# Er-doped GaN grown by molecular beam epitaxy

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Er-doped doped semiconductors have been of interest due to their potential application for optical communication components operating at wavelengths around 1.55 μm. In Er-doped semiconductors, the transition corresponding to 1.54 μm occurs due to a 4*f* intra-shell transition of the $Er^{3+}$ ion, and is therefore host independent. The incorporation of Er into III-V semiconductors and their luminescence properties have been previously reviewed [1]. However, the thermal quenching of luminescence was found to be more severe for narrower bandgap materials doped with Er [1]. Therefore in this work, GaN which is a wide-bandgap semiconductor ($E_g$ = 3.42 eV) was doped with Er and its luminescence properties investigated.

GaN films were grown on (0001) sapphire substrates by plasma-assisted molecular beam epitaxy. Er was supplied as a dopant using a standard effusion cell during the growth. One of the advantages of *in-situ* doping versus ion-implantation is the elimination of the need for post-implantation annealing which is typically performed at high temperatures. The Er incorporation level was varied between $10^{18}$ to $10^{21}$ $cm^{-3}$ as determined by secondary ion mass spectrometry (SIMS) measurements. The background oxygen impurity concentration was lower than $10^{18}$ $cm^{-3}$. A smooth surface morphology was observed using atomic force microscopy with the RMS roughness less than 5 Å over a $5 \times 5$ $\mu m^2$ area.

Electroluminescence measurements at room temperature revealed emission peaks in the visible (538, 559 and 667 nm) as well as in the near-infrared (1.0 and 1.54 μm) as shown in Figure 1. Visible emission in the green can be observed by eye under ambient room lighting. The integrated intensity of the 1.54 μm peak shows linear behavior with injected current of up to 80 mA.

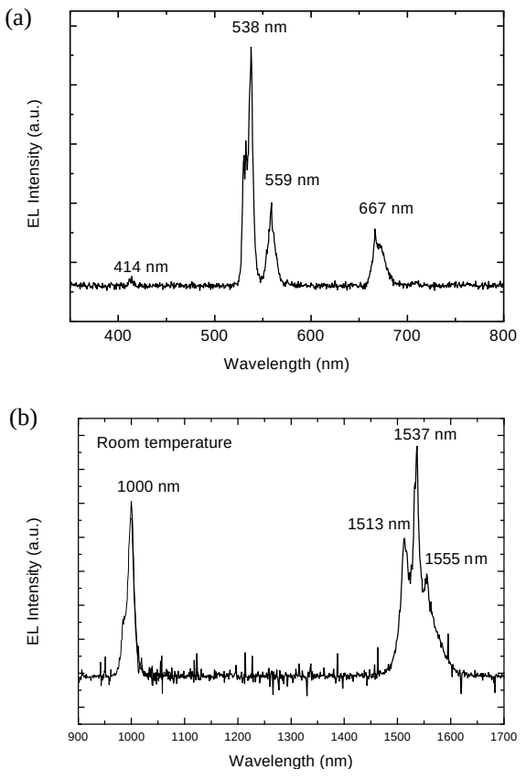


Fig. 1. Room temperature electroluminescence of GaN:Er films from (a) 350-800 nm and (b) 900-1700 nm

REFERENCES

1. J. M. Zavada and D. Zhang, Solid-State Electronics **38**, 1285 (1995).