Figure Captions

Chapter 1

Fig.1.1 Lattice constants vs linear thermal expansion coefficients of Ⅳ, Ⅲ-Ⅴ and Ⅱ-Ⅵ.

Chapter 2

Fig.2.1 Samples structures (a) and sample structure (b). Their detailed growth conditions are described in context.

Fig.2.2 XTEM image of the $Si_{0.8}Ge_{0.2}$/Si epilayers. Dislocations distribute in the entire epitaxial layer.

Fig.2.3 XTEM image of the $Si_{0.76}Ge_{0.24}$/$Si_{0.8}Ge_{0.2}$/Si epilayers. Some dislocations were blocked by the interface, but some penetrated the interface.

Fig.2.4 XTEM image of the $Si_{0.7}Ge_{0.3}$/$Si_{0.8}Ge_{0.2}$/Si epilayers. Almost all the dislocations were blocked by the $Si_{0.7}Ge_{0.3}$/$Si_{0.8}Ge_{0.2}$ interface.

Fig.2.5 (a) XTEM image of the Ge/$Si_{0.08}Ge_{0.92}$/Si epilayers. Dislocations are blocked effectively by the Ge/$Si_{0.08}Ge_{0.92}$ interface.

Fig.2.5 (b) Double-crystal x-ray diffraction result for the Ge/$Si_{0.08}Ge_{0.92}$/Si sample.

Fig.2.6 Schematic of the mechanism of the reducing threading dislocations.

Fig.2.7 Cross-sectional TEM image of the epitaxial structure.

Fig.2.8 Plan-view TEM image of the top Ge layer.

Fig.2.9 AFM image of the surface of the top Ge layer.

Chapter 3

Fig.3.1 The AFM images of the surfaces of the (a) Ge/ $Si_{0.05}Ge_{0.95}$/ $Si_{0.1}Ge_{0.9}$ sample and (b) GaAs/ Ge/ $Si_{0.05}Ge_{0.95}$/ $Si_{0.1}Ge_{0.9}$ sample, respectively.

Fig.3.2 The 2.5 μm GaAs layer grown by MOCVD on the SiGe buffer structure.

Fig.3.3 (a) XRD spectram of GaAs grown on 6^{o} off-cut Si substrate utilizing the novel Ge/$Ge_{0.95}Si_{0.05}$/$Ge_{0.9}Si_{0.1}$ buffer layers

Fig.3.3 (b) Intensity and FWHM column graph of 6°, 4° and 0° off-cut samples.

Fig.3.4 (a) The photoluminescence spectra of GaAs/GaAs, 6°, 4° and 0° offcut samples.

Fig.3.4 (b) Intensity and FWHM column graph of GaAs/GaAs, 6°, 4° and 0° offcut samples.

Fig.3.5 The two possible sublattice locations of Ga and As atoms in GaAs grown on a Ge (100) substrate. Here domain GaAs-A, with its $[01\bar{1}]$ orientation perpendicular to the surface steps, corresponds to the case that the first atomic layer on the Ge surface is as, while GaAs-B, with its $[01\bar{1}]$ orientation parallel with the surface steps, represents the situation that the first atomic layer on the Ge surface is Ga, based on the double step model of the Ge (100) surface and the simple layer-by-layer growth mechanism.

Fig.3.6 (a) The XTEM image of the GaAs epilayers grown on 0° Si substrates utilizing the novel $Ge/Ge_{0.95}Si_{0.05}/Ge_{0.9}Si_{0.1}$ buffer layers.

Fig.3.6 (b) The XTEM image of the GaAs epilayers grown on 4° Si substrates utilizing the novel $Ge/Ge_{0.95}Si_{0.05}/Ge_{0.9}Si_{0.1}$ buffer layers.

Fig.3.6 (c) The XTEM image of the GaAs epilayers grown on 6° Si substrates utilizing the novel $Ge/Ge_{0.95}Si_{0.05}/Ge_{0.9}Si_{0.1}$ buffer layers.

Fig.3.7 (a) The SIMS profile of Ge, As and Ga in GaAs layer grown on 0° $Ge/Ge_{0.95}Si_{0.05}/Ge_{0.9}Si_{0.1}/Si$ substrates.

Fig.3.7 (b) The SIMS profile of Ge, As and Ga in GaAs layer grown on 4° $Ge/Ge_{0.95}Si_{0.05}/Ge_{0.9}Si_{0.1}/Si$ substrates.

Fig.3.7 (c) The SIMS profile of Ge, As and Ga in GaAs layer grown on 6° $Ge/Ge_{0.95}Si_{0.05}/Ge_{0.9}Si_{0.1}/Si$ substrates.

Chapter 4

Fig.4.1 SIMS profiles of Ge, Zn and Se in heteroepitaxial layers grown on (a) 0° and (b) 2° $Ge/Ge_{0.95}Si_{0.05}/Ge_{0.9}Si_{0.1}/Si$ substrates.

Fig.4.2 PL spectra of the 1.0-μm-thick ZnSe layer on (a) 2° and (b) 0° off-cut $Ge/Ge_{0.95}Si_{0.05}/Ge_{0.9}Si_{0.1}/Si$ substrates.

Fig.4.3 X-ray diffraction pattern of ZnSe on Ge/$Ge_{0.95}Si_{0.05}$/$Ge_{0.9}Si_{0.1}$/Si substrate.

Fig.4.4 (a) Cross-sectional high-resolution TEM image of ZnSe grown on Si.

Fig.4.4 (b) plan-view TEM image of ZnSe grown on Si.

Fig.4.5 PL spectra of (a) 0°, (b) 4° and (c) 6° off-cut sample with 300℃ initial MEE layers.

Fig.4.6 Schematic of the mechanism of the low temperature MEE and buffer layer growth with *in-situ* annealing method.

Fig.4.7 PL spectra of the 6°off-cut ZnSe samples grown by using (a) high temperature directly growth (b) only initial MEE growth and (c) initial MEE with low temperature buffer growth process.

Fig.4.8 PL spectra of (a) 6°off-cut ZnSe sample grown by using initial MEE with low temperature buffer and (b) directly grown ZnSe on GaAs sample.

Chapter 5

Fig.5.1 (a) XRD spectra of he $Ni_2(Si_{1-x}Ge_x)$ phase annealed at the temperature of 350℃ for 30 sec.

Fig.5.1 (b) XRD spectra of the Ni $(Si_{1-x}Ge_x)$ phase annealed at the temperature of 500℃ for 30 s.

Fig.5.1 (c) XRD spectra of the Ni $(Si_{1-x}Ge_x)_2$ phase annealed at the temperature of 750℃ for 30 s.

Fig.5.2 (a) AES depth profiles of the Ni/$Si_{0.8}Ge_{0.2}$ sample after annealing at 500 °C for 30 s.

Fig.5.2 (b) AES depth profiles of the Ni/$Si_{0.7}Ge_{0.3}$ sample after annealing at 500 °C for 30 s.

Fig.5.3 (a) Scanning electron microscopy micrographs of the surface morphology of the Ni/$Si_{0.8}Ge_{0.2}$ sample after annealing at 500 ℃ for 30 sec.

Fig.5.3 (b) Scanning electron microscopy micrographs of the surface morphology of the Ni/$Si_{0.7}Ge_{0.3}$ after annealing at 500 ℃ for 30 s.

Fig.5.4 (a) Cross-section TEM micrograph of the 500℃, 30s annealed P^+-$Si_{0.8}Ge_{0.2}$ sample.

Fig.5.4 (b) Cross-section TEM micrograph of 750℃, 30s annealed P^+-$Si_{0.7}Ge_{0.3}$ sample.

Fig.5.5 Sheet resistance comparison of the annealed Ni silicide and Ni germano-silicide for the Ni/PSi, Ni/$P^+Si_{0.8}Ge_{0.2}$ and Ni/$P^+Si_{0.7}Ge_{0.3}$ samples.

Fig.5.6 The contact resistance as a function of Ge mole fraction. Measured using TLM pattern.

Fig.5.7 Sheet resistance vs silicidation temperature for Ni/$Si_{0.8}Ge_{0.2}$ on various ion-implanted samples.

Fig.5.8 Surface morphology of the (a) As^+ and (b) P^+ implanted samples after annealing at 800℃ for 30s.

Fig.5.8 Surface morphology of the (c) B^+ and (d) BF_2^+ implanted samples after annealing at 800℃ for 30s.

Fig.5.9 Sheet resistances comparison of the annealed Ni silicide and Ni germano-silicide for P-Si, Si/P^+-$Si_{0.8}Ge_{0.2}$ and P^+-$Si_{0.8}Ge_{0.2}$ samples.

Fig.5.10 (a) SEM micrographs of the surface morphology of the Ni/Si/$Si_{0.8}Ge_{0.2}$ sample annealed at 500 ℃ for 30 sec.

Fig.5.10 (b) SEM micrographs of the surface morphology of the Ni/$Si_{0.8}Ge_{0.2}$ sample annealed at 500 ℃ for 30 sec.

Fig.5.10 (c) Cross-section TEM of Ni/Si/$Si_{0.8}Ge_{0.2}$ sample annealed at 500℃ for 30 sec.

Fig.5.10 (d) Cross-section TEM of Ni/$Si_{0.8}Ge_{0.2}$ sample annealed at 500℃ for 30 sec.

Fig.5.11 Sheet resistance as a function of Ge mole fraction for 25 nm Si capping layer and P^+-$Si_{1-x}Ge_x$ layer after annealing at 500℃ for 30 sec.

Fig.5.12 The forward and reverse characteristics for the Si/$Si_{0.8}Ge_{0.2}$, $Si_{0.8}Ge_{0.2}$, $Si_{0.7}Ge_{0.3}$ P^+-N junction.

Fig.5.13 XRD spectra of nickel germanosilicide films annealed at different temperature for 30 sec. XRD spectra of nickel silicide and germanosilicide films aged at 400℃ for 48 hours are also included for comparison.

Fig.5.14 (a) Plane-view HRTEM micrograph for the Ni/$Si_{0.8}Ge_{0.2}$ aged sample.

Fig.5.14 (b) shows the cross-section TEM/EDS analysis.

Fig.5.14 (c) shows the plane-view TEM image for the Ni/Si/$Si_{0.8}Ge_{0.2}$ aged sample.

Fig.5.14 (d) Less Ge segregation at the interface between Ni silicide and $Si_{0.8}Ge_{0.2}$ layer was detected from the analysis of cross-section TEM/EDS direct image and the chemical composition of nickel germanosilicide is Ni:Si:Ge=3:70:27.

Fig.5.15 Effect of the silicidation temperature on the contact resistivity of the nickel silicide (ρ_{Cns}) and the nickel germanosilicide contacts (ρ_{Cngs}) formed.

Fig.5.16 Thermal stability of the silicidation contacts after aged at 400℃ for various aging time.

Fig.5.17 Forward and reverse I-V characteristics of the nickel silicided $Si_{1-x}Ge_x$ diodes with two different structures (Si/P^+-$Si_{0.8}Ge_{0.2}$, P^+-$Si_{0.8}Ge_{0.2}$) after aging at 400℃ for 48 hours.