

A new phosphor material: GaN powder doped with rare earth

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With the rapid development in GaN LED field, strong emission with long life time phosphor materials are in great demand. The GaN:RE phosphor development also plays a major role in the GaN:RE AC thick dielectric electroluminescent (TDEL) device optimization.

The recent demonstration of visible (blue, green, red) and infrared (1.54 μ m) electroluminescence from rare earth (RE) doped GaN brings significant interest to this class of materials for possible applications in optical communications and full color displays. In these works, the incorporation of RE atoms into GaN is achieved by either *in situ* epitaxial growth with the GaN layer or ion-implantation after the layer growth step. Although extensive work has been done on doping GaN in bulk form with RE, few studies have been done on doping GaN in a powder form with RE.

In this work, RE is successfully incorporated into GaN powder through the reaction between molten (Ga+RE) and NH₃ at 1000°C using Bi as a wetting agent. Photo excitation with an Ar and UV laser results in strong visible light emissions from two narrow lines at 537 and 558 nm identified as Er transitions from the ²H_{11/2} and ⁴S_{3/2} levels to the ⁴I_{15/2} ground state in the Er doped GaN powder sample. Red emission at 623nm corresponding to ⁵D₀ → ⁷F₂ transition has also been achieved from Eu doped GaN powder. X-ray diffraction shows that both structures of the GaN powder doped with Er and Eu are the wurtzite structure. Microprobe analysis reveals that Er or Eu is distributed evenly in the powder particles. GaN:Eu phosphor could find potential application as red phosphors for white-light generation using blue GaN-based light-emitting diodes (LEDs).

These rare earth doped GaN powders are used to make thin film on Si, glass and sapphire substrates. Continuous and highly oriented films showed good luminescence properties. Structure, morphology, Cathodoluminescence and photoluminescence characterizations have been carried out on these films.