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C. D. VANDERPOOL ET AL

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LAMPS HAVING A MOLYBDENUM PHOSPHATE PHOSPHOR

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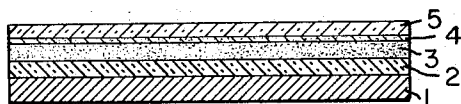


FIG. 1

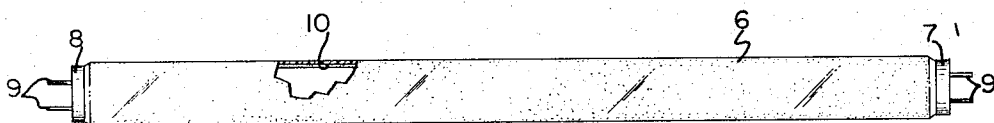


FIG. 2

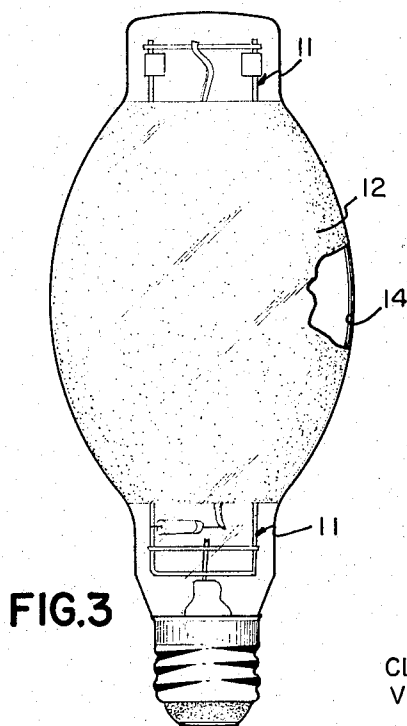


FIG. 3

CLARENCE D. VANDERPOOL
VINCENT CHIOLA
INVENTORS

BY *Clarence D. Vanderpool*
ATTORNEY

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LAMPS HAVING A MOLYBDENUM PHOSPHATE PHOSPHOR

Clarence D. Vanderpool and Vincent Chiola, Towanda, Pa., assignors to Sylvania Electric Products Inc., a corporation of Delaware

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12 Claims. (Cl. 313—108)

This invention relates to phosphors and particularly to a phosphor which can be used in fluorescent lamps, high pressure mercury lamps and electroluminescent lamps. Specifically, this invention relates to molybdenum phosphate which emits light when subjected to radiation at 2537 A. (fluorescent lamps) or 3650 A. (high pressure mercury lamps) and when placed within the influence of an electric field (electroluminescent lamps). The phosphors are self-activated or can contain activators such as copper, manganese, tin, lead, antimony, silver, gold, europium, samarium, terbium and/or dysprosium to enhance the luminescence or change the emission characteristics.

Accordingly, the primary object of our invention is the preparation of a phosphor which emits visible light in response to excitation at 3650 A. or 2537 A. and when placed within the influence of electric field.

A feature of our invention is that the phosphor can be self-activated or activated with copper, manganese, tin, lead, antimony, silver, gold, europium, samarium, terbium and/or dysprosium.

The many other objects, features and advantages of our invention will become manifest to those conversant with the art upon reading the following specification when taken in conjunction with the accompanying drawings wherein specific embodiments of our invention are shown and described by way of illustrative examples.

Of the drawings:

FIGURE 1 is a cross-sectional view of an electroluminescent lamp using our phosphor.

FIGURE 2 is a plan view of a fluorescent lamp containing an internal coating of our phosphor as shown in a partially broken away section.

FIGURE 3 is an elevational view of a high pressure mercury lamp with a portion of the jacket broken away to show the coating of phosphor.

Referring now to the drawings, the electroluminescent lamp of FIGURE 1 includes an electrically conductive sheet 1, generally of metal, upon which is coated a dielectric layer 2 of a high dielectric constant material such as barium titanate. Disposed upon the layer of dielectric is a layer of molybdenum phosphate according to our invention dispersed in a fused glass dielectric. Above the layer of phosphor is an electrically conductive, light transmitting film 4 generally made of tin oxide and upon this layer is a coating of fused glass 5 to prevent humidity penetration and accidental removal of the film layer 4.

Referring now to FIGURE 2, a typical fluorescent lamp containing mercury vapor is shown including a glass envelope 6 having end caps 7 and 8 with electrical lead-in wires 9. A layer 10 of molybdenum phosphate phosphor is coated upon the internal surface of the glass envelope 6.

Referring now to FIGURE 3, the high pressure mercury lamp is shown which includes the conventional arrangement of an arc tube (not shown) supported upon a metal harness 11. Surrounding the arc tube and harness is a bulbous envelope 12 with a coating 14 of the molybdenum phosphate phosphor of our invention disposed upon the internal surfaces thereof.

The molybdenum phosphates, specifically molybdenyl phosphate, $\text{MoO}_2(\text{PO}_3)_2$, possess unique properties of being responsive to a wide variety of excitation conditions. Of the ultra violet excitation conditions, the

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phosphor is responsive to irradiation by light energy of predominately 3650 A. and 2537 A. The material can be used as a self-activated phosphor, that is containing no activator or activators can be added if desired to change the emission color or enhance the excitation. The activator can be added in quantities up to about 4.5 percent by weight.

Example I

One hundred forty-four gms. of molybdenum trioxide, MoO_3 , is mixed with 691 gms. of 85% phosphoric acid, H_3PO_4 in a silica crucible. Agitation is continued while heating from room temperature to one in range of 325 to 600° C. The crystalline product precipitates at 325° C. Higher yield is obtained by holding the reaction mass at 450° C. for 10 to 60 minutes. The product is isolated by pouring the reaction mixture onto a metallic plate and allowing it to solidify and form a glassy mass. Excess phosphoric acid is leached from the glass with water and the crystalline product is recovered by filtration and drying at 110° C. Body color of the crystalline product is bluish-white and identified by X-ray diffraction as $\text{MoO}_2(\text{PO}_3)_2$.

Under 3650 A. radiation, the material had a faint flesh or orange luminescent color and under 2537 A. light source, it luminesces a yellowish-white color. In the usual castor-oil plaque tester for electroluminescent phosphors, it luminesces a bluish-green color. The brightness of the material in the castor-oil plaque test at 400 volts AC and 6 kc. was 0.01 foot lambert.

Example II

Molybdenyl phosphate was prepared using essentially the same procedure as set forth in Example I with various additions of copper. The copper was added as .28 gm. of the metal powder and was dissolved in the MoO_3 , H_3PO_4 mixture on heating. Spectrographic analysis of the crystalline product showed the presence of copper in the matrix. Similarly, .196 gm. of silver, .28 gm. of gold, .48 gm. of europium, .33 gm. of manganese were added to the above described reaction mixture to produce a light-emitting phosphor. When the copper was added to the reaction mixture, the final crystalline product mixture had a white body color which slowly changed to blue on exposure to normal room lighting. The electroluminescent brightness (castor-oil plaque tests) was 0.01 foot lambert at 6 kc. and 400 volts.

When a 25 gm. sample of this material was washed in 50 milliliters of a 7% ammonium hydroxide solution and filtered and dried, the crystals were white and did not turn blue on exposure to room lighting. The brightness of the material was 0.025 foot lambert at 6 kc. and 400 volts.

Example III

Another process for making the molybdenum phosphate of our invention involves mixing MoO_3 and H_3PO_4 in stoichiometric quantities to give the product molybdenyl phosphate $\text{MoO}_2(\text{PO}_3)_2$. In the process, 144 gms. of MoO_3 were mixed with 230 gms. of 85% H_3PO_4 in a silica crucible and heated to 600° C. After one or two hours at this temperature, the contents of the crucible were formed into a solid white crystalline mass. The crucible contents were leached with hot water to remove soluble matter from the crystalline product. After washing with water, followed by a final wash of 7% ammonium hydroxide solution, the product was dried at 110° C. It showed similar electroluminescent and fluorescent properties as the product described in Example I of above.

As an electroluminescent material, the phosphor shows particularly high resistance to break down a higher voltage and is at least as good as the known zinc sulfide materials. Zinc sulfides tended to arc or break down at

approximately 800 volts when using a 6 mil. film. The products of this invention resist breakdown until approximately 1000 volts using the same film thickness.

It is apparent that modifications and changes may be made within the spirit and scope of the instant invention but it is our intention, however, only to be limited by the spirit and scope of the appended claims.

As our invention we claim:

1. A low pressure electric discharge device comprising: a glass envelope containing mercury vapor and means to produce an electric discharge within said device; a phosphor coating of molybdenum phosphate disposed upon the inner surface of said envelope.

2. The device according to claim 1 wherein at least one activator selected from the group consisting of copper, manganese, tin, lead, antimony, silver, gold europium, samarium, terbium and dysprosium is present in the phosphor.

3. The device according to claim 2 wherein the activator is present in quantities up to about 4.5 percent by weight.

4. The device according to claim 1 wherein the molybdenum phosphate has the chemical formula of $\text{MoO}_2(\text{PO}_3)_2$.

5. A high pressure electric discharge device comprising: an arc tube disposed within a bulbous outer jacket; mercury vapor and means to produce an electric discharge disposed within said arc tube, a phosphor coating of molybdenum phosphate disposed upon the internal surface of said jacket.

6. The device according to claim 5 wherein at least one activator selected from the group consisting of copper, manganese, tin, lead, antimony, silver, gold, europium, samarium, terbium and dysprosium is present in the phosphor.

7. The device according to claim 6 wherein the activator is present in quantities up to about 4.5 percent by weight.

8. The device according to claim 5 wherein the molybdenum phosphate has the chemical formula of $\text{MoO}_2(\text{PO}_3)_2$.

9. An electroluminescent device comprising a first electrode and a second electrode, at least one of said electrodes being adapted to transmit light therethrough; a layer of molybdenum phosphate phosphor interposed between said first and second electrodes.

10. The electroluminescent device according to claim 9 wherein at least one activator selected from the group consisting of copper, manganese, tin, lead, antimony, silver, gold, europium, samarium, terbium and dysprosium is present in the phosphor.

11. The electroluminescent device according to claim 10 wherein the activator is present in quantities up to about 4.5 percent by weight.

12. The electroluminescent device according to claim 9 wherein the molybdenum phosphate has the chemical formula of $\text{MoO}_2(\text{PO}_3)_2$.

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DAVID J. GALVIN, *Primary Examiner*.

JAMES W. LAWRENCE, *Examiner*.

P. C. DEMEO, *Assistant Examiner*.