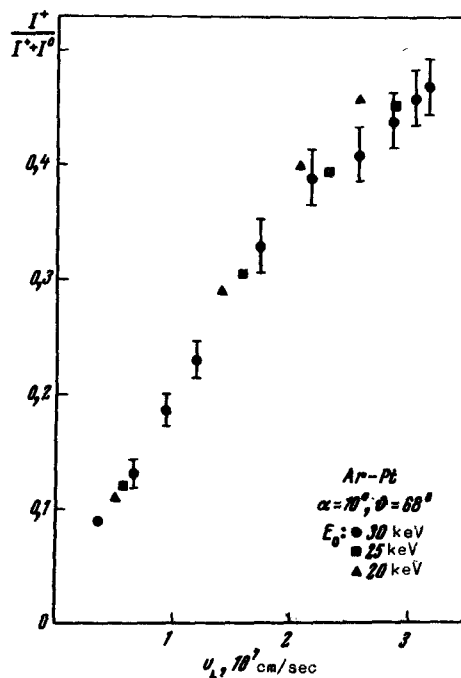


Fig. 3. Plot of the quantity  $I^+/(I^0 + I^+)$  ( $= 1 - w_0$ ) vs the normal component of the velocity at which the particle moves away from the target surface.  $E_0$  is the bombarding-ion energy.