

POTASSIUM AUGER ELECTRON EMISSION BY  $K^+$  - ION  
BOMBARDMENT OF METAL SURFACES

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1. INTRODUCTION

In this paper the results of measurements of Auger-electron spectra induced by  $K^+$ -ion bombardment of Ni(100) monocrystalline surface are presented. Auger electron emission and/or x-ray emission is observed as the result of collisions of high energy (above some keV) ions with solid surface atoms<sup>1)</sup>. According to Fano and Lichten<sup>2)</sup> the promotion of molecular orbital during a sufficiently violent collision can lead to electronic transition between molecular orbital. After separation, a vacancy can remain in an electronic level of either atom. The succeeding de-excitation occurs either by radiative photon emission, or by non-radiative ejection of an Auger electron.

2. EXPERIMENTAL

The experimental set up, Fig.1, consists of: thermoionic  $K^+$ -ion gun with a solid emitter, argon ion gun for the target cleaning (whose beam can be introduced into the direction of a primary  $K^+$ -ion beam by means of a deflection system), target holder with a system for annealing and target temperature measurement, electrostatic energy analyzer ( $\theta = 90^\circ$ ,  $R_e = 5$  cm), and electron gun for the calibration of the energy scale of the electrostatic energy analyzer. The geometry of the experiment is as follows: the angle between the incident beam direction and Ni(100) monocrystalline surface is  $17.5^\circ$ , while the scattering angle is fixed at  $35^\circ$ ; the crystal is oriented in such a way that the scattering plane is parallel to the direction  $\langle 100 \rangle$ . After polishing, the target was cleaned in situ by alternate sputtering and heating up to  $400^\circ\text{C}$ . The base pressure in the scattering chamber was lower than  $5 \cdot 10^{-8}$  Pa. The energy spectra of emitted electrons were recorded by Pc-At personal computer working in the multichannel analyzer mode.

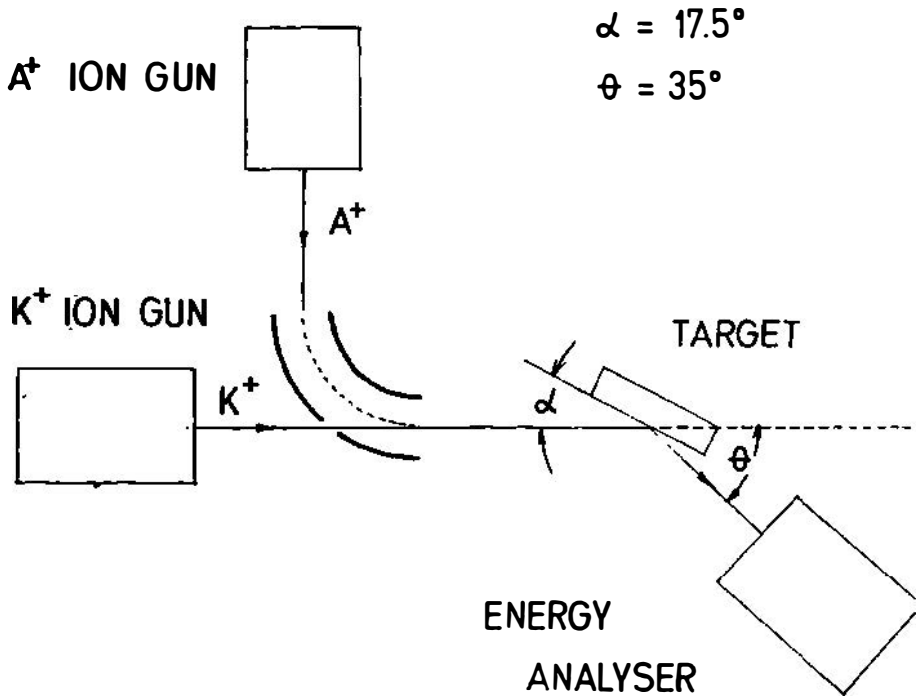


Fig.1. Schematic view of the experimental set-up.

### 3. RESULTS

From the series of secondary electron spectra, Fig.2, for different  $E_0$  projectile energies, in the (0.1-1.5) keV range, it has been observed that:

- (i) for all  $E_0$  energies from the measurement range, the low energy peak of secondary electrons exists; with the increase of  $E_0$  the intensity of this peak increases and the spectrum expands towards higher energies,
- (ii) for the projectile energies higher than (0.4-0.5) keV, in the secondary electron spectrum, a discrete peak appears at the energy,  $E \simeq 15.5$  eV.

In the experiments it has been shown that the appearance depends on the concentration of implanted K-atoms into a couple of surface atomic layers of Ni(100) monocrystalline surface. Namely, in the case of a pure surface (Ni(100) monocrystalline surface previously not bombarded by  $K^+$ -ions), the appearance of the characteristic peak at the energy  $E = 15.5$  eV is completely missing.

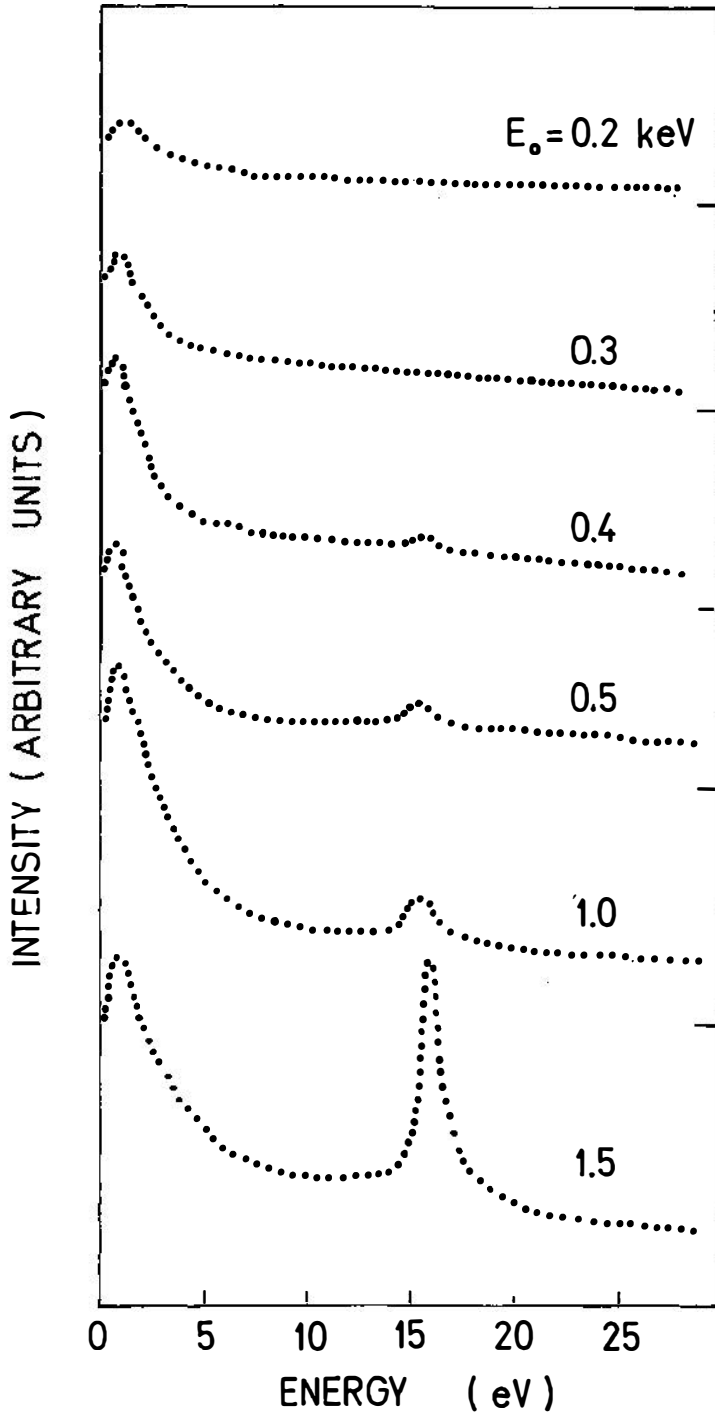


Fig. 2. Electron energy spectra induced by  $K^+$ -ion bombardment of Ni(100) surface for different projectile energies  $E_0$ .

As the same effect has been already observed on the Ag target<sup>3)</sup>, the there given assumption that the appearance of characteristic peak is a result of symmetrical  $K^+$ -projectile collisions with K-atoms previously implanted into the target, has been accepted. The peak is attributed to the deactivation of the lowest autoionized K-atom states, ( $3p^5 4s^2 2p_{3/2}, 3p^5 4s^2 2p_{1/2}$ ).

Let us now consider these collisions having in mind that the generation of inner vacancies in the observed energy region is possible. The schematic correlation diagram of the K-K system<sup>3)</sup> shows a strong  $5f\sigma$  and  $4s\sigma$  molecular orbital promotion.  $5f\sigma - 4s\sigma$  and  $4f\sigma - 4s\sigma$  crossings can cause the appearance of vacancies in 3p and 2p shells of the collision participants. The magnitude of the critical distance in the Ar-Ar collision system (which is close to the observed system) causing the  $4f\sigma - 4s\sigma$  crossing is given<sup>4)</sup> by  $r_c \approx 0.22$  nm. In order to achieve this distance in the Ar-Ar head-on collision, the projectile energy should be about 8 keV<sup>1)</sup>. The estimate of the critical distance necessary to generate 3p vacancy in the K-K collision, can be obtained on the basis of an approximate criterion,  $r_c \approx 2r_{3p}$ , where  $r_{3p}$  is 3p shell radius of K-atom, which, according to Fischer<sup>5)</sup> is,  $r_{3p} \approx 0.046$  nm. Minimum projectile energy necessary to reach this distance in the K-K head-on collision, for the Born-Mayer potential with Abrahamson constants<sup>6)</sup> is  $E \approx 0.5$  keV. The energy threshold for the formation of 3p vacancies in K-K collision obtained in the experiment,  $E_c \approx 0.4-0.5$  keV, corresponds very well to the value estimated above.

#### REFERENCES

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