PHYSICAL SCIENCES

CORRELATION BETWEEN RICHARDSON CONSTANT AND WORK FUNCTION IN MONOLAYER-STRUCTURED SYSTEM Mo(100)-Ba

Orujov A.
ph.m.PhD., associate professor
Hashimov N.
student
Baku State University
https://doi.org/10.5281/zenodo.14007264

The work was carried out in a sector-type mass spectrometer with an ion depletion angle of 90° [1-3]. The Mo(100)-Ba film system was obtained as follows. From Knudson cell, a stream of Ba atoms was directed onto molybdenum surface and the thermionic emission current was measured simultaneously. If necessary, the flow of barium atoms was blocked by a special interrupter controlled from outside the device. Based on the study of the dependence of the thermionic current – *I* on the time – *t* of the flow Ba atoms at different temperatures *T*, the formation of a barium coating was evaluated. Experiments have shown that at temperatures $T \leq 1100K$, barium atoms fully condense onto the surface of molybdenum. Due to the strong decrease in the work function of the molybdenum surface, the electron current increases by a million times, reaches a maximum value, and then remains constant. At temperatures below $T \leq 1100K$ the current decreases depending on time. The coatings corresponding to the stable and maximum current values are called monolayer and optimal coatings, respectively. It should be noted that, at all coverage levels, no anomalous Schottky effect was observed. This indicates that, at all levels of coverage, the surface is uniform in terms of work function. After obtaining a monolayer of barium on the surface of molybdenum, the dependence of the thermionic current on temperature was eliminated. Using the Richardson method, the slope of the work function dependence for the film system

$$lg\frac{I^-}{T^2} = f\left(\frac{5040}{T}\right)$$

was used to obtain the values $e\varphi \approx 2.4\ eV$. This work function value is less than the value obtained using the total current method. The differences between the values of the work function determined by the Richardson method and by the total current, in our opinion, are associated with the change in the Richardson constant when moving from a clean surface to its film system. When determining the work function for the total current, it is usually assumed that the Richardson constant does not change when moving from a clean surface to its film system. However, as shown by us in [1], when transitioning from the (111)Ir surface to its film system Ir(111)-Ba with a barium atom coverage degree of $\theta = 1$, the Richardson constant decreases by approximately four orders of magnitude. This is also the case for many other metal-film systems. Therefore when determining $e\varphi(t)$, the change in the Richardson constant cannot be neglected. After obtaining the atomic coverage Ba $\theta = 1$, the ratio $\frac{A_0}{A}$ was determined, as in the case of Ir(111)-C, and $\frac{A_0}{A_{Mo-Ba}} \approx 3 \times 10^4$ was obtained. To determine $\theta_{onm} = \frac{N_{onm}}{N_m}$, a

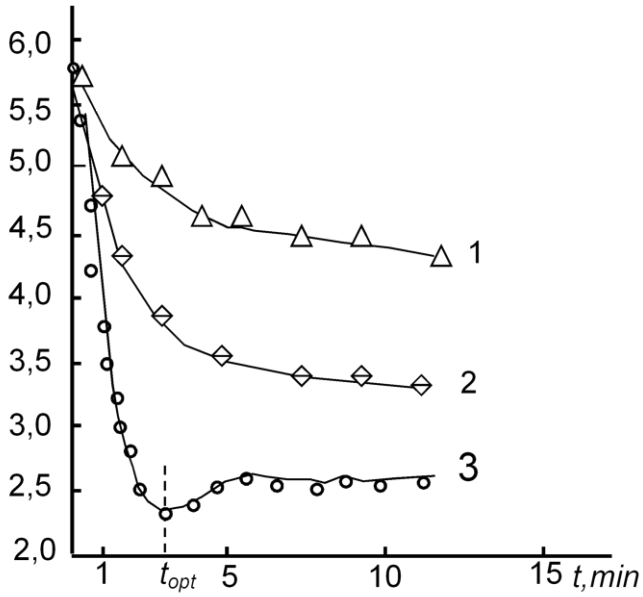

Fig. Dependences of the work function of the Mo(100) - Ba film system on the deposition time of barium atoms for different holding temperatures: 1- T=700K, 2- T=1300K, 3- T=1700K

comparison was made between the concentration of barium atoms on Mo(100) corresponding to the optimal coverage level N_{opt} and the monolayer N_m. This was done by comparing the areas of the thermodesorption spectra of Ba^+ ions corresponding to the optimal coverage and the monolayer of barium atoms on the (100) surface of molybdenum as follows. First, on Mo(100), at temperatures where there is no noticeable desorption of barium atoms (experiments showed that at $T \leq 1100K$, Ba atoms practically do not desorb from Mo(100), since when the flow of Ba atoms is stopped, the thermionic emission current from Mo(100)-Ba remains unchanged for a long time), the atom coverage corresponding to the optimal coverage level was obtained. After that, the flow of Ba atoms was stopped, and the thermodesorption spectra (TDS) of Ba^+ ions were recorded. To obtain a monolayer of Ba atoms on the (100) surface of molybdenum without clusters or other formations, we used intercalation of Ba atoms into graphite monolayer on Mo(100). For this, a graphite monolayer was obtained on the (100) surface of molybdenum heated to $T \approx 1700$K by exposing it to benzene vapors at a pressure of $P = 2 \times 10^6$ Torr, resulting from the decomposition of C_6H_6 molecules. The formation of the monolayer was assessed by the change in work function and the dissociation of *CsCl* molecules. Then, at a temperature of $T \leq 700K$, the Mo(100)-C system was irradiated with a flux of barium atoms with a density of $v = 5 \times 10^{12}$ sm^2. After stopping the flow of Ba atoms, the thermodesoprtion spectra of Ba^+ ions from the Mo(100)-C system were recorded. After that, this procedure was repeated for an expo sure time $t > t_1$. Analysis of the thermodesorption spectra of Ba^+ ions showed that with an increase in exposure time, the number of intercalated Ba atoms (Ba atoms under the graphite monolayer) increases up to a certain value, and with further increase in the exposure time of Mo(100)-C in the Ba atom flux, it does not change. This was considered by us as a monolayer of Ba atoms on the (100) surface of molybdenum under the graphite monolayer. Then, by comparing the areas of the peaks in the thermodesorption spectra of Ba^+ ions corresponding to the optimal coverage and the monolayer, the optimal coverage of barium atoms on the (100) surface of molybdenum was determined, and the value was obtained $\theta_{opt} = 0.70 - 0.05$. Determining the optimal coverage θ_{opt} allows the calculation of the concentration and coverage of Ba atoms at any given time *t* on the molybdenum surface $\theta = \frac{N}{N_M}$. At temperatures of $T < T_a$ molybdenum, where there is no desorption of Ba atoms, for a constant flux density, the following relations can be written:

$$N = \nu \times t,\ N_{opt} = \nu \times t_{opt},\ N_M = \nu \times t_M,$$

where, N, N_{opt}, N_M are the quantities of Ba atoms per 1 cm^2 of the (100) molybdenum surface area for time moments corresponding to arbitrary coverage (θ), optimal coverage (θ_{opt}), and monolayer coverage (θ_M). From these relations, θ and N can be found as functions of the deposition time *t*:

$$\theta = \frac{t}{t_{opt} \times \theta_{opt}},\ N = \frac{t}{t_M} \times N_M$$

To determine N, it is necessary to know N_{opt} or N_M. It is known that on the (1010) Re surface, on the (100) W surface from textured ribbons, and on the (112) W surface, the surface concentration of barium atoms corresponding to the minimum work function has a value of $N_{opt} = 4 \times 10^{14}$ cm^{-2} [1-3]. These results indicate that

the optimal concentration of barium atoms is primarily determined by their interactions, and the structure of the metallic substrate does not play a significant role. Therefore, this value of $N_{opt} \approx 4 \times 10^{14}\ cm^{-2}$ was used by us to determine the flux density of barium atoms and to determine *N*.

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