Properties of "phosphate-tungstate glass - $K_2Eu(PO_4)(WO_4)$ crystalline phosphor" glass-ceramics

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Luminescent glass-ceramics (GCs) are actively elaborated as alterative to phosphor-in-silicone/resin composites for light emitting diodes (LEDs). In comparison to polymers, which are used in commercial LEDs, the GCs demonstrate better stability of optical characteristics under the action of heat and powerful light fluxes, as well as lower degradability (aging) due to higher thermal conductivity. To achieve a high intensity of emission it is desirable to decrease light scattering in GCs that appears due to mismatch between refraction indices of glass and crystalline components. It was assumed that the similarity of the chemical compositions of the glass host and crystalline phosphor should result in better homogeneity of the optical glass-ceramics.

Here, the optical properties of the samples that consist of $K_2Eu(PO_4)(WO_4)$ red phosphor incorporated into phosphate-tungstate glass host have been studied. The glass of xK_2O-yP_2O_5-zWO_3-$(1-x-y-z)Bi_2O_3$ system (x = 27 – 51 mol %, y = 19 – 41 mol %, z = 16 – 41 mol %) has been synthesized by melt quenching technique. It was found from differential thermal analysis that the glass transition temperature was in 380 - 500 °C range for all of the samples. The GC were made by adding the $K_2Eu(PO_4)(WO_4)$ micro/nanocrystals into previously melted glass at 800 °C. The content of crystalline component in glass-ceramics was chosen to be 1 % mas. The X-ray diffraction patterns of the glasses and GC were very similar each to other with wide bands peaking at 29°, 45°, and 55° of 2Θ, but no narrow peaks have been found due to low content of crystalline component. At the same time, the crystallites and their agglomerations are clearly distinguished on optical microscopy images in the case of GC under white and UV light illumination. The photoluminescence spectra of the glass ceramics depend on the excitation wavelength and consist either with wide band of glass emission in 400 – 800 nm range or additionally with narrow lines of Eu^{3+} emission typical for $K_2Eu(PO_4)(WO_4)$ crystals.

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