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SINGLE-CRYSTAL GROWTH OF GOLD ON THE TUNGSTEN AUTOCATHODE

by

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## U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

| Block | Italic | Transliteration | Block | Italic | Transliteration |
|---|---|---|---|---|---|
| А а | *А а* | A, a | Р р | *Р р* | R, r |
| Б б | *Б б* | B, b | С с | *С с* | S, s |
| В в | *В в* | V, v | Т т | *Т т* | T, t |
| Г г | *Г г* | G, g | У у | *У у* | U, u |
| Д д | *Д д* | D, d | Ф ф | *Ф ф* | F, f |
| Е е | *Е е* | Ye, ye; E, e* | Х х | *Х х* | Kh, kh |
| Ж ж | *Ж ж* | Zh, zh | Ц ц | *Ц ц* | Ts, ts |
| З з | *З з* | Z, z | Ч ч | *Ч ч* | Ch, ch |
| И и | *И и* | I, i | Ш ш | *Ш ш* | Sh, sh |
| Й й | *Й й* | Y, y | Щ щ | *Щ щ* | Shch, shch |
| К к | *К к* | K, k | Ъ ъ | *Ъ ъ* | " |
| Л л | *Л л* | L, l | Ы ы | *Ы ы* | Y, y |
| М м | *М м* | M, m | Ь ь | *Ь ь* | ' |
| Н н | *Н н* | N, n | Э э | *Э э* | E, e |
| О о | *О о* | O, o | Ю ю | *Ю ю* | Yu, yu |
| П п | *П п* | P, p | Я я | *Я я* | Ya, ya |

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

## RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

| Russian | English | Russian | English | Russian | English |
|---|---|---|---|---|---|
| sin | sin | sh | sinh | arc sh | $\sinh^{-1}$ |
| cos | cos | ch | cosh | arc ch | $\cosh^{-1}$ |
| tg | tan | th | tanh | arc th | $\tanh^{-1}$ |
| ctg | cot | cth | coth | arc cth | $\coth^{-1}$ |
| sec | sec | sch | sech | arc sch | $\text{sech}^{-1}$ |
| cosec | csc | csch | csch | arc csch | $\text{csch}^{-1}$ |

| Russian | English |
|---|---|
| rot | curl |
| lg | log |

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# SINGLE-CRYSTAL GROWTH OF GOLD ON THE TUNGSTEN AUTOCATHODE.

N. V. Mileshkina.

The conditions of Au crystal production on W field emitter have been studied by field emission microscope. The results have shown that "microfield emitter" increases field emission and its stability.

The significance of transition layers on a metal substrate for crystallization is discussed.

Wide use of method of autoelectronic microscopy both in research and in practical region requires together with use of high-melting materials, decontaminated with heat treatment, expansion of wheel/circle of substances, suitable for use as autocathodes. Under-ice to a considerable degree it was possible to achieve the complete auto-emission current from "whiskers", grown from the vapors under high-vacuum conditions [1]. By this method together with the desorption by field are obtained the auto-emitters, which give the symmetrical picture of surface, and for the materials with the low melting point, in particular gold. Obtaining field emission current from the projections of low-melting substances to the surface of point is proposed in [2].

Are here described other conditions of obtaining field emission current from single crystal of gold, which gives symmetrical image of surface, upon combined adsorption on tungsten point of germanium and gold.

Observations were conducted in standard field emission microscope when $p = 10^{-10}$ *тор*. To the surface of tungsten point, preliminarily covered with germanium during the high-temperature migration, the portion of gold, sufficient for the single-layered coating, was applied at room temperature, after which the autocathode was heated to T=550-750° K. The emissive image of surface, which can be obtained as a result of this thermal treatment, it is shown in Fig. 1a. However, here is required a strict observance of conditions for an increase in the gold single crystal (depending both on the quantity of preliminarily adsorbed germanium and on the portion of gold and on the random configuration of the initial nuclei of gold on the tungsten), and experiment frequently ends with the uncontrollable increase in the gold crystallite, which leads to the death of point.

At the same surface of autocathode (Fig. 1a) it is possible to arrive by other means, which gives more reproducible results. To the tungsten point will be applied the portion of gold, migration which is over the surface gives coating with working output 5.2 eV. Fig. 1. Emissive pictures. a) the single crystal of gold on the tungsten; b) the same, after heating to T=840 K.

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Spraying by this surface of germanium and subsequent heating of the point higher than the temperature of eutectic, to T=630-800° K, leads to the emergence of the symmetrical emissive picture of surface, shown in Fig. 1a.

Optimum ratio of quantity of adsorbates for increase in this crystal is Ge:AU=1:3; however, some departures are not dangerous, since, as it was explained in [3], "excess" atoms of gold and germanium are vaporized at temperature of eutectic. This provides good reproducibility of single crystal and large operational stability in comparison with the cultivation of gold crystal with the first method.

Current-voltage characteristic, which corresponds to emissive picture Fig. 1a, is given in Fig. 2 (straight line 3). Its comparison with the characteristic of pure tungsten, different increase (Fig. 1a, 1B) unambiguously convince of the fact that the emissive picture, shown in Fig. 1a, gives actually "projection" on the surface of tungsten autocathode with a local increase in intensity of fields, and possibility to return to the initial, before spraying of gold, characteristic and the emissive picture after the thermal evaporation of single crystal, grown by the first method, it testifies in favor of the fact that this single crystal on the surface of tungsten point is formed by auric atoms.

Emissive current from gold single crystal is stable to T=800° K. A comparative change of the current with time from the tungsten autocathode in the same operating conditions is shown in Fig. 3 (curves they are recorded by automatic recorder EPPV-60).

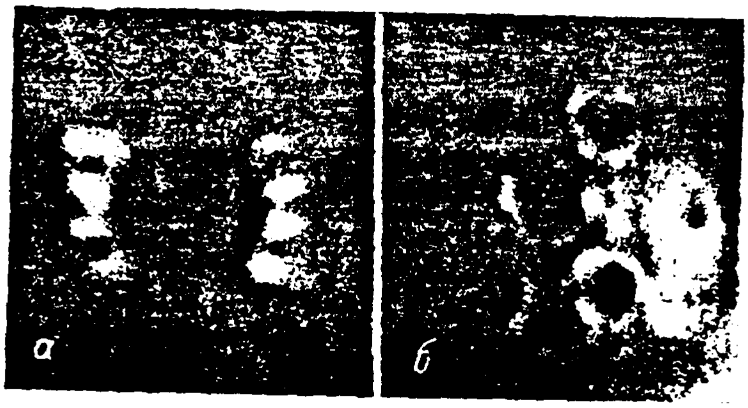
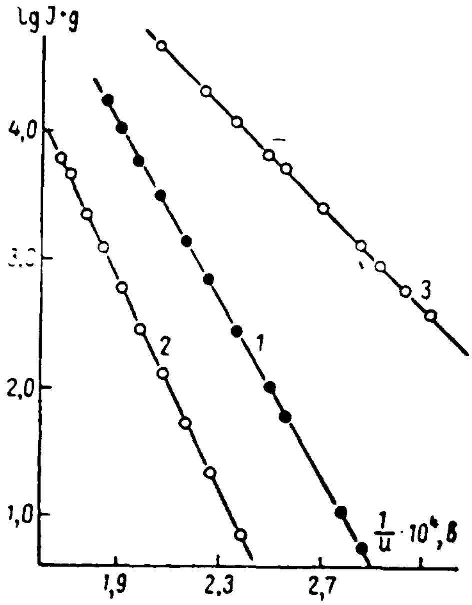



Fig.1.

a - single crystal of gold on the tungsten; b - the same afterward heating to T = 840 K

If we temperature of autocathode with single crystal of gold on surface raise to T=830-840° K, emissive picture explosion-like is changed, taking the form, shown in Fig. 1B (with T=840° K this transition it occurs in 1 s). Let us call conditionally this surface uniform coating, understanding on this, that the gold "crystallites" are more evenly distributed over the surface of tungsten (asymmetry of the brightness Fig. 1B it is connected with the defect of shield). The current-voltage characteristic of field emission current from this coating is shown in Fig. 2 (straight line 2). If we cool point, and then to gradually increase its temperature, then with T=630° K again occurs an abrupt change in the emission, at the shield of field emission microscope appears separate spot increase of emission, the annealing of point with T=400-480° K without the field leads to the transformation of this spot into the emissive picture, depicted in Fig. 1a. This transition of the emission of gold single crystal into the emission from the surface, shown in Fig. 1B and vice versa can be realized repeatedly.



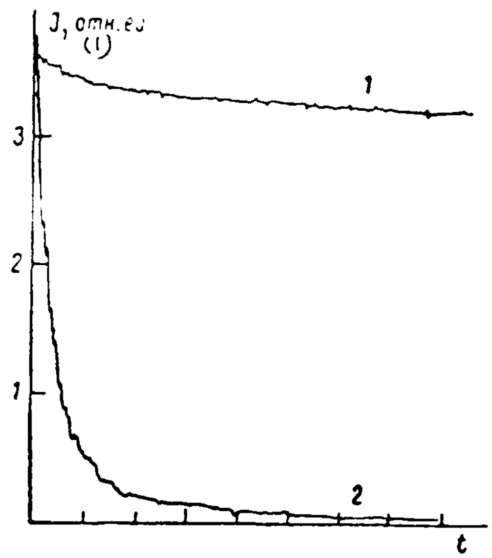




Fig. 2. Fig. 3.

Fig. 2. Current-voltage characteristics. 1 - pure tungsten; 2 - coating with gold on the tungsten (it corresponds to Fig. 1B); 3 - single crystal of gold (it corresponds to Fig. 1a).

Fig. 3. Change with time during constant selection of field emission current with p=10⁻⁶ torus/Torr. 1 - single crystal of gold on the tungsten; 2 - tungsten under the same conditions.

Key: (1). rel. un.

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Subsequent heating of autocathode after destruction of gold single crystal (higher than 840° K) leads to disappearance of "grains" in Fig. 1B, evaporation of gold (solid solution of gold in tungsten according to [4] it is absent) and increase of current-voltage characteristic and emissive picture of surface to inherent pure tungsten. Moreover after the disappearance of grains on the emissive picture (Fig. 1B) of the stage of the evaporation of adsorbate in the accuracy they corresponded to the stages of the evaporation of germanium from the tungsten. Thus, and in this case as during the single-crystal growth by the first, it grew on the surface of tungsten, partially covered with germanium.

This fact is interesting from point of view of nuclei forming and theory of crystallization. Thus, the observations of an increase in the gold films on the tungsten, carried out in the field emission and autoatomic microscopes, led the authors of work [5] to the conclusion that for the beginning of forming of the nuclei of gold on the tungsten is required nearly ten transition layers of gold. Only after several layers of gold repeated the structure of the tungsten base layer, on the subsequent layers was possibly the construction of its own structure of gold. As shown above, on the tungsten, covered with germanium, gold single crystal grows when $\theta_{Ge}<1$, atoms, to saturation and localizing upon the adsorption valence bonds of the base layer, shield the orienting effects of the base layer with much smaller than the coating. It is interesting that single-crystal growth of gold is observed in direction [011] of base layer, although the adsorption of germanium on the tungsten during such small coatings, as it follows from [6], occurs predominantly in region (111).

From point of view of stabilization of current advantage of described method of obtaining gold auto-emitter in comparison with manufacture of massive autocathode is smaller consumption of material.

This method can be useful, when the design of tool eliminates the application of additional attachments and specific conditions [1] for an increase in the gold "whisker". It can present practical interest and possibility of changing the field strength on the autocathode with the constant anode voltage (repeated transitions "uniform coating" - the single crystal of gold with an increase in the local field strength).

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