A.1: Operational improvements in Indus-2

Synchrotron radiation source Indus-2 is regularly being operated with 100 mA beam current at 2 GeV beam energy in round the clock mode. The exercise of orbit correction was pursued further to reduce closed orbit distortion (COD). It is necessary to correct the COD, when a large number of beamlines are to be simultaneously operated. In order to improve the sensitivities of beam position indicators (BPIs), old cables connecting the BPIs to their respective instrument racks were replaced with low-loss cables. With this, 51 BPIs are now available for COD measurements. Using these BPIs and steering magnets well distributed all over the circumference, orbit correction trials were made.

The BPIs and steering magnets available in one unit cell of Indus-2 for COD correction are shown in Fig. A.1.1. It has seven BPIs, six horizontal steering magnets and five vertical steering magnets. With 8 numbers of such unit cells in Indus-2, there are 48 horizontal steering magnets, 40 vertical steering magnets and 56 BPIs distributed all over the ring. Out of 56 BPIs, 51 of them were used in orbit correction trials as the remaining five are not yet fully operational. During the horizontal COD correction, RF frequency was also optimized.

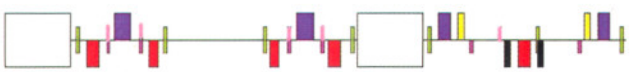

Fig.A.1.1: One unit cell of Indus-2 : empty rectangles - dipoles; blue-focussing quadrupoles; red- defocussing quadrupoles; yellow-focussing sextupoles; black-defocussing sextupoles; green- BPIs ; magenta- horizontal steering magnets and pink- vertical steering magnets.

An interactive global COD correction software has been developed in MATLAB. It requires the beam position data and response matrix of the Indus-2 for calculations of required optimal steering magnet strengths for COD correction. It generates the Indus-2 response matrix in horizontal and vertical planes. A singular value decomposition method has been used for the COD correction. Using this software, the rms COD in horizontal plane was brought down from 4.6 mm to 1.1 mm at injection energy (550 MeV) and from 4.5 mm to 0.9 mm at 2 GeV. Similarly, in vertical plane, the rms COD was reduced from 1.7 mm to 0.5 mm at injection energy and from 2.8 mm to 0.5 mm at 2 GeV. For this, 48 horizontal and 40 vertical steering magnets were used. The beam position data obtained from 51 BPIs were considered. The horizontal COD was further reduced to 0.9 mm at the injection energy and 0.6 mm at 2 GeV beam energy on reducing the RF frequency by 5 kHz. The horizontal COD before and after correction at the BPI locations at 2 GeV is shown in Fig. A.1.2. In vertical plane, the COD before and after correction are shown in Fig. A.1.3. With this corrected orbit, photon beam was provided to BL-7(X-ray lithography), BL-8(EXAFS), BL-11(EDXRD), BL-12(ADXRD), BL-14(XPES) and BL-16 (XRF- microprobe) beamlines.

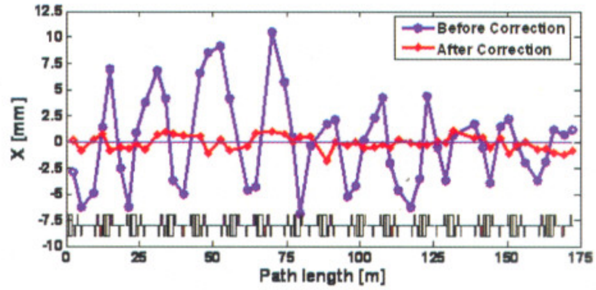

Fig.A.1.2: The horizontal COD before and after correction at 2 GeV.

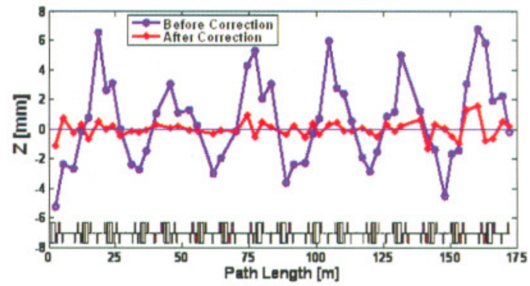

Fig. A.1.3: The vertical COD before and after correction at 2 GeV.

With COD correction and some improvement in the vacuum, the beam lifetime at 2 GeV, 100 mA has improved to 14 hours.

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A.2: Study of soft x-ray optical response of Indium Phosphide using Indus-1 Reflectivity Beamline

The response of a given material to an incident electromagnetic wave in extreme ultraviolet (EUV)/soft x-ray region is described by the energy-dependent refractive index $n=1-\delta+i\beta$, where δ (dispersion) and β (absorption) are known as optical constants. Knowledge of these two parameters is essential to predict the response of medium to an electromagnetic wave as well as interpretation of experimental results. Various techniques can be used to determine the δ and β, such as transmission, photoemission and angle dependent reflection etc.

Angle dependent reflectivity technique provides information of optical constants. This method has an advantage over transmission measurements that both δ and β can be deduced experimentally and measurements are carried out on bulk samples. The drawbacks of this method include its sensitivity to surface contamination and roughness.

InP is an important III-V semiconductor for both semiconductor and photo electronics. This material is used as a substrate for epitaxial indium gallium arsenide based opto-electronic devices. InP is an important material for making x-ray semiconductor detectors. Detectors made with these materials are being used in soft x-ray applications. However, to the best of our knowledge no experimentally measured optical constants of InP are available in the soft x-ray region. In the present study, InP wafer is used to determine optical constants using angle dependent reflectance experiments in the 50-200 Å wavelengths region. Measured data are compared with tabulated values from Henke et al. Reflectance measurements are performed on Indus-1 synchrotron source using soft x-ray reflectivity beam line.

Figure A.2.1 shows the experimental value of InP optical constants derived from angle dependent reflectivity measurements. The derived δ and β vales are in good agreement with the tabulated values below the Phosphorous L edge with a slight variation of 10%. At higher wavelengths, near Indium N_2 edge of 160.7 Å the derived δ's deviate

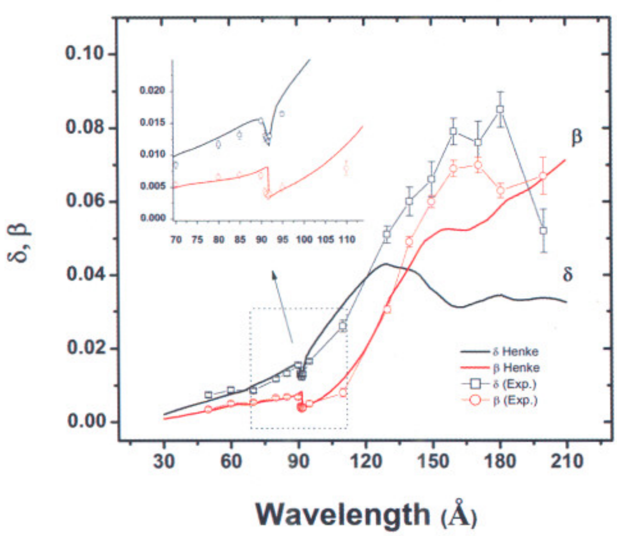

Fig.A.2.1: Measured values of InP optical constants are shown as discrete points along with the error bars. For the comparison, Henke's data are shown by continuous lines. In the inset, optical constant near phosphorous L edge is shown where measured data are in close agreement with Henke's values. Near Indium N_2 edge of 160.7Å, a huge discrepancy between experimental and tabulated values is found.

abruptly from the tabulated values. An edge shift of 0.4 Å towards lower wavelength side from the Phosphorous L edge of 92 Å is observed. Such edge shift is earlier reported in boron carbide compound materials and the reason was attributed to variation in chemical stochiometry.

The measured β's are in good agreement with tabulated values below the phosphorus L edge with a maximum deviation of 13%. In the vicinity of the edge the β's are 50% lower than the tabulated values. Above 120 Å wavelength region the β values are 30% higher than the tabulated values. Large discrepancy between measured and tabulated values of δ and β is found near N_2 edge region of Indium (160.7 Å). In this region, measured ratio of β / δ is found to be less than one in contrary to tabulated ratio whose value is more than one. For more details please see Applied Optics 49 (2010) 5381.

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A.3: Qualitative Estimation of Thin Film Composition by Soft X-ray Reflectivity Analysis

Soft x-ray reflectivity (SXR) has been previously recognized for the characterization of different thin films and multilayer structures. However, optical index profile derived over extended wavelength region of soft x-ray regime has not been utilized to obtain compositional details. In recent years, Si-rich a-SiN_x:H (SRSN) thin films have gained considerable attention due to their potential applications in optoelectronic devices, photonics and third generation solar cells. Considering SRSN film as particular example, in the present work, we demonstrate that soft x-ray reflectivity near the Si $L_{2,3}$ edge can be used to analyze compositional details of the thin film.

The SRSN thin film was deposited using Hg-sensitzied photo chemcial vapour deposition (Photo-CVD) on n-type Si (100) substrate. SiH_4 (4% in Argon) and NH_3 were used as the reactant gas sources. The substrate temperature and deposition pressure were fixed at 200°C and 0.8 Torr respectively. X-ray photoelectron spectroscopy (XPS) measurements using a Mg K_α (1253.6 eV) were carried out to analyze bonding environment. Angle-dependent soft x-ray reflectivity (SXR) measurements near Si $L_{2,3}$ absorption edge were carried out using soft x-ray reflectivity beam-line on Indus-1 synchrotron facility. Reflectivity (θ-2θ) scan with an angular resolution < 0.01° were performed from 0-50° in the s-polarized geometry.

Soft X-ray reflectivity curves, both experimental (open circles) and fitted (solid lines) of SRSN film at selected wavelengths near Si $L_{2,3}$ absorption edge are shown in Fig.