InGaAs Quantum dots with soft confinement potential for longer wavelength emission

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The use of nanostructures in the active regions of optoelectronic devices has already demonstrated to improve the previously predicted figures of merit of, for example, laser devices with quantum wells. Up to know it has been demonstrated the possibility of QD working devices at 1.3 micron. Going beyond that wavelength up to 1.55 micron in GaAs based materials is a very difficult task, although very interesting for its direct applications in telecommunications. For this purpose it is necessary to control the emission wavelength from InGaAs quantum dots (QDs) which is limited by both the In concentration (through the band gap blueshift at higher Ga concentrations) and the size of the dots (through electron confinement effects). Most groups have attempted to obtain pure InAs QDs with sharp interfaces with the GaAs matrix. This results in a hard confinement potential and consequently the wavelength is mostly limited by the quantum confinement effect. We are exploring an alternative strategy: growing larger InGaAs alloyed QDs, so that the emission wavelength is limited by the QD composition rather than by the quantum confinement effect. We use both conventional molecular beam epitaxy (MBE) and Atomic Layer MBE (ALMBE) to grow an InGaAs capping layer, the later having the advantage of allowing a wider range ($200<T<500$) of growth temperature, for modifying the relaxation critical thickness, In segregation and alloy intermixing during the capping process. There are mainly two advantages to our approach: less abrupt changes of lattice parameter, and more wavelength redshift per In content as the slope of the band gap vs lattice parameter curve decreases at high In concentrations. Photoluminescence at wavelengths beyond 1.3 microns at room temperature is demonstrated. This work has been supported by the European Commission Growth program NANOMAT project, contract no. G5RD-CT-2001-00545 and by Spanish MCYT under NANOSELF project TIC2002-04096-C03-03.