Lata Sahonta - PARSEM future plans (MBE samples on sapphire from Iliopoulos *et al.*, Crete)

GaN quantum dots in AlN: Quantum dots (QDs) have potential for use in novel device applications such as quantum cryptography, quantum computing, optics and optoelectronics by confining excitons in 3D potential minima by the high band gap of the surrounding matrix. CTEM and HRTEM experiments will be carried out on three specimens with varied numbers of MQW periods, well thicknesses and growth temperatures. The precise dot size, shape, lattice strain, dot distribution, vertical self-organisation and size/shape homogeneity will be investigated. These will all affect the optical properties of the dots, so combination with complementary PL studies would be advantageous. Enhanced vertical strain coupling is expected by increasing the number of bilayer periods, that is, the dots in the upper periods will be more uniformly-aligned due to the tendency to nucleate directly above the QDs in the underlying layer to minimize elastic strain in the AlN. Increasing the AlN barrier thickness is expected to encourage less vertical alignment of the QDs and less carrier confinement. Finally the improved ripening of the QDs is expected to give fewer dots which are larger, more evenly-distributed, and of a more uniform size and shape. It is likely that other defects will also be present in the layers, such as threading dislocations which will undoubtedly be generated at the lower GaN/AlN interface.

AlN/GaN variable superlattice: AlN/GaN superlattices have potential in strain management, dislocation reduction, *p*-contacts and also infrared intersubband detectors. Their fundamental properties can be determined by the crystal anisotropy and the strains present in the heterostructures. The sample studied consists of a series of strained AlN layers of different thicknesses: 2, 4, 6, 10, 20, 50 and 100 nm, separated by 150 nm GaN spacers. The lower epilayers of the structure with the AlN films of 2, 4, 6 and 10 nm are likely to be pseudomorphic and under high tensile strain. Above the critical layer thickness (around 10 nm) the AlN will begin to be subject to strain relaxation and misfit dislocations will be generated in these regions of the film. CTEM and HRTEM will be used to investigate the strain and the behaviour of dislocations in the structure; it is expected that dislocation density will rise in the upper regions of the film due to the generation of misfit dislocations in the thicker AlN epilayers. Movement and interactions between dislocations will be studied in detail.

InN structures: The quantum size effects in InN QDs may allow the extension of emission wavelengths into the near-IR region (especially at the important communication wavelength range of 1.3–1.55 μm), and perhaps visible red, an unreachable range for other III-nitrides. Due to the difficulty of growing InN (the low dissociation temperature and incorporation of impurities, especially oxygen), high quality InN QD growth has been rarely reported in literature. So far no TEM studies of InN QDs have been published. Low temperature MBE has been used in Crete to produce a series of samples, ranging from thick InN epitaxy on GaN to InN QD arrays on GaN. These are to be investigated by TEM, specifically the InN QD shape and size distribution, as currently only randomly-distributed QDs of varying sizes have been reported by other groups. It is expected that there will be a high threading dislocation density in all thick InN films due to the ~11% lattice mismatch with GaN, which are expected to be associated with interfacial misfit dislocations. The InN lattice parameters, measurable from diffraction patterns with reference to the thick underlying GaN layer, will be compared throughout the samples.