# TEMPERATURE DEPENDENCES OF SECONDARY ELECTRON EMISSION FACTORS OF THE TUNGSTEN AND MOLYBDENUM MONOCRYSTALS

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The parameters describing process of secondary electron emission (SEE) of tungsten (W) and molybdenum (Mo) monocrystals are investigated at liquid nitrogen temperatures. It is established that obtained effects of crystal's temperature influence on structure of the basic (SEE) characteristics are caused by interactions of electrons with phonons.

At study of temperature influence on monocrystals W and Mo (SEE) the basic attention was concentrated on measurements at low temperatures corresponding approximately to the liquid nitrogen boiling temperature (≅80K). It is caused by what at low temperatures was possible to expect the strongest display of (SEE) anisotropy effects of the monocrystals different sides. The measurements of electron reflection factors (ERF) were partially carried out at the increased temperatures of crystals up to (1200 - 1300) K. The reception of data about the true secondary electron emission factors (SEEF) at the used device construction was complicated, due to possible influence of parasitic thermal currents from the heater.

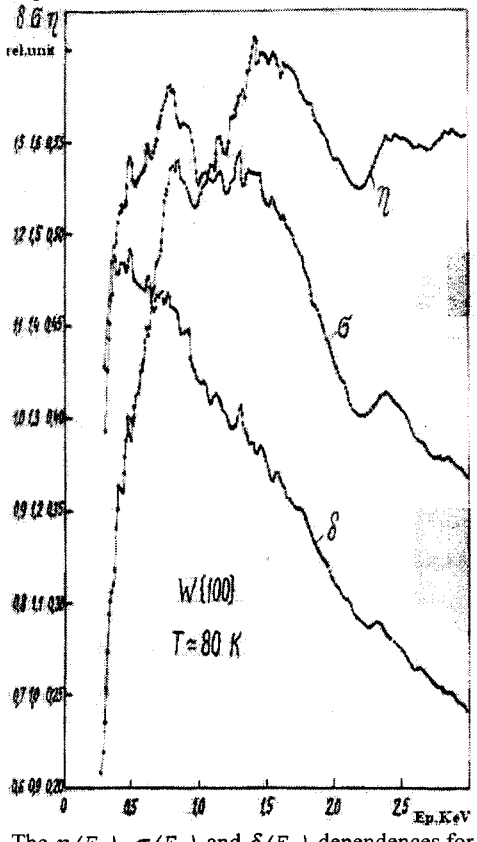


*Fig.1.* The $\eta(E_p)$, $\sigma(E_p)$ and $\delta(E_p)$ dependences for tungsten {100} side at $T$=80 K.

The measurement of monocrystals secondary-emission characteristics at $T$≅80K began in (1,5-2) hours after filling of the liquid nitrogen in vacuum bottle, in which the experimental device was placed. On fig.1 and fig 2 the dependences $\eta(E_p)$, $\sigma(E_p)$ and $\delta(E_p)$ for W two sides {100} and {111} are given as illustration of primary experimental material received in these experiences.

Here:

$\eta(E_p)$ is primary electrons inelastic reflection factor;
$\sigma(E_p)$ is complete secondary electron emission factor;
$\delta(E_p)$ is true - secondary electron emission factor;
$E_p$ is primary electrons (falling on a target) energy.

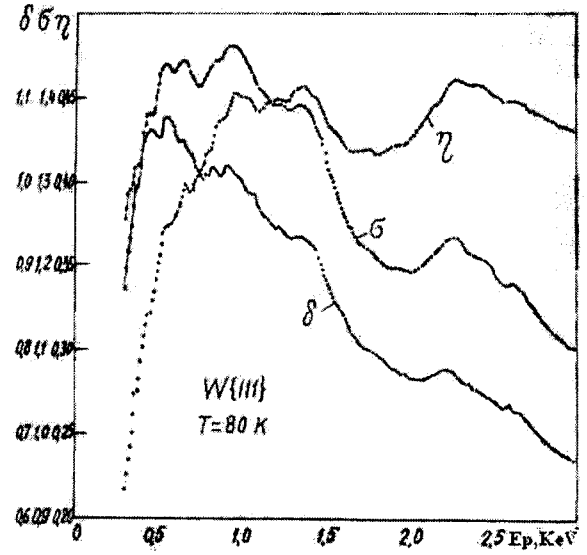


*Fig.2.* The $\eta(E_p)$, $\sigma(E_p)$ and $\delta(E_p)$ dependences for tungsten {111} side at $T$=80 K.

From fig.1 and fig.2 follows, that decrease of crystal's temperature is causes to strengthening of their structure. Much more evident and more precisely it can be seen, if the appropriate curves concerning the different temperatures to put on one diagram. It is made in a fig. 3 and fig.4 for a side of the investigated W crystals.

It is visible from the fig.3 and fig.4 data that decrease of temperature practically does not influence on absolute values of tungsten (SEEF).

Also it does not change appreciably the 1-st order structure. The influence of a crystal cooling is obtained, firstly, in the essential increase of amplitudes of structure nonmonotonities of the 2-nd order at $T$=300 K, and secondly, in occurrence of new (not observable at $T$=300 K) maximum and minimum of structures of the 2-nd order.

The differently the Mo crystals have another behaviour at cooling. For them, alongside with the above mentioned strengthening of the 2-nd order structure, as a rule, in most cases the common shift of curves in the part of factors reduction was observed.

The research of monocrystals (SEE) at low temperatures is carried out in the present work for the first time. In a number of cases the (ERF) was measured at the increased temperatures of samples (≅1000÷1300K).

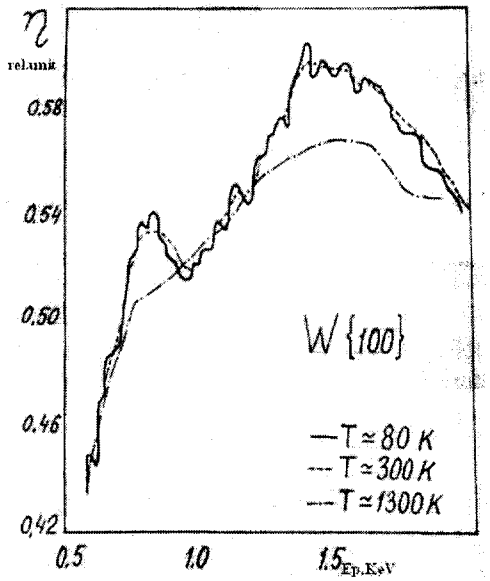


*Fig.3.* The $\eta(E_p)$ dependence for tungsten {100} side at $T$=80 K, $T$=300 K and $T$=1300 K.

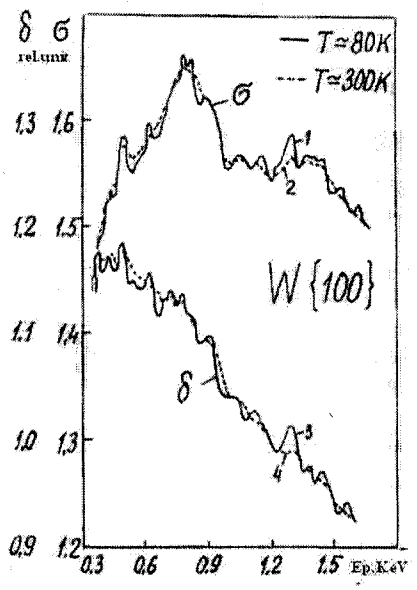


*Fig.4.* The $\sigma(E_p)$ and $\delta(E_p)$ dependences for tungsten (100) side at $T$=80 K and $T$=300 K.

Let address to consideration of the data received at $T$>300K. For the $W$'s {100} and {110} sides the $\eta(E_p)$ dependences, measured at $T$=1300K, are shown on fig.3 and fig.4. It is visible, that the increase of crystal temperature results, on the contrary, to smoothing of curves structure: disappear completely the nonmonotonities of the 2-nd order structure and the 1-st order structure is less expressed. Especially distinctly it is appreciable at the $W$ {100} side (fig.3), for which, as was specified above, the 1-st order structure is shown most strongly.

The smoothing of $\eta(E_p)$ curves structure at increase of the crystal temperature was observed for Mo samples.

The basic attention, according to specified above, in this part of work was inverted on measurements of (SEEF) at liquid nitrogen boiling temperature (≅80K).

It shown, that the downturn of crystal temperature appreciable strengthens the 2-nd order structure on $\eta(E_p)$, $\sigma(E_p)$ and $\delta(E_p)$ dependences and even reveals its additional features. Much more poorly the downturn of temperature has an effect on the 1-st order structure. For molybdenum the cases were observed, when the cooling of a crystal was accompanied by common small shift of secondary–emission characteristics in the party of smaller values.

Apparently, it is connected with the adsorption phenomena. At the crystal temperature increase, on the contrary, there is a smoothing of structure nonmonotonities of the investigated $\eta(E_p)$ dependence.

It is specified that the influence of a crystal temperature on structure of basic secondary - emission characteristics, obtained on experience, is caused by the electron-phonon interactions.

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**VOLFRAM VƏ MOLİBDEN MONOKRİSTALLARININ İKİNCİ NÖV ELEKTRON EMİSSİYASINI XARAKTERİZƏ EDƏN ƏMSALLARIN TEMPERATUR ASILILIQLARI**

Volfram və molibden monokristallarında ikinci növ elektron emissiyası prosesini xarakterizə edən parametrlərin temperatur asılılıqları tədqiq edilmişdir. Müəyyən edilmişdir ki, kristalın temperaturunun ikinci növ emissiyasının xarakteristikalarına təsir effekti, elektronlarla fononların qarşılıqlı təsiri ilə müəyyənləşir.

**Н.М. Табатабаеи, Б.З. Алиев, А.З. Панахов**

**ТЕМПЕРАТУРНЫЕ ЗАВИСИМОСТИ КОЭФФИЦИЕНТОВ ВТОРИЧНОЙ ЭЛЕКТРОННОЙ ЭМИССИИ МОНОКРИСТАЛЛОВ ВОЛЬФРАМА И МОЛИБДЕНА**

Исследованы параметры, характеризующие процесс вторичной электронной эмиссии монокристаллов вольфрама и молибдена при температурах жидкого азота. Установлено, что обнаруженные эффекты влияния температуры кристалла на структуру основных характеристик ВЭЭ обусловлены взаимодействиями электронов с фононами.

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