<u>Design and development of Multilayer mirrors for astronomical applications</u>

The recent progress in the development of multilayer mirrors has revolutionized the field of astronomical X-rays optics. A variety of multilayer mirrors are now being developed for several unique applications such as hard X-ray imaging telescopes and soft X-ray polarimeters. Technology development to fabricate good-quality multilayer mirrors carries significant importance for the realization of next-generation X-ray instruments. In this thesis, we have presented our progress in fabricating and characterizing high-quality W/B4C multilayer mirrors for various applications. We have also discussed the design and development of two X-ray instruments using the combination of grazing incidence X-ray concentrator and multilayer mirrors. We fabricated W/B4C multilayer mirrors with varied design parameters using a magnetron sputtering technique. We studied the performance and structural stability of these mirrors over time and by subjecting these mirror to the temperature variation analogous to the satellite in low earth orbit using soft X-ray, hard X-ray reflectivity as well as scanning electron microscopic studies for estimating the contamination and surface quality. We observed that multilayers with small thickness are more stable than the large thickness multilayers. We designed a multilayer mirror-based soft X-ray polarimeter to operate at energies less than 1 keV. We proposed this design coupled with a hard X-ray polarimeter as a simultaneous back- end instrument to a hard X-ray telescope. For this application, to make multilayer mirrors transparent to hard X rays, we etched the Silicon substrate of the mirrors to reduce the absorption. We observed that the etching process significantly degraded the performance of large thickness multilayers (~ 5 nm) while the process did not affect the performance of short thickness multilayers (~ 3 nm).