SOME FEATURES OF SECONDARY ION EMISSION FROM A W-Mo ALLOY UNDER THE ACTION OF SLOW IONS

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SOME FEATURES OF SECONDARY ION EMISSION FROM A W–Mo ALLOY UNDER THE ACTION OF SLOW IONS

It has been established ([1,2]) that, when ions with an initial energy E_0 of several hundred electron volts and higher interact with a solid, the scattering of ions occurs from individual free atoms of the target. In the energy spectra of secondary ions, peaks of singly elastically scattered ions have been found ([3–6]), whose energy E_p agrees well with the energy calculated from the expression

$$E_\mathrm{p} = E_0 \left(\cos\theta + \sqrt{\mu^2 - \sin^2\theta}\right)(\mu+1)^{-2}, \tag{1}$$

where θ is the scattering angle and μ is the ratio of the mass of the target atom to the mass of the incident ion.

In work ([7]), investigations were carried out on a Cu–Ag alloy with 30-keV Ar^+ ions. In this work two peaks of scattered ions were detected, arising as a result of pair collisions of ions with Cu and Ag atoms. In work ([6]) the isotopic effect was investigated, where two peaks of singly scattered ions, arising in the process of pair collisions with isotopic copper atoms, were also observed.

To elucidate the mechanism of the influence of the bonding of atoms in the crystal lattice on ion scattering, it is of interest to study the energy spectra of secondary ions from alloys in the low-energy region.

In the present work, investigations of the energy spectra of secondary ions from an alloy were carried out by means of the method used by us earlier ([8]). As the energy analyzer, a 127° cylindrical capacitor with high resolving power was used. The energy spectra were recorded on the screen of an oscillograph. A beam of K^+ ions with intensity 10^{-6} A struck the target at an angle $\alpha = 55°$, and the secondary ions were analyzed at a scattering angle $\theta = 71°$. The vacuum in the instrument was $5 \cdot 10^{-8}$ torr. Before measurement, targets of 50% W–Mo alloy were heated at a temperature of 1700° K, and those of pure W and Mo at 2400° K.

Fig. 1. Oscillograms of the energy spectra of secondary ions obtained in bombardment of a W-Mo alloy heated to 1350°K by K^+ ions with energy $E_0 = 490$ eV (1); 340 eV (2); 230 eV (3) and 170 eV (4)

Figure 1: Fig. 1. Oscillograms of the energy spectra of secondary ions obtained in bombardment of a W-Mo alloy heated to 1350°K by K^+ ions with energy $E_0 = 490$ eV (1); 340 eV (2); 230 eV (3) and 170 eV (4)

Fig. 2

Figure 2: Fig. 2

Fig. 1. Oscillograms of the energy spectra of secondary ions obtained in bombardment of a W-Mo alloy heated to 1350° K by K^+ ions with energy $E_0 = 490$ eV (1); 340 eV (2); 230 eV (3) and 170 eV (4)

Figure 1 shows a series of oscillograms representing the energy spectra of secondary ions obtained in bombardment of a W-Mo alloy heated to 1350° K by K^+ ions with energy $E_0 = 490;\ 340;\ 230$ and 170 eV. Three peaks are observed on the oscillograms in Fig. 1. The peak in the low-energy part of the spectrum consists of the peak of evaporated ions and the peak of slow secondary ions. On the oscillogram in Fig. 1 two peaks in the high-

the energy part of the spectrum correspond to ions singly elastically scattered from W and Mo atoms constituting the W—Mo alloy. The presence of these peaks from the alloy in the region $E_0 \approx 490 \div 170$ eV argues in favor of pair collisions.

In Fig. 2 are given experimental curves of the dependence $\eta(E_0)$ (where $\eta = E_\mathrm{p}/E_0$), obtained upon bombardment by K^+ ions of a pure W—Mo alloy and of the metals W and Mo, and curves calculated from equation (1) for pure W and Mo. As can be seen, the experimental points for the alloy and for the pure metals coincide. The observed deviations from the calculated curve at $E_0 < 220$ eV indicate the influence of the binding energies of the target atoms on the energy of the secondary ions ([9]).

Fig. 2. Curves of the dependence $\eta(E_0)$, obtained upon bombardment by K^+ ions of a W—Mo alloy and of the metals W and Mo, and calculated from equation (1) for pure W—Mo. *a*—experimental points obtained for the alloy, *b*—for pure metals, *v*—calculated from equation (1)

It is interesting that in the case of the W—Mo alloy (Fig. 1), when E_0 is decreased to ~ 170 eV, the peak of elastically scattered ions from W gradually disappears. This is apparently connected with the formation, on the surface of the W—Mo alloy heated to 1350° K, of a film of Mo atoms and with the fact that, as E_0 is decreased, scattering occurs from an ever smaller depth. At $E_0 \approx 180$ eV scattering occurs only from the Mo film. Indeed, in works ([10,11]) it was shown that penetration of ions into the depth of the target ceases at $E_0 \approx 180$

Fig. 3

Figure 3: Fig. 3

eV.

Thus, the disappearance of the peak of elastically scattered ions for one of the components of the alloy can be used to determine the thickness of the film, and determination of the number of the group of slow and sputtered ions can provide information on the magnitude of the potential barrier at the surface of the target as a function of the film thickness.

Fig. 3. Energy spectra of secondary ions obtained upon bombardment of a W—Mo alloy by K^+ ions with energy $E_0 = 480$ eV. Oscillograms 1, 2 and 3 were recorded at temperatures 1200, 1500 and 1700° K, respectively. Oscillograms 4, 5 and 6 were recorded at a temperature of 1300° K after 1, 2 and 3 min, respectively, of continuous bombardment by an ion beam with intensity $\sim 1{\cdot}10^{-6}$ A

In Fig. 3 are presented the energy spectra of secondary ions obtained upon bombardment of a W—Mo alloy by K^+ ions with energy $E_0 = 480$ eV. Before the oscillograms were recorded, the target was heated at 1700° K, and then for 5 min was subjected to bombardment by the ion beam at a temperature of 1200° K.

With an increase in the target temperature to 1700° K (oscillograms 1, 2 and 3, Fig. 3), the peak of elastically scattered ions for W gradually disappears, which indicates an increase in the thickness of the Mo film on the surface of the target mi-

···tion. When the temperature is lowered to 1300° K and the target is bombarded for a prolonged time (oscillograms 4, 5, and 6), as a result of sputtering of the film by the ion beam, the peak of elastically scattered ions for W appears again.

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Note: Figure translations are in progress. See original paper for figures.