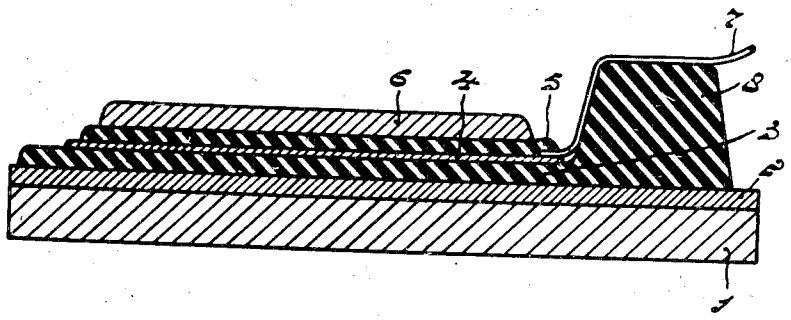
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BLOCKING-LAYER ELECTRODE SYSTEM

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BLOCKING-LAYER ELECTRODE SYSTEM

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1

The invention relates to a blocking-layer electrode system comprising at least one grid embedded in the blocking layer.

With blocking layer cells of the above-mentioned type grid emission may occur to a high extent. As is well-known this drawback may be combatted by constituting the grid or the superficial layers thereof of semi-conductive or poorly-conducting material.

The invention has for its object to combat the drawback of grid emission still more efficiently.

The present invention is based on the idea that grid emission is always liable to occur since the grid and the anode jointly form a blocking-layer electrode system wherein the grid performs the function of a cathode, for when a blocking-layer cell is used as an amplifier, a detector or a modulator the anode always has a positive potential with respect to the grid. If the emissive capacity of the grid exceeds that of the anode, the total of the forward current in the sytem grid-anode has to be taken into account.

The invention is based on the view that if in the system formed by the anode and the grid the latter has a poorer emissivity than the former this system, considered as a rectifier is utilized exclusively in the non-conductive direction, which involves that the current flowing in this system has a very low intensity. The feature of the invention is therefore that the emissive capacity of the grid material is at the most equal to that of the anode material.

If the conductivity of the grid material is exactly equal to that of the anode material, for example if they both consist of metal, there consequently occurs in this system no emission at all, for in order to obtain an electron current in a blocking-layer cell it is necessary that both electrodes should consist of materials having different emissive capacities. Also, however, if the grid material has a lower emissive capacity than the anode material the emission is of so low an order as to be negligible.

By carrying the rule according to the invention into effect we obtain a great liberty in the choice of the materials for the electrodes, harmful grid emission being always avoided.

One particular embodiment is characterized, for example, in that the cathode consists of satisfactorily emitting, semi-conductive material which has a higher emissivity than the anode- and grid-materials.

If previously semi-conductors were utilized in blocking-layer cells, they acted as anodes and for the latter use was made of substances having a

2

low emissive capacity. Since in the present case this semi-conductive material acts as a cathode, use is made here, in contradistinction to the previously utilized semi-conductors, of a substance having a favourable emissive capacity. A few examples of satisfactorily emitting semi-conductors are lead sulphide and copper sulphide. The specific resistance of these substances, which is a measure of the emissive capacity, amounts to 10^{-2} ohm-cm.

In this embodiment, wherein the cathode and the anode are both semi-conductors, the characteristic curve of the cathode-anode current is a 3/2-power curve. Systems having such a characteristic curve are extremely suitable for operation in the region of comparatively low anode voltages since, even at low voltages, there flows a proportionally heavy emission current.

In this form of construction, for the cathode-anode current of the system use is still made of the satisfactory emission of the cathode.

It may be advantageous, however, to utilize a form of construction wherein the anode consists of satisfactorily emitting material, for example of metal, the cathode of a material having an appreciably lower emissive capacity and the grid of a material of equal or still lower emissivity.

In fact, if the anode consists of a metal the current-voltage characteristic curve has in general the shape of an e-power curve, in which event at comparatively high voltages the current acquires a relatively considerable value since at higher voltages the curve has a steep slope.

In this case, as in the case of the preceding form of construction, it is advantageous to take the emissive capacity of the grid equal to or lower than that of the cathode since otherwise, considering the low emissivity of the cathode, there exists a particularly great danger of a grid-cathode current being produced.

The expressions "emissive capacity of the anode, cathode or grid material" have, of course, fundamentally to be understood in such manner that that superficial layer of the electrode which plays a part in the emission, that is to say the layer adjoining the blocking layer, is meant here. It is consequently possible to start for these electrodes, for example, from a layer of satisfactorily conductive material both surfaces or one of the surfaces of which are converted into a layer of lower emissive capacity.

Starting from the principal idea of the invention that the emissive capacity of the grid material is lower or at the most equal to that of the anode material, it may occur that for the grid use

is made of a material which has itself a higher emissivity than the cathode material if the latter has a lower emissive capacity than the anode. It would be possible, for example, to start from metal for the anode and the grid. According to one advantageous embodiment of the invention, in order to suppress grid emission in this case the grid is provided on the side directed towards the cathode with a covering layer whose emissive capacity is at the most equal to that of the cathode material.

This idea may be further extended and the grid may be supposed to be fundamentally built up from two portions viz. a portion directed towards the anode and whose emissive capacity is chosen in accordance with the invention to avoid undesirable grid-anode current while the material on that portion of the grid directed towards the cathode is chosen to avoid undesirable grid-cathode current.

An advantageous form of construction consists in that the grid is constituted by a material which has a higher emissive capacity than the anode and cathode materials and which exhibits on the anode side a covering layer whose emissive capacity is at the most equal to that of the anode material whilst on the cathode side there is also a covering layer whose emissive capacity is, however, at the most equal to that of the cathode material. In this case the starting point is consequently formed by a satisfactorily emitting and therefore satisfactorily conductive material for the grid. This is advantageous, for, although no current may pass through the grid, the use of poorly conducting substances is undesirable since in this case such a grid follows with difficulty the applied voltage variations, the drawbacks inherent in the use of a satisfactorily emitting grid material being nevertheless eliminated in the above-described manner.

The invention may be advantageously carried out with the use of one and the same starting material for different electrodes whilst, depending on the character of the electrodes, this material is given different conductivities. As such may be utilized, for example, selenium which is known to have an emissive capacity which is liable to be varied within very wide limits.

There follow below a few practical examples of electrode systems according to the invention whilst, in addition, the manner in which such systems may be manufactured, is briefly indicated.

Example I

The starting point is formed by a silver plate which acts as a cathode and to which is applied from a solution a polystyrene layer having a thickness of about 5 microns and acting as a blocking film. Then the grid is formed by applying selenium to which admixtures are added in order to increase the conductivity of the selenium. The grid layer is coated with a second blocking layer, for example Canada balsam. The anode is formed on this layer by applying cuprous iodide. In this form of construction the materials for the different electrodes are chosen in such manner that the cathode has the highest emissive capacity, the anode has a lower emissive capacity and the grid consists of a material which has the lowest emissive capacity.

Example II

As the anode is utilized satisfactorily conducting selenium applied in the known manner to an underlayer. The first blocking film is constituted

by a layer of chlorinated rubber lacquer applied from a solution, to which layer selenium having a lower emissive capacity than the anode material is applied by vaporisation. Subsequently the second blocking film, constituted by a layer of nitro-cellulose lacquer, is provided whereupon the cathode consisting of cuprous sulphide is formed. The emissive capacities of the various electrodes are in this case such that the cathode has the highest emissive capacity, the anode has a lower emissive capacity and the grid has the lowest emissive capacity of all three.

Example III

In the formation of an anode the starting point is formed by a copper plate which is superficially converted, owing to the action of iodine vapours, into cuprous iodide which is a semi-conductor. On this layer is formed a blocking film of Canada balsam to which is applied the grid consisting of selenium. To the latter is applied the second blocking film, which consists of chlorinated rubber lacquer, whereupon the cathode is formed, which cathode consists of selenium which has a higher emissive capacity than the grid material but a lower emissive capacity than the anode material.

Example IV

In this practical example the cathode consists of metal, for example copper, the first blocking film of polystyrene to which film a layer of copper is applied by vaporisation. Owing to the action of iodine or sulphur, the separate copper layer of the grid is converted into cuprous iodide or cuprous sulphide respectively. To the latter layer is applied the second blocking film of chlorinated rubber lacquer to which is applied the anode consisting of cuprous iodide. In this mode of realisation the anode has a lower emissive capacity than the cathode. That surface of the grid which is directed towards the anode has an emissive capacity which is equal to that of the anode so that grid emission in the direction of the anode does not occur. On the other hand, the emissive capacity of that side of the grid which is directed towards the cathode is equal to that of the cathode, for this surface and the cathode consist both of copper, grid emission in the direction of the cathode being consequently also excluded.

Without departing from the basic invention, other materials of lower or higher emissive capacities for the electrodes may be chosen. However, the mutual proportion of the emissive capacities of the electrodes must still be retained for an efficient blocking layer system.

As regards the construction of the grid, it may furthermore be noted that the power of transmitting electrons travelling from cathode to anode is obtained, for example, owing to the fact that the grid layer is given an extremely slight thickness, for example of 1 micron. In the layer are produced in this case extremely small holes which impart thereto the properties of a grid.

The figure shows the construction of an electrode system according to the invention. 1 designates a supporting plate consisting of copper, which carries a layer 2 of cuprous iodide. On this layer bears a blocking film 3 consisting of Canada balsam. This film carries in its turn a grid layer 4 consisting of satisfactorily conducting selenium. The grid layer bears a second blocking film 5 which consists of chlorinated rubber lacquer. Finally there is present a silver layer 6 applied by vaporisation, which layer constitutes the cathode. The formation of this system is a

variant of the third example. The grid has connected to it a supply conductor 7 which serves to connect the grid to an external circuit. In order to avoid emission from this conductor towards the anode, it is supported by a boss 8 on the blocking layer, owing to which the spacing between the conductor and the anode is so large that the electric field between these two members is so slight that an electron current cannot be produced.

With the use of cuprous iodide and similar substances the conductivity can be adjusted at will by ensuring that the material contains more or less free iodine.

What I claim is:

1. A blocking layer cell comprising cathode and anode electrodes, a blocking layer between said electrodes, a control electrode embedded in said blocking layer and consisting of a material of which at least the surface portion thereof facing said anode electrode has an electron emissive capacity not greater than the emissivity of the material comprising said anode electrode.

2. A blocking layer cell comprising anode and cathode electrodes, a blocking layer between said electrodes, a control electrode embedded in said blocking layer and consisting of a material of which at least the surface portions thereof facing said anode and cathode electrodes have an electron emissive capacity not greater than the emissivities of the materials comprising said anode and cathode electrodes.

3. A blocking layer cell comprising anode and cathode electrodes, said cathode electrode consisting of a material having a higher electron emissive capacity than the material comprising said anode electrode, a blocking layer between said electrodes, and a grid electrode embedded in said blocking layer and consisting of a material having an electron emissive capacity not greater than the emissivity of said anode material.

4. A blocking layer cell comprising anode and cathode electrodes, said anode electrode consisting of a material having a higher electron emissivity than the material comprising said cathode electrode, a blocking layer between said electrodes, a grid electrode embedded in said blocking layer and consisting of a material of which the surface portion thereof facing the anode electrode has an electron emissive capacity not greater than the emissivity of said anode material and the surface portion thereof of said grid material facing said cathode electrode having an electron emissive capacity not greater than the emissivity of said cathode material.

5. A blocking layer cell comprising anode and cathode electrodes, said cathode electrode consisting of a material having a higher electron emissive capacity than the material comprising said anode electrode, a blocking layer between said electrodes and a selenium grid embedded in said electrode, said selenium grid having an electron emissive capacity not greater than the emissivity of said anode material.

6. A blocking layer cell comprising anode and cathode electrodes, said anode electrode consisting of a material having a higher electron emissive capacity than the emissivity of the material comprising said cathode electrode, a blocking layer between said electrodes, a selenium grid embedded in said blocking layer, said selenium grid having an electron emissive capacity not greater than the emissivity of said anode material, and said selenium grid also having an electron emissive capacity not greater than emissivity of said cathode material.

7. A blocking layer cell comprising a cathode electrode consisting of cuprous sulfide, an anode electrode consisting of selenium, said anode electrode having an electron emisisve capacity not greater than the emisisve capacity of said cathode electrode, a blocking layer between said electrodes, and a selenium grid embedded in said blocking layer, said selenium grid having an electron emissive capacity not greater than the electron emissive capacity of said anode electrode.

8. A blocking layer cell comprising a cathode electrode consisting of selenium, an anode electrode of which at least that surface portion facing the cathode consists of cuprous iodide, said cathode electrode having an electron emissive capacity not greater than the electron emissive capacity of said anode electrode, and a blocking layer between said electrodes, a selenium grid embedded in said blocking layer, said selenium grid having an electron emissive capacity not greater than the emissivity of said anode electrode, and said grid electrode also having an electron emissive capacity not greater than the emissivity of said cathode electrode.

9. A blocking layer cell comprising a cathode electrode consisting of copper, an anode electrode consisting of cuprous iodide, a blocking layer between said electrodes, and a grid electrode embedded in said blocking layer, said grid electrode consisting of a layer of cuprous iodide on the side facing said anode electrode and a layer of copper on the side facing said cathode electrode.

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