# EMISSION OF ELECTRONS AND IONS FROM $Ar^+$-ION BOMBARDED SOLID SURFACES

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## Introduction

Electron and ion emission from solid surfaces under bombardment by energetic ions are well known phenomena. Various models has been presented to explain qualitative features of the total yield of emitted electrons or ions.[1,2] The energy necessary to eject electrons from the solid can be provided from two distinct sources: the potential energy released upon neutralization and the kinetic energy of the projectile ion. But we do not know how to separate them from each other and whether electrons come from the collisions of the projectile with the target atoms or from the collisions of recoiling atoms inthe solid. Furthermore, we know how a sputtering event proceeds but do not know by what mechanism a fraction of sputterred atoms become ionized.

We feel that progress could be made from simultaneous measurement of relative ion and electron yield and from measurement of energy spectrum of emitted electrons.

## Experimentals

$Ar^+$-ion beam was produced by a 100 kV accelerator with a Duoplasmatron, mass-analysed with a double focusing magnet, and was introduced through a 2-mm limiting aperture onto the specimen placed in the atmospheric pressure of $10^{-7}$ Torr.

Electrons emitted at 45° angle to the beam were accelerated/deccelerated (by sweeping) to 20 eV energy and analysed by a semispherical-electrostatic analyser with a resolution of $E/\Delta E = 100$.

Secondary ions emitted also at 45° were analysed in a quadrapole mass spectrometer(ULVAC MSQ-300).

## Results

The targets we used were Al, Si, Ti, Cu, Mo, W, and Pt. The projectile were 10, 30, and 70-keV $Ar^+$ with current intensity varying from $10^{-9}$ to $10^{-6}$A/0.03cm$^2$.

The total electron yields were found to be in the order:

Al, Pt > Mo > Si, W > Ti >> Cu

The ion yields were in the order:

Si > Al, Ti > W > Cu > Mo >> Pt

The observed energy spectrum of emitted electrons consists of several "lines". In Fig. 1 is shown the spectrum obtained using Al as a target and the components are marked as A, B, and C. Each component behaved differently when the energy or current intensity of the bombarding $Ar^+$-beam was varied. The heights of the line A and B increase as the energy or current of the ion increases. The position of line B is around 2.5 to 3 eV when the bombarding ion energy is low, but the peak shifts to 3.5~4 eV when the bombarding energy is 70 keV. "line C" behaves differently. At bombarding energy of 10 keV, the line grows at first rapidly with increasing ion current (toward ~ 500 cps at $5\times10^{-8}$A/0.03cm$^2$) and then diminishes with increase in the ion current. At bombarding energy of 30 and 70 keV, "line C" is weak and increases monotonically with ion current intensity.

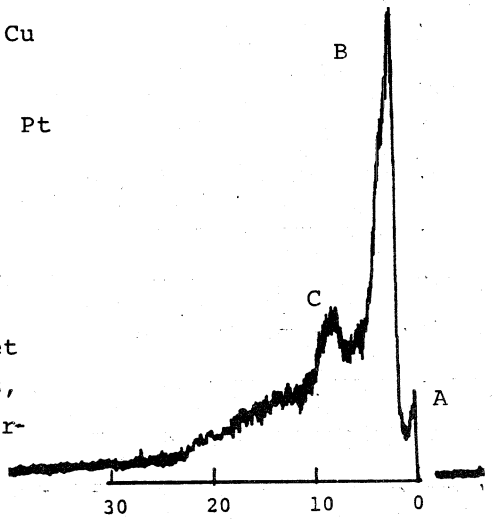


Fig.1. Spectrum of low energy electrons emitted from Al bombarded by $5\times10^{-8}$A/0.03cm$^2$ beam of 30 keV $Ar^+$-ion.

Thus, it is likely that there are several mechanisms operating for the ejection of electrons.In the case of Si and Ti as a target broad Auger lines due to the target were observed in 20 to 70 eV region. Moreover, Ar-LMM Auger lines were observed at 120 — 180 eV when Mo was bombarded.

1) R. A. Baragiola, et al.:Surface Science 90, 240 (1979).
2) P. Williams:ibid., 90, 588 (1979).