

Optical properties of GaN nanowires grown by plasma assisted molecular beam epitaxy on Si(111) substrates with amorphous Al₂O₃ buffers

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GaN nanowires (NWs), with their thermal and chemical stability, are very promising candidates for various electronic and nanophotonic applications, including photovoltaic devices, field effect transistors, light emitting diodes, lasers, nanogenerators and biochemical sensing devices [1-3]. In spite of great attention received from many research groups, several aspects of GaN NWs need to be developed technologically. One of the most important issues is the controlled growth of GaN nanowires on various substrates. In this communication, we present our research on GaN nanowires grown by plasma-assisted molecular beam epitaxy (PAMBE) on Si(111) substrates with amorphous Al₂O₃ buffers [3]. GaN NWs obtained under different growth conditions were studied using scanning electron microscopy (SEM), Raman spectroscopy and low temperature microluminescence.

Photoluminescence spectra of NWs grown on Si substrate with Al₂O₃ buffers are shown in Fig. 1. The emission peak of neutral donor bound exciton (D⁰X) is observed at 3.472 eV, which corresponds to the relaxed GaN. For some NWs samples, an emission peak at 3.453 eV is observed. The origin of this luminescence is still under discussion, however it is frequently present in NWs, irrespectively of the growth method [4]. As presented in Fig. 2, Raman spectrum is dominated by a strong signal from the Si substrate, however Raman peak due to E₂(high) mode of GaN is also observed. The position of this peak (567.2 cm⁻¹) and its halfwidth (about 3.5 cm⁻¹) confirm that nanowires are strain-free. Surprisingly, Raman spectra of Si beneath NWs are shifted by about 0.13 cm⁻¹ towards lower energy, which corresponds to tensile strain of Si substrate. As shown in Fig. 2, the signal remnants obtained after background subtraction are asymmetrical, which indicates that the strain is inhomogeneous. These results might suggest that Si stress is locally caused by nanowires.

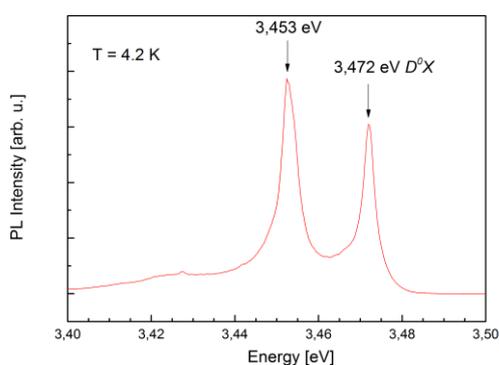


Fig. 1. Photoluminescence spectrum of the GaN NWs ensemble grown on Si substrate with Al₂O₃ buffer.

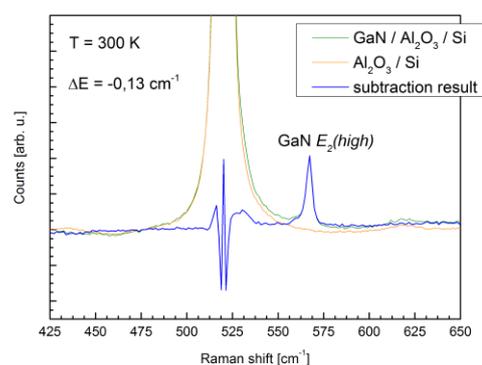


Fig. 2. Raman scattering spectra obtained for different parts of the sample, together with the spectrum obtained by subtraction of the background Si spectrum shifted by 0.13 cm⁻¹.

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