World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:10, No:10, 2016

Photoluminescence of Barium and Lithium Silicate Glasses and Glass Ceramics Doped with Rare Earth Ions

Authors : Augustas Vaitkevicius, Mikhail Korjik, Eugene Tretyak, Ekaterina Trusova, Gintautas Tamulaitis

Abstract : Silicate materials are widely used as luminescent materials in amorphous and crystalline phase. Lithium silicate glass is popular for making neutron sensitive scintillation glasses. Cerium-doped single crystalline silicates of rare earth elements and yttrium have been demonstrated to be good scintillation materials. Due to their high thermal and photo-stability, silicate glass ceramics are supposed to be suitable materials for producing light converters for high power white light emitting diodes. In this report, the influence of glass composition and crystallization on photoluminescence (PL) of different silicate glasses was studied. Barium ($BaO\text{-}2SiO_2$) and lithium ($Li_2O\text{-}2SiO_2$) glasses were under study. Cerium, dysprosium, erbium and europium ions as well as their combinations were used for doping. The influence of crystallization was studied after transforming the doped glasses into glass ceramics by heat treatment in the temperature range of 550-850 degrees Celsius for 1 hour. The study was carried out by comparing the photoluminescence (PL) spectra, spatial distributions of PL parameters and quantum efficiency in the samples under study. The PL spectra and spatial distributions of their parameters were obtained by using confocal PL microscopy. A WITec Alpha300 S confocal microscope coupled with an air cooled CCD camera was used. A CW laser diode emitting at 405 nm was exploited for excitation. The spatial resolution was in sub-micrometer domain in plane and ~1 micrometer perpendicularly to the sample surface. An integrating sphere with a xenon lamp coupled with a monochromator was used to measure the external quantum efficiency. All measurements were performed at room temperature. Chromatic properties of the light emission from the glasses and glass ceramics have been evaluated. We observed that the quantum efficiency of the glass ceramics is higher than that of the corresponding glass. The investigation of spatial distributions of PL parameters revealed that heat treatment of the glasses leads to a decrease in sample homogeneity. In the case of $BaO\text{-}2SiO_2$: Eu, 10 micrometer long needle-like objects are formed, when transforming the glass into glass ceramics. The comparison of PL spectra from within and outside the needle-like structure reveals that the ratio between intensities of PL bands associated with Eu^{2+} and Eu^{3+} ions is larger in the bright needle-like structures. This indicates a higher degree of crystallinity in the needle-like objects. We observed that the spectral positions of the PL bands are the same in the background and the needle-like areas, indicating that heat treatment imposes no significant change to the valence state of the europium ions. The evaluation of chromatic properties confirms applicability of the glasses under study for fabrication of white light sources with high thermal stability. The ability to combine barium and lithium glass matrixes and doping by Eu, Ce, Dy, and Tb enables optimization of chromatic properties.

Keywords : glass ceramics, luminescence, phosphor, silicate
Conference Title : ICGST 2016 : International Conference on Glass Science and Technology
Conference Location : New York, United States
Conference Dates : October 10-11, 2016