Nanocomposites and nanomaterials

Nanostructured luminescent materials based on yttrium-aluminum garnet for light-emitting-diode lighting devices

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A new method of obtaining nano-structured powders of yttrium-aluminum garnet doped by cerium ions, based on the combustion method of nitrate salts in the presence of organic fuel and hexamethylenetetramine, is developed. The modes of synthesis, structural and spectral-luminescent characteristics of the nanostructured powders are optimized leading to chemical composition of $Y_{3-x}Ce_xAl_5O_{12}$ (x = 0,02 – 0,06) with the powder size of 40 – 60 nm, spherical form, a specific surface of 50 m2/g. Dependences of spectral-luminescent characteristics of powders with respect to concentration and nature of doping impurities (Ce, La, Gd, Li, Mn, SiO2), temperature of heat treatment, type of gas environment are revealed. At excitation of 455 nm doping of yttrium-aluminum garnet by cerium causes broadband luminescence in the range of 500 – 700 nm, additional processing of powders in the environment of argon at 1200 °C provides growth in intensity of luminescence by 1,5 – 2 times for a phosphor obtained by burning, and addition of gadolinium allows for a shift of the spectrum of luminescence in the red area.

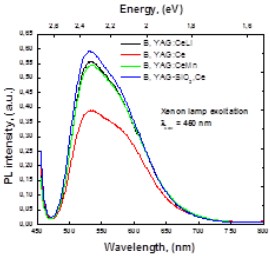

Fig.1. Luminescence spectra of powder YAG: Ce^{3+}, doped with Li, Mn, SiO_2

As a result of computer simulation of luminescence and a color rendering process, parameters in a system «light-emitting diode – luminophor covering» are calculated. Model samples of discrete polymeric and ceramic remote converters in the form of a thick-film covering deposed on polymeric, glass smooth and grooved substrates, with concentration of the nanostructured phosphor up to 30 mas.% are fabricated. The method of forming of a composite «quartz glass – nanoparticles YAG:Ce» have been developed in addition to samples of a glass-ceramic luminophor material, which are formed at lower temperature sintering (1200 – 1300 °C). Nanostructured powders of YAG:Ce to be used in remote converters of light-emitting-diode lighting devices.