ABSTRACT

Key words: *Polysilicon, Silicon-Germanium, $Si_{1-x}Ge_x$, $Si_{1-x-y}Ge_xC_y$, Ion Beam Sputtering, Single Ion Beam (SIB) Deposition, Dual Ion Beam (DIB) Deposition, R.M.S. Roughness, Thermal Oxidation, Plasma Oxidation, Polyoxide, MOS Capacitors, Strained Layer, Ion-Assisted Oxidation, Fixed Oxide Charge Density, Interface Charge Density, Charge to Breakdown, Nanocrystals.*

Polycrystalline silicon and silicon-germanium films are useful for various applications in advanced VLSI/ULSI technology. This thesis deals with the characterization of ion beam sputter-deposited poly-Si and poly-SiGe films and also with the low temperature oxidation of poly-Si and strained SiGe and SiGeC films.

Dual ion beam (DIB) sputter deposition technique, with concurrent ion bombardment on the film surface, has been employed for the deposition of poly-Si and poly-SiGe films suitable for microelectronic applications (Chapter-2). Poly-Si films of average grain size 320Å to 380Å with principal growth textures along <111>, <220> and <311> have been obtained. A uniform Ge concentration of about 8% is found in poly-SiGe films of average grain size 220Å to 270Å. Relatively smooth polysilicon surface with a minimum r.m.s. roughness of 0.19 nm is observed for the film deposited with the secondary ion beam energy of 25 eV. DIB deposited poly-SiGe films are found to be smoother than SIB deposited films.

The electrical properties of the as-deposited and annealed poly-Si and poly-SiGe films have been investigated (Chapter-3). The increase of secondary ion beam energy from 25 eV to 30 eV results in a sharp decrease of resistivity for as-deposited poly-Si and an increase of Hall mobility for annealed poly-Si films. Unlike poly-Si, Hall mobility is quite low in case of poly-SiGe, which may be

due to the higher carrier concentration in the latter as a result of enhanced dopant activation.

The transport properties of the poly-Si films have also been investigated in the low temperature region up to 50K. The experimental temperature variation of resistivity agrees well with the theoretical calculations based on the existing carrier trapping model.

An experimental study has been carried out (Chapter-4) on the growth of polyoxide on LPCVD grown polysilicon film by using conventional thermal oxidation as well as low temperature plasma oxidation. The current density (J) vs. electric field (E) measurements have been performed on the MOS capacitors of these oxide, and it is found that the carrier injection is more in the accumulation mode than in the depletion mode for thermally grown polyoxide. But in the case of plasma grown polyoxide, the current is higher in the depletion mode bias. Considerable amount of electron trapping is observed in the plasma grown boron-doped polyoxide. The charge-to-breakdown values (Q_{bd}) determined from the constant current stressing technique are 40 C/cm^2 for 200Å thermal polyoxide, and 2.5 C/cm^2 for plasma polyoxide.

A study of ion-assisted processing for the formation of gate oxides and nanocrystallites of silicon alloy films has also been undertaken (Chapter-5). A low energy Ar ion beam was used to excite the oxygen molecules sprayed over the strained layers. The substrate temperature was kept at 150^{0}C. The characteristics of $Si_{1-x-y}Ge_xC_y$ MOS capacitor structure has been compared with that of $Si_{1-x}Ge_x$. It is observed that the addition of 0.5% carbon lowers both the fixed oxide charge density (Q_{fb}) and interface state density (D_{it}). The constant current stressing indicates that hole trap density reduces either with the reduction of Ge content or with the increase of C fraction in the layer.

Finally, an effort has been made in the present study to test the efficacy of the ion-assisted processing for the formation of group-IV nanocrystals. A preliminary study on the formation of Ge nanocrystals embedded in SiO_2 matrix by ion-assisted deposition has been presented.