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ELECTROLUMINESCENT LAMP
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2,728,870

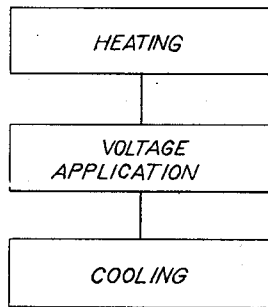


Fig. 2

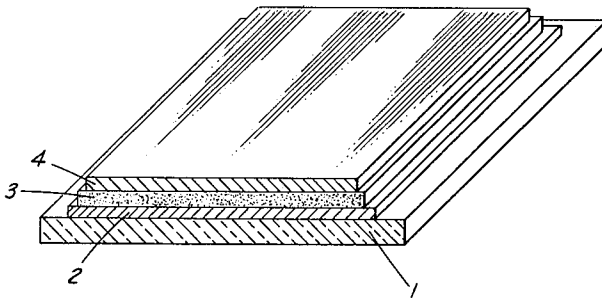


Fig. 1

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ELECTROLUMINESCENT LAMP

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4 Claims. (Cl. 313-108)

The present invention relates to electroluminescent lamps, that is to lamps in which light is produced by electrical excitation of a phosphor.

Such lamps have two spaced electrodes, between which are electroluminescent phosphor particles suspended or embedded in a dielectric material. Plastic materials are generally used as the embedding dielectric. We have found that when the plastic dielectric in such a lamp is heated to a temperature above its softening point but below its decomposition point, and voltage below the breakdown voltage of the lamp is applied to the lamp while the plastic dielectric is so heated, a remarkable increase in brightness of the lamp and decrease of current through the lamp will be found during its subsequent operation.

The phosphor particles are longer in one dimension than in another, and the heating of the plastic allows the phosphor particles embedded therein sufficient freedom of motion to allow them to line up in the direction of the field when voltage is applied to the electrodes. When the dielectric constant of the embedding material is smaller than that of phosphor particle, as is the case with most plastics, the field in the phosphor particles will be a maximum when the particles are aligned in the direction of the field, and will be a minimum when it is aligned in a direction transverse to the field.

The simultaneous application of heat and voltage lines up the particles in the direction of the field, and they are set in that position when the phosphor cools. The application also tends to break up any agglomerates present into separate phosphor particles.

When a soft dielectric substance such as nitrocellulose is used as the embedding medium, the phosphor particles may actually move around in the dielectric material as the field is varied and reversed, as on alternating current, for example. Such continued motion of the particles is undesirable. The use of fairly hard plastic, which holds the phosphor particles rigidly in place, such as the thermosetting resins for example, will keep the particles lined up properly after they are once oriented by the field in the above-described manner. However, some advantage is obtained by our invention even when the dielectric is of the cellulose type.

Other objects, features and advantages of the invention will be apparent from the following specification, taken in connection with the accompanying drawings, in which Fig. 1 shows a view, partly in section, of one embodiment of the invention, and Fig. 2 is a box diagram showing the sequence of steps in the process of one embodiment of the invention.

In Fig. 1, the glass plate 1 carries a transparent conductive coating 2, over which is the coating 3 of phosphor particles embedded in a dielectric material, with a metal coating 4 over at least part of said phosphor-dielectric coating 3 and out of electrical contact with said conductive coating 2.

The transparent conductive coating can be of stannous chloride, applied as in copending application Serial Num-

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ber 120,398, filed October 8, 1949, by Eric L. Mager, now Patent No. 2,624,857, although other transparent conductive coatings can be used. The metal coating 4 is of aluminum, although other metals can be used, and is applied as in the copending Mager application.

The phosphor suspended in the dielectric material was zinc sulphide containing small amounts of lead, copper and chlorine for activation, as shown in copending application, Serial Number 230,713, filed June 8, 1951, by Keith H. Butler and Horace H. Homer, although other phosphors can be used.

160 grams of phosphor powder, having particles whose average dimension is about 10 microns, was ground for one hour in a quart ballmill together with 28 grams of a vinyl chloride-acetate copolymer known commercially as VAGH resin, in a 10% solution by weight of methyl ethyl ketone and butyl acetate. The ketone and acetate were in proportion by weight of 1 to 9. This mixture was milled for one hour.

After milling the above suspension 72 grams of a 55% solution by weight of melamine formaldehyde resin in butanol and 196 grams of a 50% solution by weight of soya-modified alkyd resin in xylol was added to the above suspension.

The ballmill was then washed with 50 ml. each of ethyl acetate, butyl acetate and methyl Cellosolve acetate and 100 ml. of Tolvul which were then added to the phosphor suspension.

The mixture was then applied by spraying over the conductive layer 2 of a piece of glass 1, so that the coating 3 had a weight of approximately 0.1 gram per square inch of surface. The coated glass was then allowed to air dry for one hour, allowing evaporation of a larger portion of the solvents. After air drying, the piece was baked at a temperature of approximately 145° for 15 minutes. The coated glass was then placed in a vacuum bell-jar and a thin layer 4 of aluminum applied over the phosphor-resin coating 3 by evaporation.

The lamp was then heated in an ambient temperature of 180° F. for 30 minutes with a voltage of 450 volts, 60 cycles per second, A. C., connected between the conducting surface 2 and the metal coating 4. The lamp was then cooled.

The results of tests on several such lamps are given below, the current being given in milliamperes and the surface brightness in footlamberts. The applied voltage was 600 volts, 60 cycles per second, alternating current, in each case. Current readings under such conditions are shown only for three of the lamps, but brightness readings are shown for all. The readings are given before and after the heat-and-voltage treatment described above.

Table 1

Current in Milli-amperes		Brightness in Foot-lamberts	
Before	After	Before	After
10	6.0	5.0	6.0
----	----	2.0	2.8
----	----	1.9	2.8
----	----	1.4	2.3
2.0	1.8	1.9	3.2
----	----	2.1	3.5
----	----	1.3	3.4
2.3	2.0	2.3	3.5

The above shows that the current is reduced and the brightness increased by the treatment.

The first lamp in the above list had a dielectric-phosphor layer about 2 mils thick; in the others, the layer was about 4 mils thick.

The heat and voltage may be applied before or after

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the normal baking of the phosphor-dielectric layer in manufacture. The treatment can be used with lamps using various plastic dielectric materials, including glass, melamine-alkyds, epoxy resins (Shell Chemical Co.), and others of both the thermoplastic and thermosetting types, although the latter is preferable.

The following test shows the effect of the voltage applied during the heating period, the measurements being made at 600 volts after the lamp had cooled. The heating period was 30 minutes at 180° F. at both voltages shown, and the "Initial" readings were taken before the heat was applied at 600 volts.

Table 2

	Current, Milliamperes	Brightness, Footlamberts
Initial.....	10.0	5.0
200 volts.....	8.5	5.2
450 volts.....	6.0	6.0

The brightness increases with the voltage applied during treatment. The voltage may be D. C. if desired.

What we claim is:

1. An electroluminescent lamp comprising two electrodes and a layer therebetween of electroluminescent phosphor particles embedded in a solid dielectric, the electroluminescent phosphor particles being aligned in the direction in which a field would be produced by the application of voltage between said electrodes.

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2. The lamp of claim 1, in which the material of the dielectric is hard enough to maintain the particles in alignment against the action of the electric field during operation.

3. The combination of claim 1, in which the dielectric is a thermosetting plastic.

4. The method of increasing the brightness of electroluminescent lamps having a layer of electroluminescent phosphor particles in a plastic dielectric medium, said electroluminescent phosphor particles being longer in one dimension than in another, said method comprising heating the plastic to a temperature above its softening point but below its decomposition point, and simultaneously applying to the plastic, an electric field in the same direction as the operating field and of sufficient strength to align the particles in its own direction, and then cooling the plastic while the particles are aligned so that the plastic will set and hold the particles rigidly in their aligned position.

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