ABSTRACT of the Ph. D. thesis

"Heteroepitaxial Growth of Indium Phosphide Quantum Dots on Silicon (100) by Metal Organic Chemical Vapour Deposition Technique for Optoelectronic Applications"

submitted by

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This work deals with the growth of indium phosphide (InP) quantum dots (QDs) on Silicon (100) substrates using metalorganic chemical vapor deposition technique with an aim to monolithically integrate III-V optoelectronics with Si microelectronics. A particular temperature window has been achieved to grow InP QDs with desired dimension and density. A blue shift of the emission peak has been found as a result of competitive effect of different physical processes like quantum confinement, strain, and surface states. Band alignment in the grown InP QDs/Si heterostructures has been determined theoretically to understand the origin of photoluminescence and carrier escape phenomenon. Photoluminescence due to free and bound excitonic recombination together with transition from the 1^{st} electron excited state in the conduction band (e_1) to the heavy hole band (hh_1) has been observed from the dot ensemble. Luminescence mechanisms have been explained on the basis of temperature dependent emission. X-ray photoemission spectroscopy has been used to determine the valence and conduction band offset. Effect of strain, surface energy, shift in the electrostatic dipole and charge transfer at the interface have been introduced to account for the mismatch between the experimental and theoretical values of the band offset in the nano-heterojunction. The transport properties of the charge carriers have been investigated with temperature dependent current voltage measurements. A strategic growth procedure has been developed to obtain alloy free interface on capping the QDs with gallium phosphide. Absorption is found to be dominating over scattering in the capped QD structures leading to higher photo generated current.

Keywords: Quantum dots, Confinement, Luminescence, Carrier relaxation, Carrier transport.