ABSTRACT

Light emitting diodes (LEDs) are called as next generation solid state lighting sources due to their eco-friendly nature and promising applications in various industries. In this thesis, we have chosen aluminate luminescent materials doped with rare -earth ions for the generation of white light because of their excellent advantageous features such as wide range of luminescence, high quantum efficiency, good stability and high quenching temperature etc.

Calcium dialuminate host lattice was chosen to explore their emission richness in the whole visible region by activating with Tm^{3+}, Er^{3+} and Eu^{3+} rare earth ions under NUV excitation. These trivalent ions gained attention due to their high color purity in blue, green and red regions. Calicum dialuminate doped with trivalent europium ion was synthesized by the Pechini method. The photoluminescence properties were studied as the function of calcination temperature. The XRD pattern confirmed the monoclinic structure and the lattice parameters were calculated. SEM micrograph showed that the particle size increased from 235 to 283 nm as the calcination temperature increases from 950 to 1050 °C. The photoluminescence spectrum shows the maximum emission wavelength at 611 nm with the excitation wavelength of 395 nm. As the calcination temperature increases from 950 to 1050 °C, the emission intensity decreases due to the decrease of crystallite size. The CIE coordinates of europium doped calcium dialuminate is found to be x=0.451 and y=0.271 with a color purity of 50 %. The decay studies shows the life time of europium ion is 1.89 ms.

Calcium dialuminate doped with thulium was synthesized by Pechini method at 1000 °C. XRD and TEM confirms the monoclinic structure and the crystallite size as 41 nm. Under the NUV excitation of 359 nm, the thulium ion shows the characteristic emission at 460 nm. The optimum concentration of thulium was found to be 5 mol%. As the thulium concentration was increased,

the interaction between the thulium ions become more prominent and it is studied by Inokutti-Hirayama model. The energy transfer between the thulium ions take place through cross-relaxation phenomena and it is found that the electric dipole-dipole interaction is responsible for the non-exponential behavior. The critical distance of thulium was calculated to be 6 Å and the average life time of thulium is 14.95 μs. The sample exhibits excellent CIE coordinates of x = 0.191 and y = 0.111 with a color purity of 73 %.

Calcium dialuminate doped with erbium ion is studied. The luminescence studies shows the optimum concentration of erbium as 7 mol%. The PL emission shows the characteristic emission at 549 nm when excited at 378 nm. The PL emission intensity has been enhanced by the addition of sodium and lithium ions (separately) along with erbium. The luminescence life time of erbium ion and the nature of the decay curves with varying dopant concentration is studied. The decay curve shows the non-exponential behavior and the non-exponential nature increases as the erbium concentration increases. The non-exponential decay nature of the curve decreased due to the addition of sodium. The optimum concentration of sodium co-doped sample is 5 mol%. The CIE coordinates of erbium, erbium-lithium co-doped, erbium-sodium co-doped calcium dialuminate is found as (0.28, 0.39), (0.28, 0.41), (0.26, 0.42) with the color purity of 12.24, 17.35 and 20.03% respectively. In order to obtain white light, 1 mol% of europium, 1 mol% of thulium, 1 mol% of erbium doped calcium dialuminate samples were mixed well and were excited with 364 nm. The PL emission showed the simultaneous emission of blue (459 nm), green (549 nm) and red (611 nm) colors to combine to generate white light. The x and y coordinates of CIE were found to be (0.22, 0.22) which is close to the standard CIE of white light (x = 0.313, y = 0.329).