POSSIBLE CAUSES OF SCREEN BACKGROUND RADIATION OF ELECTRO-OPTICAL TRANSFORMER (EOT)

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The analysis of the possible mechanisms of the appearance of the screen background radiation of (EOT) has been carried out.

As it is known, the electron (φ) work function for the effective functioning of the photocathode should be less than the energy of the absorbed photon. The important circumstance is the spectral distribution of the photosensitivity. Nowadays the photocathodes Ag – O – Cs have the biggest photosensitivity in the wave-length region of the spectrum (nearest is infrared). At the same time these photocathodes have the biggest current density of the thermionic emission at the room temperature [1]. However, the thermionic emission of photocathode of EOT is very undesirable, i.e. it leads to the appearance of the parasitical background radiation of the luminescent screen. The big quantity of the investigations on the revealing of the mechanisms, causing this phenomenon has been carried out, but the final answer hasn't been found yet. Thus, in the ref [2] the high density of the thermionic current (as cause – background radiation) connects with presence of the caesium oxide in the photocathode, and in the ref [3] it connects with the existence of the corpuscular caesium in the photocathode. Below we will consider the set of another circumstances, which can cause the screen background radiation of EOT.

The metallic argentum, evaporated in high vacuum ($p<10^{-6}$mm of mercury) at the production of Ag – O – Cs photocathode oxidizes [4]. As Ag_2O and Ag have different crystallic structure, and the pressure of the steams of oxygen under Ag_2O is significantly even at the room temperature, so Ag_2O film can't be total and consists from the smallest particles. The photocathode formation carries out in the result of the interaction of the gaseous caesium with the oxidated film of argentum. The caesium oxides, rolling each submicroparticle of argentum are created at Cs evaporation because of the presence of the oxygen around Ag_2O particles [5]. The pressure of the saturated steams of the oxygen under Ag_2O at 400K≈58mm of mercury, and at 450K is 464mm of mercury [2]. Thus, Ag_2O decomposes with the creation of the metallic argentum at the photocathode formation in the evacuated volume, and evaporated Cs transfers into Cs_2O (as in the solid phase because of the diffusion processes, so in the gas phase directly). The creation of the caesium oxide, which as impurity in Cs_2O (semiconductor with forbidden band width is ≈2,4eV approximately [4]) influences on the photocathode characteristics, creating the p-type levels in the forbidden band Cs_2O and causes the chemosorption of corpuscular Cs in the evaporation process of the last is possible because of the excess of the oxygen.

For the increase of the emission ability of the cathode it is needed to form thin layer of the metal with the low ionized potential on its surface. The use of Cs is caused by the fact, that it has the less work function (φ=1,87÷1,94 eV [6,7]), melting temperature (303K) and high pressure of the saturated steams at the moderate temperatures (for example at 423K≈10^{-2} mm of mercury [7]) among alkali elements. In the result of the thermal ionization the electrons of Cs atoms transfer into the conductivity band of Cs_2O and the negative volume charge forms in the near-surface layer, which is equal to the charge of the positive ions (Cs^+) on the surface. The electric field of the double layer, created by this way leads to the decrease of the cathode work function. The work function of photocathode Ag – O – Cs, defined on the red line (≈1300 nm) is $\varphi \approx$ 0,95eV, the measures on the method of the contact potential difference give the same value [6].

The integral sensitivity of photocathode Ag – O – Cs achieves ≈$8\cdot10^{-5}$ A/Lm, and quantum efficiency in the wave-length region of the spectrum ≈0, 002 el/kv. [6].

The semiconductor layer Cs_2O, supplying the photosensitivity in the short-wave region and the colloidal particles of the argentum, covered by caesium, causing the photosensitivity in the wave-length region of the radiation are the main emitters in the photocathode Ag – O – Cs. The spectral sensitivity of the photocathode includes the spectrum region ≈300÷1300 nm (with maximums ≈350 and ≈800 nm). The typical spectral distribution of the photosensitivity of photocathode Ag – O – Cs is given on the fig.1.

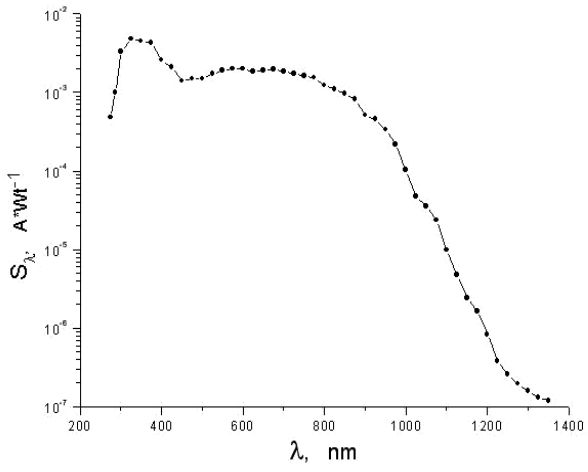

Fig. 1.

In spite of the big quantity of the data the detail structure of photocathode Ag – O – Cs hasn't been established yet. The finally formed cathode is multicomponent and complex system, consisting from Ag, Cs and semiconductors Ag_2O, Cs_2O. The quantitative ratio of the components and technological steps, supplying optimal photoemission and spectral sensitivity, are chosen by the experimental way in the process of photocathode formation, and this can't be reflected on screen background radiation of EOT.

Let's consider the set of the circumstances, causing the appearance of the screen background radiation of EOT. The exclusive purity of the surface as the base (substrate), so photocathode is the important thing, i.e. the absence of the roughnesses and adsorbed alien atoms (molecules) that can cause the filling of the surface levels by the current carriers with all consequences. In spite of the fact, that modern technological methods allow to come to the minimum this circumstance, it is impossible to exclude it totally.

It is widely known, that the islands of the (aggregation) metal form on the substrate at the precipitation (evaporation) of thin layers (≈10 nm) of Cs or Ag because of the high mobility of the condensated atoms even at the enough low temperature of the substrate. And this, on the level with the technological fluctuations, is the one of the important reasons of the incomplete repeatability of the properties, produced photocathode. Moreover, the isle structure can cause the significant background radiation. Thus, if we are proceed from theory of Langmuir spots [6], then the local work functions of the separate regions won't be similar because of the irregularity of the cesium distribution on photocathode surface and consequently, the photo- and thermoemission of the electrons will be different from these regions and this will create directly nonhomogeneous distribution of the brightness of screen background radiation on the screen of EOT.

At the isle distribution the interfaces between particles Ag, Cs and Cs_2O present the enough developed surface with the irregulars and microlugs and the effect of the strong field appears at the current chose from the photocathode on the anode because of the known phenomena of the increase of the electric field on the microlugs [8], that leads to the increase of the electron emission from these regions, i.e. to background screen radiation. And indeed, it is established by the electron-microscopic investigations, that sizes of metal particles (Ag, Cs)≈10 nm, sizes of the irregulars on these particles ≈1 nm. Thus, the size of the canals, where electrons can tunneled through the barrier in the boundary layer from the metals as into cesium oxide, so into vacuum because of the effect of the strong field.

For the calculation of the gain β we can use the formula [9]:

$$\beta = \frac{1{,}89 \cdot 10^9 \cdot \varphi_0^{3/2} \cdot \Delta d}{\chi\, \varepsilon},$$

Where Δd is thickness of semiconductor Cs_2O film (m), ε is its dielectric constant, χ is the energy of the electronic relationship of the semiconductor (external work function in eV), φ_0 is metal work function (eV). Substituting the typical values of the parameters of the semiconductor film and metal ($\Delta d \approx 40$nm, $\varepsilon \approx 8$, $\chi \approx 0{,}3$eV, $\varphi_0 \approx 4{,}5$eV [1,10]), we obtain that β can achieve the value ≈300.

Thus, the resistance of the electric field can achieve the value $\approx 3 \cdot 10^5$ V/cm at the usual values of the electric fields for the vacuum volume of EOT ≈1000 V/cm in separate regions of the photocathode. At such electric fields the significant current of the autoelectronic emission even from the metals is observed. The density of the dark current of the autoelectronic emission from photocathode Ag – O – Cs achieves the value $\approx 10^{-10}$A/cm at the room temperature, and isle character of the autoelectronic emission causes the background luminescence of the screen.

The photocathode Ag – O – Cs has the significant second electronic emission because of the electron warming-up, thermoexcited into the conductivity band Cs_2O by the electric field inside the last one (especially at the existence Cs^+ ions on the photocathode surface). The coefficient of the second electronic emission ≈10 at the energy of the primary electrons 600eV and ≈4 at 100eV [11]. Finally the current of the photocathode emission even at the constant luminescence isn't strictly constant; it has the statistical fluctuation (shot noise). The second electronic emission and shot effect also are causes of the original background luminescence of the screen of EOT.

All above mentioned factors (each separately and in aggregate) put the definite contribution in the parasitic background radiation of the luminescent screen of the electron-optical transformer.

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ELEKTRON – OPTİK ÇEVİRİCİ EKRANININ KÜY ŞUALANMASININ SƏBƏBLƏRİ HAQDA

Elektron-optik çevirici ekranının küy şualanmasının səbəbləri araşdırılmışdır.

Х.Н. Везиров, Н.И. Ибрагимов

О ВОЗМОЖНЫХ ПРИЧИНАХ ФОНОВОГО ИЗЛУЧЕНИЯ ЭКРАНА ЭЛЕКТРОННО-ОПТИЧЕСКОГО ПРЕОБРАЗОВАТЕЛЯ (ЭОП)

Проведен анализ возможных механизмов возникновения фонового излучения экрана ЭОП.

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