Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Excitation mechanisms of Er optical centers GaN epilayers

MATTHEW HAWKINS, Department of Physics, Virginia Tech, Blacksburg, Virginia 24061, HONGXING JIANG, JINGYU LIN, Department of Electrical and Computer Engineering, Texas Tech University, Lubbock, Texas 79409, JOHN ZAVADA, Department of Electrical and Computer Engineering, NYU Polytechnic School of Engineering, Brooklyn, New York 11201, NGUYEN VINH, Department of Physics, Virginia Tech, Blacksburg, Virginia 24061 — We report direct evidence of two mechanisms responsible for the excitation of optically active Er3+ ions in GaN epilayers grown by metal-organic chemical vapor deposition. These mechanisms, resonant excitation via the higher-lying inner 4f shell transitions and band-to-band excitation of the semiconductor host, lead to narrow emission lines from isolated and the defect-related Er optical centers. However, these centers have different photoluminescence spectra, local defect environments, decay dynamics, and excitation cross sections. The photoluminescence at 1.54 micrometer from the isolated Er optical center which can be excited by either mechanism has the same decay dynamics, but possesses a much higher excitation cross-section under band-to-band excitation. In contrast, the photoluminescence at 1.54 micrometer from the defect-related Er optical center can only be observed through band-to-band excitation but has the largest excitation cross-section. These results explain the difficulty in achieving gain in Er doped GaN and indicate approaches for realization of optical amplification, and possibly lasing, at room temperature.

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Date submitted: 05 Nov 2015 Electronic form version 1.4