Aukštos galios baltiems šviestukams skirtų dvikomponenčių silikatinių stiklų, legiruotų Ce, Dy, Eu ir Tb jonais liuminescencija

Luminescence in two-component silicate glass doped with Ce, Dy, Eu, and Tb ions for high-power white light sources

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Reliable high-power white and monochromatic light sources are on increasing demand. Currently, blue LEDs and downconverting YAG:Ce phosphors encapsulated in silicone is the conventional method for producing solid state white light sources. However, this approach suffers from strong thermal degradation at high emission power and poor color rendering. Fortunately, glass phosphors have superior thermal properties and good prospects for appropriate color conversion. Glass phosphors exhibit also better chemical and thermal stability. Color rendering properties of glass phosphors can be quite easily improved by modifying the composition or doping the glass host. Due to these properties, glass phosphors are potentially good candidates for commercial production of high-power white LEDs.

We investigated heat–treated two-component silicate glasses with compositions $CaO\text{-}SiO_2$, $BaO_2\text{-}SiO_2$, and $SrO\text{-}SiO_2$ doped with Ce, Dy, Eu, and Tb activators. The doping concentration of all the samples was 1 at.%. The samples were produced at the Belarusian State Technical University.

The light emission properties of the samples under study were investigated by measuring their photoluminescence (PL) spectra. The measurements were performed using the WITech Alpha 300S microscope system operated in confocal mode. PL emission spectrum was recorded using a spectrometer with a thermoelectrically cooled CCD camera. PL excitation was performed by a CW laser diode emitting at 405 nm (*ALPHALAS*) as well as by a He-Cd laser emitting at 442 nm. The photoluminescence at different excitation power densities and in various sample depths was investigated. All the measurements were performed at room temperature.

The PL results show that different rare earth ions are affected by their surroundings in different ways. This is illustrated in Fig. 1, where the spectra of cerium and europium are presented in the samples with three glass matrixes. For cerium ions, the variation of their environment due to the different glass matrix composition has a weak effect. Only in the sample of $BaO_2\text{-}SiO_2$ glass the emission band is redshifted by 15 nm in respect to the position in the spectra of Ce in other two glasses. Meanwhile, the shape of the PL band remains unchanged. The influence of the glass matrix is more pronounced for europium ions. Europium doped glass contains both Eu^{2+} and Eu^{3+} ions. The higher energy emission band is associated with Eu^{2+} ions and is significantly more sensitive to the glass matrix than the bands due to optical transitions of Eu^{3+} ions. As seen in Fig. 1, the high energy band is hardly detectable in $BaO_2\text{-}SiO_2$, and $SrO\text{-}SiO_2$ glasses but is clearly visible in $CaO\text{-}SiO_2$ glass.

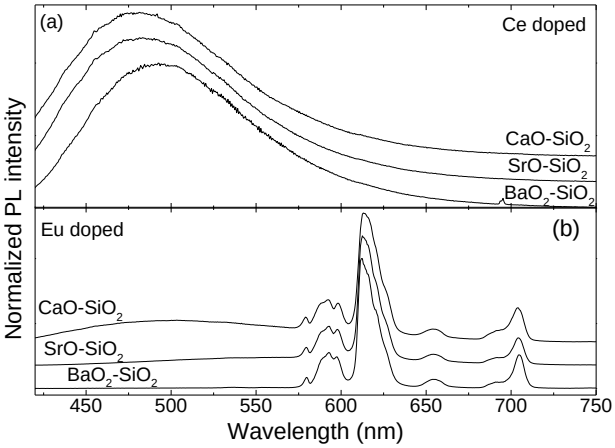

Fig. 1 Photoluminescence spectra of $CaO\text{-}SiO_2$, $BaO_2\text{-}SiO_2$, and $SrO\text{-}SiO_2$ glasses doped with Ce or Eu ions (indicated).

To test the applicability of the rare earth doped glasses for light conversion in white LEDs, color coordinates of all the samples were calculated. The results show that this material system is easily tunable by variation of the glass composition and has potential for solid state lighting with laser excitation.

Keywords: luminescence, glass, phosphor, white LED