Optical characterization of GaN, 4H-SiC, and β-Ga_2O_3

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Given the current increase in energy consumption, more efficient technology design, especially for electronic and optoelectronic devices, is strongly required. Due to their promising characteristics (such as bandgap energy, high breakdown field, etc.), WBS and UWBS have attracted interest in the optimization and development of new technologies. Defects in these materials, play an important role as they can alter the optical and electrical response. In this work, structural and optical properties of epitaxial layers of GaN, 4H-SiC, and β-Ga_2O_3 grown by chemical vapor phase deposition were assessed by transmittance, Raman, photoluminescence (PL), and photoluminescence excitation (PLE) spectroscopies.
Raman analysis revealed compressive stress effects in GaN and 4H-SiC samples. To identify the emitting optically active defects and their main population mechanisms, PL and PLE measurements were performed. The presence of free and bound exciton recombination and a deep yellow band (YL1) were observed in the GaN sample. At RT three recombination bands were identified for the 4H-SiC sample: green (GL) and blue (BL), which are due to donor-acceptor pair (DAP) recombination, and a band in the near-infrared region (NIRL). The GL is only observed in samples doped with boron, where it acts as an acceptor. Considering the excitation density study results and the DAP nature of the GL, the NIRL band may also have a DAP nature, involving boron impurities. N-bounded excitons were observed at 14 K, which allowed us to assume that the observed BL may be an overlap of different DAP recombinations. In addition, an emission band in the red region (RL) was observed and attributed to the spectral overlap of several optically active centres. The RL could be a result of the superposition of the GL and NIRL. For the β-Ga_2O_3 sample, emission bands were observed in the ultraviolet and blue regions. A red emission was also detected, being due to the intraionic recombination of Cr^{3+} ions (a common contaminant in this oxide host).

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