Abstract

Very exciting and promising results from the group-IV alloy layers (viz. SiGe, SiGeC, SiC, GeC and strained-Si on relaxed SiGe buffers) have opened up an entirely new dimension in VLSI/ULSI Si technology. Strained $Si_{1-x}Ge_x$ and strained-Si offer many desirable electronic and optical properties due to favorable band alignment and strain-induced modification of band structure, effective mass and optical transitions. For strained $Si_{1-x}Ge_x$, most of the advantages are encountered in hole transport and the band discontinuity is obtained mostly in the valence band. Tensilely strained-Si films exhibit both the hole and electron mobility enhancement, making them useful for n- and p-type MOSFETs. Growth of gate quality ultrathin oxide/oxynitride films is a key technology issue in device scaling efforts since they form the 'heart' of n- and p-channel MOSFETs in CMOS technology and largely determine the transistor's performance. Low-thermal budget growth/deposition of ultrathin dielectrics on SiGe layers are attractive for device applications since strained SiGe are metastable in nature. The present research study is concerned with the investigation on $Si_{1-x}Ge_x$ and strained-Si heterolayers for high performance p- and n-MOSFETs applications. The following studies have been carried out in detail:

- Heterostructure $Si_{1-x}Ge_x$ and strained-Si layers have been grown using GSMBE and UHVCVD. Microstructural characterization of the films have been performed using DCXRD, RBS, and AFM techniques.

- Electrical characterization and annealing effect on low temperature deposited ultrathin oxide/oxynitride on strained Si/SiGe substrate using TEOS, NO and O_2 as a precursor by plasma enhanced chemical vapor deposition (PECVD) have been studied.

- Nitrogen incorporated ultrathin oxide/oxynitride films grown using rapid thermal oxidation on strained Si/SiGe substrate exhibit improved electrical, interfacial, charge trapping and reliability properties. Nitrogen profiling and chemical analysis of oxide/oxynitride films have been done using XPS, ToFSIMS, DCXRD, high-resolution cross-section TEM and FTIR.

- To extract the device parameters such as transconductance, subthreshold swing, threshold voltage, source/drain resistance, and field mobilities, several strained Si-MOSFETs have been characterized. Design and simulation of strained-Si channel MOSFETs and advanced SOI MOSFETs with strained-Si channel on SiGe-on-insulator have been performed.

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