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Fig. 1

Figure 1: Fig. 1

Abstract

Full Text

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ENERGY SPECTRA OF IONS SCATTERED BY POLYCRYSTALLINE SURFACES THROUGH SMALL ANGLES

(Presented by Academician L. A. Artsimovich, November 13, 1963)

According to Bohr (⁀1), the interaction of fast ions with a solid should be regarded as a sequence of binary collisions of the ion with target atoms. If the ion velocities are less than the orbital velocities of the electrons, then energy losses to excitation, as well as the interaction of target atoms with one another, may be neglected, and it may be assumed that the ions lose energy only as a result of elastic scattering by target atoms. This makes it possible, in analyzing the energy spectra of reflected ions, to use the classical laws of conservation of energy and momentum (see, for example, work (⁀2), in which the energy spectra of ions scattered through an angle of 90° were studied). It was of interest to study the dependence of the energy spectra on the scattering angle.

Fig. 1

The basic scheme of the experiment is shown in Fig. 1. A beam of argon ions with an energy of 25 keV, obtained in the apparatus (⁀3), was incident on the target at an angle ϑ to its surface. The scattered beam was studied with the aid of an electrostatic analyzer with double curvature, calculated by V. G. Tel' kovskii according to the theory of axially symmetric fields of A. F. Malov (⁀4). The resolving power of the analyzer was $\Delta E/E = 1/80$, and the angular resolution was $\pm 1^\circ$. The ion current was measured by an electrometric circuit analogous to (⁀5). The measurement results are given for a copper target in Fig. 2, and for a graphite target in Fig. 3.

It is seen that in the energy spectrum of ions scattered by the copper target, at all scattering angles studied there is a maximum whose position depends on the scattering angle: as the latter increases, the maximum shifts toward lower energies (see (⁀6)). This fact appears natural if, following (⁀2), one assumes that the maximum corresponds to particles that have undergone single scattering by target atoms. It is interesting to note that at large scattering angles, beginning with 30°, that part of the energy spectral···

Fig. 2

Figure 2: Fig. 2

Fig. 3

Figure 3: Fig. 3

···distribution, which is associated with multiple scattering through small angles —to the right of the maximum.

The energy spectrum of ions scattered by graphite in the region of small scattering angles is qualitatively similar to the spectrum of ions scattered by copper. However, as the scattering angle increases, the shape of the spectrum changes— the maxima in the high-energy region broaden and then disappear. This is an additional confirmation of assumption ([2]) that the maximum is associated with particles that have undergone single scattering. Indeed, since the mass of argon is greater than the mass of carbon, there is a limiting scattering angle equal to $\sim 17.5^\circ$, so that at larger scattering angles particles that have undergone single scattering are absent. At the same time, it is evident that the change in the shape of the spectrum occurs gradually as the scattering angle increases, and we did not observe any peculiarities at a scattering angle equal to the limiting angle for single scattering (cf. ([7])). These results, as well as the results of studying the angular distribution of fast particles neutralized at the target surface ([8], [9]), indicate a substantial role of multiple scattering even for angles of incidence of ions on the target close to grazing.

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Fig. 2. Copper target. Angles ϑ of incidence of ions on the target: *a*—4° = Φ; *b*—10°; *v*—22°. Scattering angles $\varphi+\Phi$: 1—4°; 2—10°; 3—14°; 4—18°; 5—22°; 6—26°; 7—30°; 8—34°; 9—

Fig. 3. Graphite target. Angles ϑ of incidence of ions on the target: *a*—4° = Φ; *b*—14°; *v*—19°. Scattering angles $\varphi+\Phi$: 1—4°; 2—10°; 3—14°; 4—18°; 5—22°; 6—26°; 7—28°; 8—30°; 9—

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