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THE CURRENT CHARACTERISTICS OF THE FIELD EMISSION MICROELEMENTS

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Об'єктом математичного та фізичного моделювання були вакуумні автоелектронні мікроелементи з загостреними мікроемітерами радіусів (5... 100) 10^{-6} м та міжелектродними відстанями (0,5...20) 10^{-6} м. Діапазон напруг та струмів вибирався з умови одержання мінімальної освітленості у 50 лк на відстані 0,03 м від катодолюмінесцентного екрана. Для елементів з графітовими емітерами були одержані струми (8….600) 10^{-6} А у невисокому вакуумі.

Object of mathematical and phisical modeling was vacuum field emission micro elements with sharp micro emitters to radius (5... 100) 10^{-6} m and between electrode distances (0,5...20) 10^{-6} m. A range voltages and currents got out of conditions of reception of minimum light exposure 50 lux on distance 0,03 м from the screen. For elements with graphite emitters was obtained currents on (8….600) 10^{-6} A in non-high vacuum.

Introduction

By one of directions, where the influence of the electrical and electromagnetical factors is used, there is a corpuscular and optical radiated therapy. And a basis is the treatment by the charged particles or optical radiation. Most of all in techniques physiotherapy two types corpuscular a of therapy are used: ion theraphy, which is divided on ion pherez, airion theraphy, hidroion theraphy, combined ion theraphy, and also, electron beam therapy. Last of them consists that the procedures will be carried out with the low-power concentrated flow electrons, which have at transformation of energy therapeutic influence.

Both types of corpuscular a therapy have identical structure: source of a high voltage (10... 10^4 V) and radiated gun. Depending on polarity moved to electrodes of a gun, the device can radiate the positive charged particles (positive ions) or negative charged of a particle (electrons, negative ions), directed on bio object. Such mechanism is observed in the event that the gun works in air. In vacuum variant and with presence of an entrance window, which is transparent for электронов, on close distance to bio objects it is possible to create small, about 10-7... 10^{-10} A/ sm^2 flow electrons.

In majority of optical radiators and radiated sources for non contact of diagnostics and the treatments, in particular, UF-exposure of blood, for excitation of luminescence UF-cathode luminescence radiators are used an optical radiation mercury discharge of a radiated discharge plasma. Such excitation has essential shortages, first of all presence thermal components in a spectrum of a radiation and ecological danger of mercury. For elimination it is possible to use cathode luminescence radiators, first of all, with non-heated (cold) field emission micro elements (FEM), which simultaneously do not contain mercury and heated components.

The FEM, as electron radiated sources in some applications for medical engineering have essential advantages before other sources of radiation. Substantially it is caused by universality of the form and sizes эмитирующего of a body, which in FEM serves cathode luminescence screen or thin element, that is heated up by electronic bombardment (foil, grid). Cathode luminescence FEM allow to receive "could" radiations with various variations of the spectral characteristics in a seen range, and ERS with elements of heatings give radiation in an infra-red range.

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Modeling

On the basis of computer modeling for FEM with electrical field in the axial direction Ex with a border level x_0 the FE carrient characteristic are described by the approached analytical expression

$$I = 10^{-6} \cdot \int_{d}^{d+x_0} \exp\left[-\frac{6.35 \cdot 10^8}{E_x}\right](E_x)^2 x dx,$$

and by the approached expression of a type

$$I = 0{,}25\ k\, r\, d\, j_{0,}$$

where k – empirical koefficient, r - radius of curvature of emitted surface; j_0 - axial density of a current, that is defined by the theoretical tables for a concrete material to the cathode; d - distance between electrodes. For hulfspherical emitters to radius r, round extending electrode to radius R with thickness 2re expression for intensity an electrical field near the emitter under condition of r/d >>1 can be displayed in the approached kind:

$$E_x = \frac{U}{\sqrt{(re + x)^2 + \left(R + re - \sqrt{r^2 - (d + r - x)^2}\right)^2} - re},$$

where U – anode voltage.

The researches were carried out at rather low density emission of a current, which excludes influence of collateral processes, which accompany with issue, and thus opportunity of objective check of conformity of the received results considered on FE the equation was provided.

Object of research was vacuum FEM with sharp emitters to radius (5... 100) sm and the distances between electrodes (0,5... 20)10^{-6} m. The metal emitters were produced by a electrochemical method of a W-wire on a technique. Between electrode distance received also by an electrochemical method described in. The preparation, for example, of W-wires was immersed by one end on 5... 10 mm in 5 % - a water solution NaOH or KOH, then on it concerning a bath moved a voltage of change 10V with frequency 50 Hz. The digestion came to an end automatically, when the contact between the end of preparation already sharpened on an edge, and surface electrolyte vanished.

The assembled design was immersed in 5 % a solution NaOH or KOH, on one of electrodes the low positive voltage (approached 1V) moved concerning a bath and the electrodes were exposed to electro-chemical processing, which automatically ended at reception given between an electrode interval. Stability of the d_0, that will determine thus and the stability of a light flow of luminophore if necessary can be provided connecting with the cathode linear termo- or pjezocompensators with a feedback on emission current.

The vacuum in FEM was provided oil diffusion with the pump with next hetter pumping by system to reception of vacuum devices not below 10^{-7} Torr. The researches were carried out in a stationary mode with restriction of a current by ballast resistance 10^{6} Om. The technique of experiment was enough idle time and did not differ from similar researches of usual auto electronic devices. The voltage on electrodes moved smoothly, with five-minute endurance through everyone 10... 20 V. A range voltage and currents got out of conditions of reception of light exposure not only 50 Lux on distance 0,03 m from the screen of radius 3 10^{-2} m.

The first occurrence emission of currents (I ~10^{-11}A) in experimental FEM was observed at rather low anode voltage on the average 100... 600 V (fig. 1). At increase of a current to meanings(importance) 10-8 A, that was achieved by the appropriate increase of an anode voltage, grew of fluctuation of a current with frequency about units of hertz, which complicate an estimation of results of measurements.

At high currents grew frequency and amplitude of fluctuations, stronger were shown bursts, which on duration did not exceed 10^{-4} sec. The separated bursts caused irreversible displacement of the initial characteristics of FEM on 10...30 % in relation to an initial voltage (fig. 2).Before occurrence of the secondary phenomena and them not of return consequences carrient characteristics were well reconstructed, were rather stable (unstability of a voltage did not exceed 5 %), and their course answered of exponent ed dependence.

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The steepness of the characteristics was a little bit lower, than for usual FEM, however has appeared positive, that an initial site (10^{-10}... 10^{-8} A) was put in a rather narrow interval of voltage 200 V. The decrease of a steepness characteristics of FEM at high currents (fig. 2) is explained, first of all with increase d, amplification of beating off action of a spatial charge of emitted electrons.

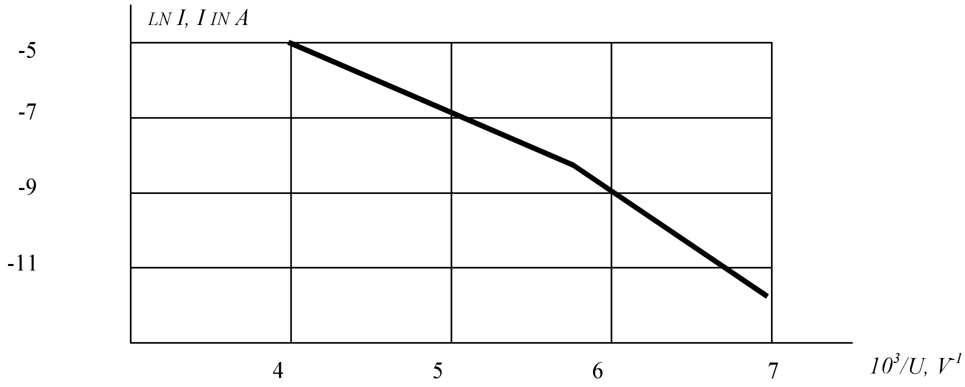

Fig.1. The typical experimental emission characteristic of FEM with W-emitter

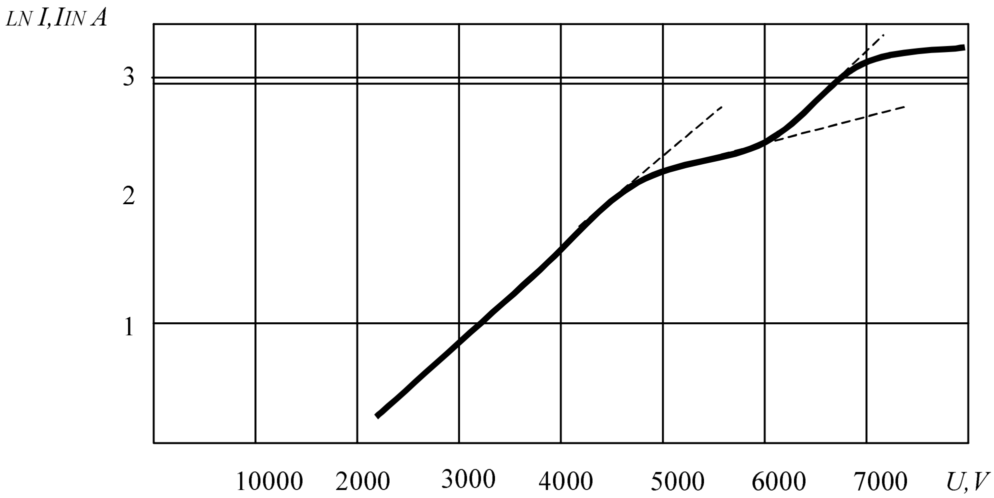

Fig. 2. Experimental current characteristic of FEM at high currents

Were investigated characteristics of FEM, in which emitter and extending electrode made from pointed on the part of reference(manipulation) one for Ni or C (graphite) wires. Experimental FEM with C-emitters at voltage 1,0... 8,0 kV gave currents (8... 600) 10^{-6}A, that is enough for a luminescence in low vacuum (10^{-2} Torr) item. Some tents such elements connected in parallel and, if they work on one common fluorescented screen, allow to receive from it light flows, that sufficient for photomedical technologies.

The comparison of experimental data with settlement has shown, that between them there are certain divergences - settlement meanings(importance) of a working voltage and emission of the area have appeared considerably overestimated. It is possible to explain by a role of a microrelief emitted of a surface. Really, at presence of a microrelief the intensity of a field in separate sites to the cathode And reduction resulting emitted of the area through prevailing issue from these sites grows. Calculation of both opposite working factors is by enough difficult analytical task. The it is not less, for FEM with the certain technology it can be solved input in the formula of a current of empirical correction factors: amplification of a field - K_E and efficiency of use emitted of the area - Ks. An estimation of a field and emitted of a surface have allowed to establish approximately meaning(importance) of these factors: K_E=10... 15; Ks=10... 10^{-6}.

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Discussions and conclusions

The replacement of thermionic cathodes by FEM, for example, as a two or is more with necessary radius r of conuse microelectrodes, that divided by microintervals d with an FE, which creates FE pinches, which raise a luminescence of a covering on screen, to the full releases from these lacks.

Really, at replacement of heated cathodes on "could", disappears necessity in increased of additional power of heating to cathodes and accordingly in radiation from the heated up parts. It creates economy of the electric power, simplifies a design and warns indirect thermal action on an environment.

For its manufacturing any metal or semi-conductor materials can be used i.e. disappears necessity for scarce and precious refractory metals, is especial W and Mo or their alloys, and also, materials of a covering of oxide - Ba, Ir, Ca, Zr. Disappears necessity and at characteristic for the majority of light sources precious rare noble gases and mercury, as working environment of FE elements is the vacuum.

Could character of FE allows to create effective ERS. The efficiency of vacuum generators of light on FEM practically equal to efficiency of transformation of energy of an electronic flow to the optical radiation in cathode luminophores, which now achieves 10... 20 %. For comparison, for film and powder electro luminophores efficiency equal 0,1... 2,0 %, for radiated (light) diodes - 0,6 % and for discharge cells - 0,5 %.

The obtained results has shown, that decrease between electrode distance has allowed to reduce anode voltage in experimental FEM practically on the order. The application of modern technological achievement by development of a field emission microelements with low voltage and hight stability allows to create new and to improve, existing photo medical devices, for example, as ecological alternative of Hg discharged UV-radiators for hematology providing significant improvement of the characteristics.

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CREATION OF TEMPERATURE FIELD USING RESISTIVE THICK – FILM HEATER SYSTEMS

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In a great number of electronic devices the operation temperature higher than room temperature is required. Sensors of the different physical and chemical quantities are very good example of such circuits. Additionally, the temperature field distribution is one from the main factor which determines proper exploitation parameters. Thick – film technology is often used for creation of heater systems in above-mentioned devices. The idea of heater systems construction (made in thick-film technology) has been included in the paper. The results of simulations (using ANSYS program) and IR measurements have been also presented.

Introduction

One of the most important features of thick-film technology is a big design flexibility of resistive elements. Additionally, very good heat conductivity of used substrates, low thermal capacity and possibility of resistive element geometry forming makes this technology an excellent solution for manufacturing of wide range of different heaters and heater systems with given temperature distribution.

In thick-film technology (characterised by layer structure of the circuit) heaters are generally made from resistive or conductive (PdAg, PtAg, PtAu, Au, Pt) pastes. It is placed – in most cases – on the opposite side of the substrate in relation to active part of microcircuit. The heaters made from typical resistive pastes are the simple (and the cheapest) solutions characterised by good dynamic parameters. The main disadvantage is the lack of good time stability but this problem can be solved by using special compensation circuit in supplying systems [1,2,3,4].

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