Chapter 6

Conclusion and future scope

6.1 Conclusion

Present thesis deals with the stability of x-ray multilayer mirror. A detailed study of thermal annealing of W/Si multilayer mirror yields the activation energy and the pre-exponential factor for the interdiffusion. This information can be used to estimate long term thermal stability of the multilayer at any given temperature. Some important information about the mechanism of interdiffusion has also been obtained. Diffusion mechanism in W/Si multilayer is similar to that in amorphous alloy were diffusion jumps involved collective motion of atoms. It is also found that strain generated due to unequal thermal expansion of the substrate and different constituent layers of the mirror is the main cause of interdiffusion and hence deterioration in the properties of the mirror.

The role of B₄C as a diffusion barrier in order to improve the thermal stability of W/Si multilayer has also been studied. Interfaces between B₄C and Si have been studied using neutron reflectivity. Excellent improvement in the stability in terms of both peak position as well as peak reflectivity has been obtained. It is found that inhibition of diffusion at W/B₄C interfaces is the main cause for increased thermal stability.

A controlled modification of the interfaces in W/Si mirror has been archive using irradiation with swift heavy ions. Such a controlled modification of the interfaces may be needed for designing multilayer mirror for use as monochromators with reduced higher harmonics contain. This study also
provided interesting information about the mechanism of swift heavy ion induced intermixing in system with positive heat of mixing.

It is demonstrated for the first time that tensile stress present in the film may have significant influence on swift heavy ion induced intermixing.

6.2 Future scope

The field of x-ray multilayer mirror is an active field and long term stability of multilayer mirrors is an important issue. There is a lot of scope for further studies in this field.

Our in-situ study during thermal annealing strongly suggest that stresses generated in the film as a result of unequal thermal expression may be one of the main reasons for the deterioration in the quality of interfaces. It will be interesting to verify this conjecture by doing in-situ stress measurement. Measurement of curvature of the surface of the mirror using laser beam is a convenient method for getting information about stresses in the film. Such experiments are planned by us in near future. Possible creation of point defects as a result of stresses should also be studied using technique like resistivity or positron life time measurement.

We have been able to throw some light on the role of B₄C in inhibiting the interdiffusion and hence deterioration in the peak reflectivity. However inter layer of B₄C also results in an improvement in the stability of the position of the Bragg peak. The cause for the same is still not cleared and needs further experimentation.

Effect of stresses on swift heavy ion induced intermixing as seen by us is a new result. More studies are planned in future to study this aspect by fabricating multilayers with controlled internal stresses.