Resolved Band-Edge Luminescence of AlN on Different Substrates

N. Teofilov, K. Kornitzer, K. Thonke, R. Sauer
Abteilung Halbleiterphysik, Universität Ulm, D 89069 Ulm, Germany

D.G. Ebling, L. Kirste, K.W. Benz
Freiburger Materialforschungszentrum, Universität Freiburg, D 79104 Freiburg, Germany

The luminescence spectra of bulk or epitaxial aluminium nitride (AlN) are mostly dominated by a defect related band at ≈ 3 eV energy ("violet band"). Resolved near-band-edge spectra have only rarely been reported. In the present contribution we observe relatively narrow, multiply structured luminescence emissions from different epitaxial layers, and study the temperature dependence of these lines.

The samples used in this study were aluminium nitride (AlN) layers with Wurtzite structure grown alternatively on sapphire (0001) substrates, on Si-terminated SiC (0001) substrates, or on silicon (111) substrates. The growth conditions in the RF-plasma enhanced molecular beam epitaxy (MBE) system were similar, but the nucleation procedures differed.

In cathodoluminescence (CL) at 77 K sample temperature, the broad band centred around 3 eV is the dominant feature for all these layers. However, in the band-edge region at ≈ 6 eV also well-resolved transitions are observed, which indicate comparably good material quality of the epitaxial layers on the different substrates.

The near band-edge transitions show multiple substructures, which slightly vary for different substrates. In all cases, the line at the lowest energy is replicated by several phonon satellites with 110 meV energy. The energy position of these band-edge transitions is highest among all samples for the sapphire substrate case, and a little lower but similar for the samples with Si and SiC substrates. This is interpreted in terms of varying built-in strain due to the different thermal expansion coefficients. We numerically decompose these lines and tentatively assign them to donor- and acceptor-bound excitons.

keywords: cathodoluminescence, AlN, bound excitons, MBE, hetero-epitaxial growth

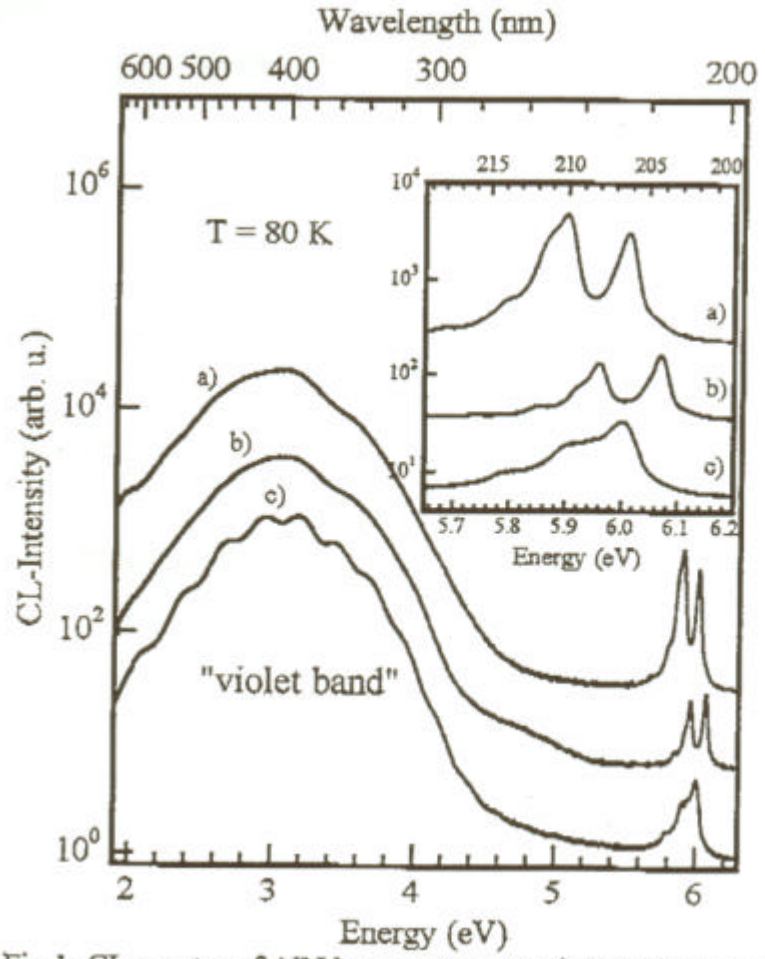

Fig 1: CL spectra of AlN layers grown on a) SiC, b) on sapphire, and c) on Si