The continuous scaling of Si devices has guided the microelectronics into the era of nanoelectronics when the components are with nanoscale dimensions. While manufacture aspects dominated the problems of scaling in the past, one now faces the first fundamental physical limitations as structures approach atomic dimensions. SiO$_2$ is most commonly used gate dielectric in electronic devices like DRAMs. Miniaturization of devices can be accomplished by reducing the thickness of the dielectric. When the thickness of SiO$_2$ is reduced below 2nm, there is adverse increase of leakage current due to quantum tunneling of electrons through SiO$_2$ layer and the device will malfunction. The leakage current increases exponentially with decrease in thickness of the dielectric. Therefore only alternative is to replace SiO$_2$ layer with any other high dielectric oxides like TiO$_2$, SrTiO$_3$, BaTiO$_3$. The thickness of SiO$_2$ used now is about and below 1.4 nm. The most effective approach to overcome the fundamental limits for SiO$_2$-device scaling is the use of new, alternative dielectrics with high dielectric constant $k$. With high-$k$ dielectrics the desired equivalent oxide thickness (EOT) can be achieved concurrently with a reduced current by increasing the physical thickness.

The objective of this thesis work is to study the electronic structure of high dielectric oxides like TiO$_2$, SrTiO$_3$ and BaTiO$_3$ etc. deposited on Si(111) surface. When oxides are deposited on Si there may be possibility of interactions like metal-oxygen, metal-silicon, silicon-oxygen and metal-silicon-oxygen. All these interactions influence the physical and chemical properties that are important for technological applications. Therefore, investigation of these interaction strengths is a major concern for device fabrication. In this work three samples TiO$_2$, SrTiO$_3$ and BaTiO$_3$ have been synthesized. Bulk SrTiO$_3$ and BaTiO$_3$ were prepared by solid state reaction technique. TiO$_2$, SrTiO$_3$ and BaTiO$_3$ thin films on Si(111) surface were deposited by pulsed laser deposition technique. Both bulk and thin film samples have been investigated using X-ray Diffraction (XRD), Raman spectroscopy, X-ray Photoelectron spectroscopy (XPS) and Atomic Force Microscopy techniques. Both XRD and Raman data suggests the deposited TiO$_2$ is in anatase phase. The binding energy peak position of Ti 2p also supports the formation of anatase phase. The AFM topography of as deposited film indicates the formation of non uniform TiO$_2$ growth with the formation of voids on Si(111) substrate which disappeared after sputtering with
argon ion beam due to surface erosion. The Ti 2p core level of sputtered TiO$_2$ exhibits the formation of Ti$_2$O$_3$, TiO and pure Ti on the surface. After sputtering the high binding energy shoulder of O1s peak becomes sharp. Ti LMM Auger peaks become broader but no shift in kinetic energy is observed. The XRD pattern of SrTiO$_3$ and BaTiO$_3$ were indexed assuming a cubic structure with lattice parameter of 3.905Å and 3.992Å respectively. The binding energy positions of Sr 3d, Ba 3d and Ti 2p core levels observed in XPS studies indicated that Sr and Ba exist in 2$^+$ valence state while Ti exists in 4$^+$ valence state respectively. Sr 3d core level could not be resolved in to spin orbit doublets due to extra broadening occurring from oxygen defects present in the sample. An unusually broad O1s spectra for SrTiO$_3$ was also observed indicating large amount of adsorb oxygen at the grain boundaries. XPS results indicated a shift of the core levels of BaTiO$_3$/Si(111) to high binding energy by about 0.5 eV compared to the core levels of bulk BaTiO$_3$. Also the core level of the thin film are sharper compared to the core levels of bulk sample indicating more oxygen vacancies in bulk BaTiO$_3$ compared to thin film BaTiO$_3$. The AFM topography of both SrTiO$_3$ and BaTiO$_3$ on Si(111) surface indicate the formation of nano particles.