ESRF	**Experiment title:** **Experimental studies of an x-ray standing wave between long-distance separated crystals**	**Experiment number:** HS-432
Beamline: BM5	**Date of experiment:** from: 5/11/97 to: 9/11/97	**Date of report:** 20/11/97
Shifts: 12	**Local contact(s):** Dr Alexei Souvorov	*Received at ESRF:*

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Report:

The aim of the experiment was to observe a 90 degree Bragg reflection. The x-ray radiation energies were selected to allow Si(800) and Si(555) 90 degree reflections from crystal samples. The samples were mounted on the third axis of the triple-crystal diffractometer arrangement at the beamline BM5 (BL-10) at the European Synchrotron Radiation Facility (ESRF), Grenoble, France.

Since the 90 degree reflection profiles exhibited an extremely high sensitivity to the radiation energy, a two-monochromator arrangement was implemented to create an ultra-highly monochromatic parallel x-ray beam to be incident on the crystal-sample. The arrangement consisted of a primary Si(111) double crystal followed by a single reflection Si(400) crystal monochromators. As a result, the beam incident on the crystal sample possessed very narrow energy spread in the vertical and horizontal diffraction planes.

The 90 degree Bragg reflection intensity profiles were measured as a function of the angular position of the crystal sample using a scintillator detector coupled to a thin in-beam scattering foil. The NaI scintillation detector collected diffuse scattering produced by the incident and back-scattered beams propagating through either a 20 μm micron thick polycrystalline aluminium foil or 130 μm thick amorphous KAPTON foil. Careful measurements showed that valid data could be collected using either foil.

Angular scans of the crystal sample performed about the surface normal in the horizontal and vertical directions displayed an extremely high sensitivity to the energy of the radiation in the vicinity of the 90 degree Bragg reflection. These results suggest that a new experimental technique for the direct mapping of three-dimensional crystal lattice strains in the near-surface region may be feasible using a modified and enhanced quantitative method of x-ray phase retrieval (e.g. [l]). Future research will be concerned with the development of this technique. This new approach to strain mapping will extend the previously developed 1D and 2D techniques (e.g. [l-2]) to the 3D mapping of internal strain but with dramatic improvement in sensitivity. The new technique is sensitive to strains of $\Delta d / d = 10^{-5} - 10^{-6}$ compared to $\Delta d / d = 10^{-3} - 10^{-4}$ obtainable by most other x-ray diffraction methods.

Intensity profiles obtained when using the Si(555) reflection contained an unexpected modulation which is suggestive of interference fringes. The intensity modulation behaviour is not predicted by the existing theory for a 90 degree Bragg reflection. The occurrence of artefacts due to imperfections in the particular crystal sample or to a particular azimuthal orientation of the crystal surface was eliminated by repeated data collection for different crystal samples and rotation of the crystal around its surface normal. The origin of the intensity profile modulations, possibly interference effects, has not been established. These original results warrant further detailed investigations of the intensity modulation phenomenon in the vicinity of the 90 degree Bragg reflection.

[l] Nikulin et al., J. Appl. Phys. 80, 6683, 1996.

[2] Nikulin et al., J. Appl. Cryst. 28, 803, 1995.