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MBE growth of Eu or Tb doped GaN and its optical properties

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Sharp luminescence originating from intra atomic 4f-4f transition from both Eu doped GaN, and Tb doped GaN was observe at 622nm which can be assigned as ^5D_o-$^7F_2$ transition of Eu^{3+} and 491nm , 580nm and 545nm which can be assigned as $^5D_4$-$^7F_6$, $^5D_4$-$^7F_5$, and $^5D_4$ - $^7F_4$ transitions of Tb^{3+}, respectively.[1~3] However, the luminescence intensity of Eu^{3+} is two orders of magnitude stronger than that of Tb^{3+}. The reason for the strong intensity of the luminescence from Eu^{3+} is studied by means of RBS/C and EXAFS measurements.

Eu or Tb doped GaN films were grown on sapphire (0001) substrates by gas source molecular beam epitaxy (GSMBE) using uncracked ammonia for nitrogen source.[4,5] The growth temperature of Eu or Tb doped GaN was 700°C and the cell temperatures of Eu and Tb was varied from 400 to 500°C , 1200°C to 1300°C respectively. The Ga cell temperature and ammonia pressure were kept constant at 950°C and 2.6×10^{-3} Pa, respectively. To investigate the structural property of the film, *in-situ* reflection high-energy electron diffraction (RHEED) patterns were observed during growth. Rutherford back scattering ion channeling (RBS/C) and extended X-ray absorption fine structure (EXAFS) measurement were performed to analyze the lattice structure around Eu and Tb ions.

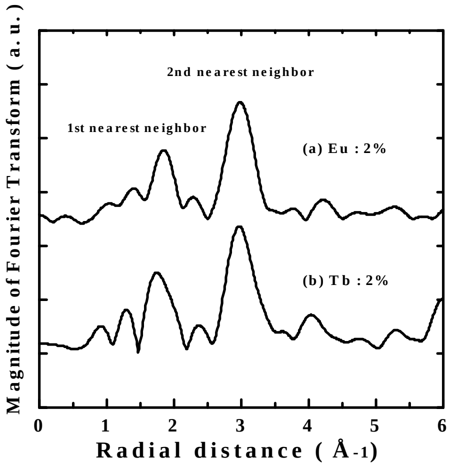

Fig.1. Radial distribution function of Eu doped GaN (a) and Tb doped GaN (b)

Both Eu^{3+} and Tb^{3+} are found to be incorporated into the substitutional Ga lattice site from the RBS/C and EXAFS analysis. Though the coordination symmetry of Tb^{3+} can be assigned as tetrahedral symmetry, Eu^{3+} can be assigned as C_{3V} since two kinds of bond length between Eu and N were observed with the coordination number ration of 1:3.

It is well known that the f-f transition, which is intrinsically forbidden transition, is enhanced by lowering the coordination symmetry which has an effect of mixture of 4f orbital and other orbital components. Therefore, it can be said that one of reasons for the higher luminescence intensity of Eu in GaN than Tb in GaN is responsible for the lower coordination symmetry.[6,7]

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