

Preface

This monograph is based on research into the structural, optical and spectral properties of InAs/(In)(Al)GaAs quantum dot (QD) heterostructures, grown by using molecular beam epitaxy (MBE) with an ultimate aim to fabricate high-performance quantum dot infrared photodetectors (QDIPs).

Since the introduction of intersubband photodetectors, much attention has focused on III–V semiconductor-based, MBE-grown quantum dot (QD) heterostructures for medium- and long-wavelength infrared-imaging technology. The three-dimensional carrier confinement possible with QDs is predicted to provide better performance than available from its quantum well counterpart. We optimized various MBE growth parameters using single-layer InAs/GaAs QDs and investigated their structural, optical and spectral properties. Then, we explored the effects of growth pause or ripening time on the properties of dots. The introduction of growth pause during the growth can extend the emission wavelength of the QDs. We have also examined the effects of post-growth rapid thermal annealing (RTA) treatment on properties of single-layer QDs. The next part of the work studied InAs/GaAs bilayer QD heterostructures with very thin (~ 7.5 – 8.5 nm) spacer layers. We have optimized minimum spacer thickness required to grow electronically coupled bilayer QD heterostructures. We have also established the superiority of bilayer QD heterostructures over the single-layer and uncoupled multilayer QD heterostructure in terms of optical and structural properties. We have examined the effects of RTA on bilayer QDs and found remarkable thermal stability of the same at high annealing temperature. Finally, we used sub-monolayer (SML) growth technique to grow QDs. This recent technique is expected to improve the electronics properties of the dots compared to those grown with the conventional Stranski–Krastanov (S-K) growth mode. After an initial study on material characterization, we established that SML QDIPs can be considered as a potential alternative to the conventional S-K QDIPs based on the comparison of the device performance.

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