These measurements helped in qualifying the deposition process as well as in testing the stability of surface quality after various test cycles as mentioned above. Reflectivity measurements at different wavelengths helped to assess the performance of the mirrors in the operating range of the telescope. Roughness values of all the good mirrors were in the range of 9-15 Å as measured with Cu K_α, and 5-12Å by Cr K_α radiation. The density of the gold film was found to be equal to the bulk value, as desired.

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A.6: Effect of Si layer thickness on structural properties of Co/Si multilayer system

Co/Si is a metal/semiconductor multilayer (ML) system that shows an oscillatory magnetic behavior between different Co layers as a function of Si layer thickness (<17Å). This type of coupling is well established and understood in the case of metal/metal multilayers. However, the picture is not clear for insulating or semiconducting spacer layer. There is a finite possibility that the origin of the interesting magnetic behavior in Co/Si system, might be related to the formation of cobalt silicide layer at the interface. For this reason, Synchrotron Utilization and Material Research Division of RRCAT has undertaken the present investigation and has prepared Co/Si MLs of varying thickness [Co (~ 45-80Å) and Si (~20-75Å)] to study the interlayer coupling in this system. X-Ray Reflectivity (XRR), X-Ray Diffraction (XRD), and Magneto Optical Kerr Effect (MOKE) measurements have been performed on these MLs.

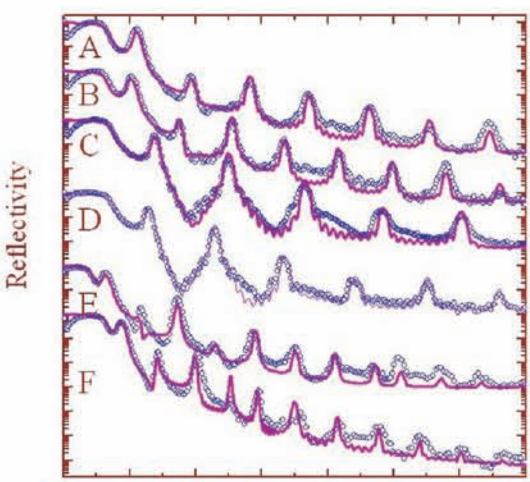

Fig.A.6.1 : XRR pattern of Co/Si MLs. Circles are experimental data and continuous lines show the fitting.

The XRR patterns, as shown in Fig.A.6.1, show well defined Bragg peaks upto 8^{th} order, arising due to ML periodicity. Fitting was done using Parratt recursion formalism. It was found that the fitting is quite good when no silicide layer formation at the interface is considered. This suggests that in these Co/Si MLs, if silicide layer is present, its thickness or the volume fraction is so low (<10Å) that it could not be detected distinctly as a layer.

In the wide angle XRD, as shown in Fig.A.6.2, it is found that the samples with low Si (<50 Å) show a well-defined peak corresponding to the (002) hcp planes of Co. However, for samples with Si layer thickness (>50Å), instead of one peak there are three different peaks, identified as reflections from the hcp (100), (002) and (101) planes, as shown in Fig.A.6.2. This indicates that the films, which were otherwise strongly textured for low thickness of Si, lose their texture for higher thickness of Si (~56Å) layers.

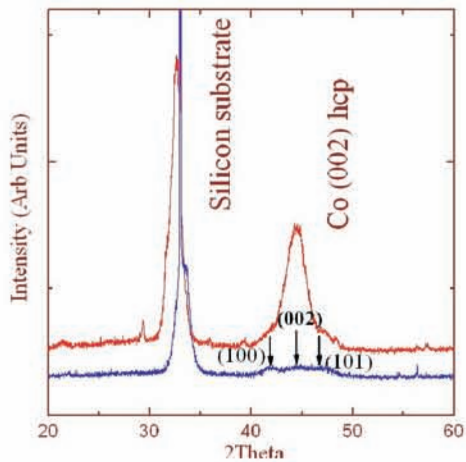

Fig.A.6.2: XRD pattern of the MLs; Red for the ML containing Si layer thickness <50Å, Blue for Si layer thickness > 50Å

MOKE measurements at ambient temperature show no oscillatory behavior as a function of Si layer thickness. For samples, which are not textured, large value of coercivity is observed. Loss of texture suggests that cobalt layer has become polycrystalline. Response of each grain towards the applied magnetic field will be different and hence the coercivity is large for these samples. These studies suggest that it is the texture of the Co layer, which depends on the thickness of the Si layer that affects the magnetic properties of Co/Si system. Since silicide layer is not visible distinctly at the interface, its possible effect on the magnetic behavior of the system is not clear. Structural, and in turn magnetic properties of Co/Si ML system, are highly governed by thickness of the Si layer and not by silicide layer *[A. Jaiswal et al., J. Phys.: Condens. Matter, 016001 (2007)].*

Here the oscillatory coupling between the Co layers could not be observed. This might be due to the reason that the thickness of the samples in the present study is large as compared to the thickness as reported for the oscillatory behavior to be observed. Thus, for the future studies, this work will be continued with the samples of Co/Si MLs, which have smaller thickness of Co as well as Si.

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A.7 : Indigenous development of turbo molecular pumps

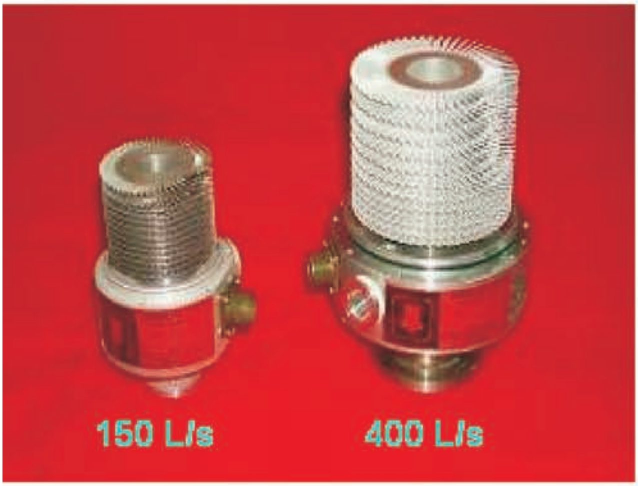

Fig..A.7.1: Assembly of turbomolecular pumps

Indigenous development of two sizes of Turbo Molecular Pumps (TMP) having pumping speed capacities of 150 lit/sec and 400 lit/sec, is going on at the Proton Linac and Vacuum Technology Laboratory of RRCAT (see Fig.A.7.1). Efforts have been made to study the useful life of bearings in the indigenously made TMPs. Few pumps have been assembled with the high precision deep groove ceramic ball bearings. Dynamic balancing of the individual rotating components of TMP was carried out on a hard pedestal balancing machine. Gross unbalance correction due to machining of parts and assembly errors were carried out at low speed (1500 rpm). The balancing of TMP rotor on its motor was performed on a soft pedestal balancing machine up to the operating speed of 48,000 rpm. A software using LabView has been developed for the mass correction on the TMP rotor using soft pedestal balancing machine. The program displays online status of unbalance value in a graphical format in terms of magnitude and direction. The software also helps in comparing the mass correction with respect to the resultant unbalance. Fig.A.7.2 shows the display window of the program developed. This programming has helped in reducing the number of trials required for balancing a TMP rotor assembly. The balanced rotor was assembled. The TMP assembly with stators and stator rings was then subjected to a continuous run for performance evaluation of the TMP and bearing life. Various operating parameters like bearing temperature, bearing shocks, vibration velocity, acceleration, vacuum etc. were recorded during the continuous run test.

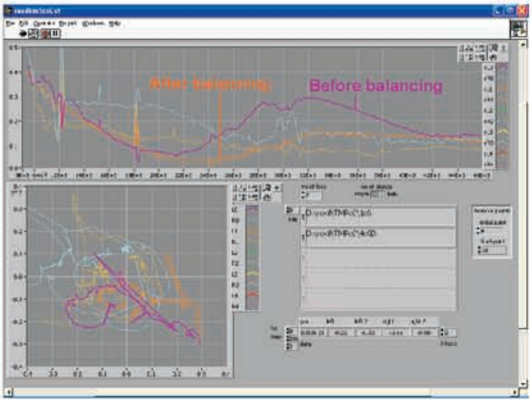

Fig.A.7.2: TMP unbalance spectrum

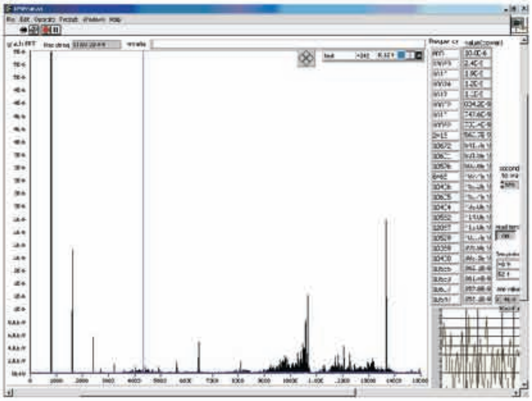

Fig.A..7.3 : FFT of an acceleration signal of an operating TMP

A program was also developed for conditioning monitoring of high-speed bearings. The signal received from an accelerometer was processed to generate a FFT of the vibration signal of a pump, as shown in Fig.A.7.3. Even after a continuous operation of more than 1000 hours, no noticeable deterioration in performance was observed. Two TMPs of 150 lit/sec and one of 400 lit/sec capacity have been operated for ~1000 hrs. One of the smaller capacity TMPs has been given to VPID, BARC Mumbai for field trials and evaluation.

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