

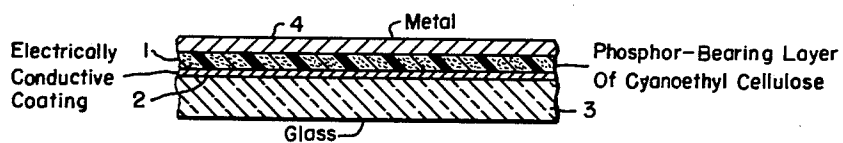
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ELECTROLUMINESCENT LAMP STRUCTURES

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WITNESSES:

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1

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ELECTROLUMINESCENT LAMP STRUCTURES
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The present invention relates to electroluminescence and has particular reference to electroluminescent lamp structures embodying a material of high dielectric constant.

This application is a continuation-in-part of my copending application Serial No. 571,536, filed March 14, 1956, now Patent No. 2,920,256, entitled "Electrical Apparatus and Solid Dielectric Thereof."

Broadly, in electroluminescent lamp structures, also known as luminous capacitors, a transparent or translucent dielectric having a suitable phosphor embedded or dispersed therein is placed between two electrical conductors across which a suitable voltage may be applied. In general, the higher the dielectric constant of the dielectric material in which the phosphors are embedded, the greater the light intensity at a given voltage.

The surprising discovery has now been made that cyanoethyl cellulose provides a dielectric medium having a high dielectric constant such that it is outstanding for use as an embedment material for carrying the phosphors in electroluminescent lamp structures.

The object of the present invention is to provide electroluminescent lamp structures having a phosphor-bearing layer comprised of cyanoethyl cellulose.

Another object of the present invention is to provide flexible electroluminescent lamp structures wherein the phosphors are carried by cyanoethyl cellulose.

Other and further objects of the invention will in part be obvious and will in part appear hereinafter.

For a more complete understanding of the present invention, reference is made to the following description taken in conjunction with the accompanying drawing, the single FIGURE of which is a view in cross-section illustrating one embodiment of an electroluminescent lamp structure in accordance with the present invention.

In the attainment of the foregoing objects, there is provided an electroluminescent lamp structure comprising a phosphor-bearing layer of cyanoethyl cellulose sandwiched between (1) an electrically conductive layer and (2) a light transmitting, electrically conductive layer.

As illustrated in the drawing, the phosphor layer 1 comprises a sheet of cyanoethyl cellulose having phosphors suspended or embedded therein. The phosphor-bearing layer of cyanoethyl cellulose is sandwiched between a conductive layer 2 carried by a light transmitting layer 3, such as glass, and a conductive metal layer 4. The glass layer 3 has a transparent conductive layer 2 disposed at least on the side thereof immediately adjacent to the phosphor layer 1.

Numerous conductive materials may comprise conductive layer 2. Such a layer may be applied to a glass layer 3 in any convenient manner. An example of one method includes the steps of first applying a coating comprising an aqueous solution of tin chloride to at least one surface of the glass layer 3. This coating then is dried in a baking oven of suitable design whereupon a semi-conducting layer of oxide forms. This layer comprises tin oxide in the mixed valent state of SnO and SnO₂.

The phosphors embedded in the layer 1 of cyanoethyl cellulose may comprise any of the phosphors well known in the art and may include, for example, those which are electric field-responsive, i.e., those which will lumi-

2

nesce under the influence of an electric field such as, for example, a mixture of zinc oxide and zinc sulfide powders or zinc sulfide activated by copper or copper and lead, or manganese, or copper and manganese.

The proportion of phosphors used in preparing the electroluminescent lamp structures of this invention may vary over a wide range. In general, the larger the amount of phosphors incorporated into a given thickness of cyanoethyl cellulose, the brighter will be the light produced. The upper limit for a given thickness of cyanoethyl cellulose is dependent upon the particle size of the phosphor. Thus, the smaller the particle size the greater the amount that may be used. Particularly satisfactory results are obtained using a weight ratio of 2 to 3:1 of phosphor to cyanoethyl cellulose. This ratio may be extended to greater or lesser amounts depending upon the thickness of the layer of cyanoethyl cellulose.

The conducting layer 4 may comprise a layer of any conducting metal such as, for example, aluminum, copper, silver, or the like. Layer 4 may be of any desired thickness ranging from a thin foil to a relatively thick sheet.

Cyanoethyl cellulose provides an excellent dielectric medium for carrying the phosphors of the electroluminescent lamp structure of this invention because it has outstanding flexibility, moisture insensitivity, transparency, high voltage breakdown and the like. As has been described in the above-mentioned copending application Serial No. 571,536, cyanoethyl cellulose has an extremely high dielectric constant, viz., from about 12 to 16 at temperatures of from 25° to 100° C. and frequencies below 1 mc. This characteristic, in combination with the other excellent characteristics enumerated, makes it particularly well suited for use in electroluminescent lamp structures.

Cyanoethyl cellulose may be prepared by reacting cellulose with a relatively large amount of acrylonitrile in the presence of a relatively large amount of water and an alkaline catalyst. In order to indicate one convenient method for preparing cyanoethyl cellulose, the following specific example is set forth. The parts given are by weight unless otherwise indicated.

Example I

Forty parts of cellulose are soaked in 400 parts of 2% sodium hydroxide for 1.5 hours. The liquid then is decanted, and the cellulose is pressed between sheets of blotting paper. The wet cellulose, constituting about 100 parts, then is transferred to a suitable reaction vessel equipped with a reflux condenser to which is added 680 parts of acrylonitrile. The mixture is heated and stirred until refluxing commences. External heat is removed and the exothermic reaction is allowed to continue for about 80 minutes whereupon the cellulose is completely dissolved. The resultant fluid is poured into a suitable vessel containing about 500 parts of water and a few large pieces of Dry Ice. The Dry Ice is effective in agitating the liquid and neutralizing the alkali. After 5 minutes the liquid is decanted, and fresh water and Dry Ice are added. The washing is continued until the washings are clear, colorless and neutral. During the washing the product changes from a gummy mass to a collection of small, hard, light yellow granules. Further purification may be achieved by dissolving the product in acetone and precipitating it from a large excess of water.

In preparing an electroluminescent lamp structure in accordance with this invention the phosphor-bearing layer of cyanoethyl cellulose preferably is prepared first. This may be prepared in accordance with any one of

several different techniques. One convenient method comprises dissolving the cyanoethyl cellulose and phosphor powder in a suitable solvent such as dimethyl formamide, acetone, pyridine or the like and casting the same in the form of a thin film. Alternatively, this solution may be sprayed directly onto the metal layer 4 or onto the conductive layer 2 of the light transmitting glass layer 3.

Since sheets of cyanoethyl cellulose may have conductive coatings applied thereto, for example, by vacuum metalizing metal films of aluminum, silver, gold, copper and the like thereon in thicknesses of the order of about 0.00025 mil or less, down to 96 to 24 angstroms, for instance, it is within the scope of this invention to substitute such a coated sheet for the glass layer 3 and conductive layer 2 illustrated on the drawing. If such a substitution is made a flexible electroluminescent lamp structure is obtained, provided layer 4 is metal foil or other flexible, electrically conductive sheet material.

As an illustration of one specific embodiment of this invention, an electroluminescent lamp structure may be made by first admixing about 7.5 grams of cyanoethyl cellulose with about 200 cc. of acetone to form a solution. About 15 grams of the powdered electroluminescent or field sensitive phosphor described hereinabove then is suspended in the solution. The mixture then is sprayed onto the conductive coating 2 carried by glass plate 3 with a spray gun in accordance with conventional paint spraying techniques in successive layers to build up the desired thickness. The sprayed coating then is dried either in air or in a suitable oven at 80 to 110° C. Thereafter, onto the surface of the dielectric-phosphor film 1 so formed, there is deposited an electrically conductive layer or coating 4 of aluminum or other metal such as gold, silver, copper, or the like by conventional vacuum metalizing techniques. If desired, instead of utilizing vacuum metalizing techniques, a sheet of metal foil 4 may be laid onto the free surface of the phosphor-cyanoethyl cellulose film 1, by gluing or hot pressing techniques. Alternatively, the phosphor and cyanoethyl cellulose mixture may be spray coated onto a sheet of metal 4 and that sheet placed onto glass 3 with the conductive layer 2 of the glass being in contact with the sprayed layer of phosphor-cyanoethyl cellulose.

The thicknesses of the various layers forming the electroluminescent lamp structure of this invention may be altered to suit various voltage conditions. Layer 3 which is glass may be any thickness. Usually one-eighth inch thicknesses are preferred. The electrically

conductive layer 2 should have a thickness on the order of from 0.0001 to 0.0025 to provide optimum light-transmitting properties. The phosphor-containing layer of cyanoethyl cellulose 1 may vary from 0.0005 to 0.01 inch or more in thickness. Layer 4 should be a dense coating of a thickness of about 0.025 inch or more to provide good reflection and good electrical conducting properties.

In operation, a voltage, preferably alternating, is applied between conductive layers 2 and 4 through suitable conducting leads (not shown). The particular voltage used necessarily will depend upon the phosphor used, the thickness of the phosphor layer, and the brightness of the light intensity desired. Thus, for 110 volt operation and a weight ratio of phosphor to cyanoethyl cellulose of 2:1 the thickness of layer 1 should be about 0.0005 inch, for 400 volt operation the thickness should be increased to about 0.0018 and for 600 volt operation the thickness should be about 0.0024 inch.

While the invention has been described with respect to what is at present considered to be a preferred embodiment thereof, it will be understood, of course, that substitutions, modifications, changes and the like may be made therein without departing from its true scope.

I claim as my invention:

1. In an electroluminescent lamp structure comprising a phosphor-bearing layer disposed between an electrically conductive layer and a light transmitting electrically conductive layer, the improvement which consists of embedding said phosphor in a layer of cyanoethyl cellulose.

2. An electroluminescent lamp structure containing, as one of its components, a phosphor-bearing layer consisting essentially of a film of cyanoethyl cellulose having phosphors therein.

3. A phosphor-bearing film adapted for use in an electroluminescent lamp structure comprising a film of cyanoethyl cellulose having phosphors therein.

4. In an electroluminescent lamp structure having a layer of electrically conductive, light-transmitting glass, a phosphor-bearing layer in which phosphors are embedded in a solid film of cyanoethyl cellulose.

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