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Changes of electrical, optical and emission features of iridium covered with graphite tape at intensive diffusion of potassium atoms

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Abstract:

*By methods of thermo-electronic emission and changes of luminance and real temperature at intensive diffusion of potassium atoms in iridium its electric, optical and emission features were found. It was proved that after intensive diffusion potassium atoms through inter-phase border surface-volume of side **(111)** of iridium, its output work is reduced from **5.8 eV** till **5.3 eV**, where as following items are increased: integral coefficient of blackness of irradiation ~ 10%, spectral coefficient of blackness of irradiation for ~ 30% and electric resistance for ~ 20%.*

Keyword*: super effective diffusion (SED)*

In [1] a new occurrence was discovered - super effective diffusion (SED) of potassium atoms in ***Ir (111)*** at their absorption on heated ***Ir (111)*** with multi-lay of graphite. This occurrence was explained by effective migration of potassium atoms on valence-saturated surface of multi-lay of graphite on metal and with big extension of time of life of potassium's atoms in intercalation condition under multi-lay of graphite at iridium. The effect of intercalation with multi-lay of graphite at iridium with atoms of samarium was first observed in [2], many atoms at ***Ir*** and ***Re*** intercalate: ***K, Cs, Ba, Sr, Si, C, Pt*** [3]. In [4] SED of cesium was found in iridium at irradiation of heated iridium with multi-lay of graphite. The changes of electrical resistance of metal (***Rh, Re)*** and its coefficients of blackness of irradiation at diffusion of carbon atoms though inter-phase border of surface-volume of metal was found and studied even in [5-6]. Therefore it is reasonable to expect that it will happen even at intensive diffusion and in other atoms in metal. The test were carried out in high-vacuum mass-spectrometer plant, with methods of thermo-electron emission, catalytic dissociation of molecules of ***CsCl***, as well as with changes of luminance and real temperatures and electric resistance. Semi-crystalline iridium tape, heated with alternating current at ***T=2000K***, during time of ***15 hrs*** was re-crystallized, and the surface of tape turned to be uniform on output of work, which proved an absence of anomalous electron Shottky effect. The work of output of tape was defined on Richardson method and on surface ionization of hard ionized element of ***Bi.*** Multi-lay of graphite on surface of iridium was created by method of simple exposition of heated up to **T>1800K** ***Ir (111)*** in fumes of benzole, which fed from system of letting into mass-spectrometer, and forming of multi-lay of graphite on side ***(111)*** of iridium was judged basing on change of work of output and on dissociation of molecules ***CsCl*** [7]. The current of thermo-electron emission from sample was measured on collector with anti-dynatron net, and the current of surface ionization of atoms – at output of mass-spectrometer with aid of second ionic–electronic multiplier.

The temperature of iridium tape was measured by optic pyrometer. Pressure of residual gas in device was **– 5-10^{-10} tor.**

1. Changes of resistance of iridium at intensive diffusion of potassium atoms

Diffusion saturation of volume of iridium with atoms of potassium was done in optimal conditions, worked out in [1]. As it was shown in work, the share of flow of potassium atoms diffusing in iridium (effectiveness of diffusion) made ***~10%.*** Therefore at durable exposition of heated iridium with multi-lay of graphite of flow of potassium atoms of high density in iridium significant amount of potassium atoms may be solved and it might effect on its electro –physical feature. With this purpose heated up to ***T=1700K*** sides ***(111)*** of iridium with multi-lay graphite was irradiated with flow of potassium atoms with density of ***v=5,10cm^{12} s^{-1}*** and after some period of intervals they did measurement of resistance of $R_{20^0 C}$ of iridium tape. Till time of exposition of ***Ir (111)-C*** with flow of potassium atoms ***t=4 hrs*** resistance of iridium from initial value of $R_{20^0 C}$ is slightly reduced (~2%) and at further increase of exposition time till ***t=25 hrs*** resistance of iridium is increased for ~20% and further till ***t =30 hrs*** of exposition it was not changed.

2. **Definition of coefficients of blackness of irradiation of iridium by diffusing saturated potassium.**

At diffusion of potassium atoms in iridium the changes of luminance and real temperature of iridium were found. Changes of real temperature of sample was defined from comparison of current TEE with ***Ir (111)-C*** till and after diffusion of potassium in iridium, as the work of output of system ***Ir (111)-C*** is permanent and has value of ~4.5 electron volt [8]. The luminance temperature is defined by ordinary method - optical and pyrometer. At this current incandescence the changes of real and luminance temperature of sample showed that integral and spectral coefficients of the blackness of irradiation of iridium may be changed. Integral coefficient of blackness of irradiation ε_T iridium is defined from comparison of input power $W_{input} = I^2_H R$ and power of irradiation $Wsq = \varepsilon_T \sigma T^4$ till and after diffusion of potassium in iridium. As at high temperatures the power of current on sample is distinguished mainly at shape of irradiation, then we can write:

$$I^2_H R = \varepsilon_T \sigma T^4 \qquad (1)$$

Where $\boldsymbol{I_{H^-}}$ is current incandescence, ***R*** – sample resistance, $\boldsymbol{\sigma}$ – constant of Stephen-Boltsman, ***T***- absolute temperature.

Defining this temperature $T = const$ of iridium on current $I^- = const$ with ***Ir (111)- C*** till and after diffusion of potassium in iridium from (1) we get

$$\frac{\varepsilon_T^*}{\varepsilon_T} = \left(\frac{I^*}{I}\right)^2 \cdot \frac{R^*}{R} \quad , \qquad (2)$$

Here (*) sign related to relevant values after diffusion of potassium in iridium. From equity (2) on measured values I^*, I, R^*, R , $\varepsilon^* / \varepsilon \approx 1{,}10$. So, integral coefficient of irradiation increases on ~ 10% after intensive diffusion potassium.

Spectral coefficient of irradiation ε_λ (λ= 0.65 mcm) of iridium after SED of potassium in iridium was found on measuring of luminance *(T_{lum})* and real *(T)* temperature of iridium from correlation between ε_λ, T_{lum} and T (9).

$$\frac{1}{T_{lum}} - \frac{1}{T} = \frac{\lambda}{C_2} \ln \frac{1}{\varepsilon_\lambda} \ , \qquad (3)$$

where $C_2 = 1{,}438 \cdot 10^{-2}\, m \cdot grade$ - constant.

Deduction ε_λ on formula (3) showed that intensive diffusion of potassium in iridium increases its spectral coefficient of blackness of irradiation from ε_λ =0.30 till ε_λ = 0.40 i.e. for 30%.

3. Definition of work of output of iridium after SED potassium in iridium

After removing of multi-lay of graphite from iridium on known equity $\varepsilon^* / \varepsilon$ from (2), the deduction of R^*/R showed that it does not match with measured value and in is ~ *1.3 times* more. It meant that conditions of ***T=const*** followed from assumption of constancy of iridium has violated, i.e. at result of SED potassium in iridium, its work of output decreased. Actually, from comparison of current TEE of iridium till and after SED of potassium, it resulted that work of output is reduced for **~ *0.45 eV*** and it is $\varphi_{Ir} = \varphi_{Ir(111)-C} - 0{,}45eV = 5.35eV$, and on method of Richardson it was received ***eφ_{ir} = 5.38 ±0.05 eV***. It corresponded with work of output of side of ***(100)*** iridium (8). So, at result of SED of potassium in iridium, reconstruction of densely packed measure ***(111)*** in flabby side ***(100)*** occurs. In the conclusion it is to be noted that after high temperature clean of iridium, from basic share of pro-diffused potassium again it is possible to restore side ***(111)*** of iridium with work of output ***5.8 eV***.

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