FLUORESCENT LIGHTING WITH ALUMINUM NITRIDE PHOSPHORS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to and benefit under 35 U.S.C. §119(e) of U.S. Provisional Patent Application No. 62/046,768 filed Sep. 5, 2014 entitled "Aluminum Nitride Phosphors for Fluorescent Lighting," the content of which is hereby incorporated by reference in its entirety for all purposes.

STATEMENT AS TO RIGHTS TO APPLICATIONS MADE UNDER FEDERALLY SPONSORED RESEARCH AND DEVELOPMENT

The United States Government has rights in this application pursuant to Contract No. DE-AC52-07NA27344 between the United States Department of Energy and Lawrence Livermore National Security, LLC for the operation of Lawrence Livermore National Laboratory.

BACKGROUND

1. Field of Endeavor

The present application relates to fluorescent lighting and more particularly to aluminum nitride phosphors for fluorescent lighting.

2. State of Technology

This section provides background information related to the present disclosure which is not necessarily prior art.

U.S. Pat. No. 6,867,536 for a blue-green phosphor for fluorescent lighting applications issued Mar. 15, 2005 to Alok Srivastava, Holly Comanzo, and Venkatesan Manivannan of General Electric Company provides the state of technology information reproduced below.

"Fluorescent lamps typically have a transparent glass envelope enclosing a sealed discharge space containing an inert gas and mercury vapor. When subjected to a current provided by electrodes, the mercury ionizes to produce radiation having primary wavelengths of 185 nm and 254 nm. This ultraviolet radiation, in turn, excites phosphors on the inside surface of the envelope to produce visible light which is emitted through the glass.

Generally, a fluorescent lamp for illumination uses a phosphor which absorbs the 254 nm Hg-resonance wave and is activated so as to convert the ultraviolet luminescence of mercury vapor into visible light. In some conventional fluorescent lamps, a white-emitting calcium halophosphate phosphor, such as $Ca._{10}(PO_4)_6(F,Cl)_2$:Sb,Mn, has been used. More recently, in order to improve the color-rendering properties and emission output of fluorescent lamps, efficient illumination of a white color is provided using a three-band type fluorescent lamp which employs the proper mixture of red, green and blue-emitting phosphors whose emission spectrum occupies a relatively narrow band, has been put to practical use. For example, for the blue-emitting phosphor, europium-activated barium magnesium aluminate phosphor ($BaMg_2Al_{16}O_{27}:Eu^{2+}$), for the green-emitting phosphor, cerium and terbium-activated magnesium aluminate phosphor [$(Ce,Tb)MgAl_{11}O_{19}$], and for the red-emitting phosphor, europium-activated yttrium oxide phosphor ($Y_2O_3:Eu^{3+}$) may be used and are mixed in an adequate ratio. The combined spectral output of the phosphor blend produces a white light.

In such a three-band type phosphor lamp, the emitting colors of the respective phosphors are considerably different from one another. Therefore, if the emitting intensity of any of the three corresponding phosphors is decreased, color deviation occurs, degrading the color-rendering properties of the lamp.

The apparent color of a light source is described in terms of color temperature, which is the temperature of a black body that emits radiation of about the same chromaticity as the radiation considered. A light source having a color temperature of 3000 Kelvin has a larger red component than a light source having a color temperature of 4100 Kelvin. The color temperature of a lamp using a phosphor blend can be varied by changing the ratio of the phosphors.

Color quality is further described in terms of color rendering, and more particularly color rendering index (CRI or R_a), which is a measure of the degree to which the psycho-physical colors of objects illuminated by a light source conform to those of a reference illuminant for specified conditions. CRI is in effect a measure of how well the spectral distribution of a light source compares with that of an incandescent (blackbody) source, which has a Planckian distribution between the infrared (over 700 nm) and the ultraviolet (under 400 nm). The discrete spectra which characterize phosphor blends will yield good color rendering of objects whose colors match the spectral peaks, but not as good of objects whose colors lie between the spectral peaks.

The color appearance of a lamp is described by its chromaticity coordinates which can be calculated from the spectral power distribution according to standard methods. See CIE, Method of measuring and specifying color rendering properties of light sources (2nd ed.), Publ. CIE No. 13.2 (TC-3,2), Bureau Central de la CIE, Paris, 1974. The CIE standard chromaticity diagram includes the color points of black body radiators at various temperatures. The locus of black body chromaticities on the x,y-diagram is known as the Planckian locus. Any emitting source represented by a point on this locus may be specified by a color temperature. A point near but not on this Planckian locus has a correlated color temperature (CCT) because lines can be drawn from such points to intersect the Planckian locus at this color temperature such that all points look to the average human eye as having nearly the same color. Luminous efficacy of a source of light is the quotient of the total luminous flux emitted by the total lamp power input as expressed in lumens per watt (LPW or lm/W).

Spectral blending studies have shown that the luminosity and CRI of white light sources are dependent upon the spectral distribution of color components. Blue or bluish-green phosphors are important components, the performance of which is important to maximize CRI. It is expected that such phosphors preserve structural integrity during extended lamp operation such that the phosphors remain chemically stable over a period of time while maintaining stable CIE color coordinates of the lamp. For class M and AAA high color rendering fluorescent lamps, a bluish-green phosphor is highly desired. Such phosphors can be used in conjunction with existing **3**-band lamps to increase the lamp's CRI."

SUMMARY

Features and advantages of the disclosed apparatus, systems, and methods will become apparent from the following description. Applicant is providing this description, which includes drawings and examples of specific embodiments, to give a broad representation of the apparatus, systems, and methods. Various changes and modifications within the spirit