ESRF	**Experiment title:** Investigation of the phason and phonon components for defects in icosahedral quasicrystals by combined synchrotron X-ray topography and phase radiography	**Experiment number:** HS246
Beamline: ID19	**Date of experiment:** 2nd six month period 1998	**Date of report:** *25/02/98*
Shifts:	**Local contact(s):** Lucia MANCINI	*Received at ESRF:* 02 MAR. 1998

Names and affiliations of applicants (* indicates experimentalists):
GASTALDI J. *, REINIER E. *(CRMC2 - CNRS, Marseille)
BARUCHEL J.*, CLOETENS P.*, HARTWIG J.*, MANCINI L.* (ESRF, Grenoble)
SCHLENKER M (CNRS, Grenoble)

Report:

The allocated beam time was used, as part of the study of defects in real quasicrystals (QC) we are carrying out, to the identification of the strain field of the Loop Shaped Defects (LSDs) we observed previously by conventional and Synchrotron white beam X-ray topography (at LURE), both in AlCuFe and AlPdMn grains [1,2]. Two PhD thesis [3,4] have been prepared with the results obtained from the beginning of this study (1996). On end, a list of abstracts of the papers (in press or published) relative to the experiments performed at the ESRF in 1997, by using the allocated beam time, is reported. References are listed at the end of this report.

[5]: Identification of loop shaped defects in as grown and annealed single quasicrystals

Soon after their discovery, quasicrystals were found to contain structure defects such as phasons and dislocations. More recently, X-Ray topography allowed us to evidence in Al-Pd-Mn and Al-Cu-Fe icosahedral grains the presence of peculiar defects having the shape of loops. The present paper is aimed at attempting to identify these Loop Shaped Defects by complementing X-Ray Topography with observations and chemical analyses performed in Transmission Electron Microscopy.

[6]: Investigation of structural defects and inhomogeneities in Al-Pd-Mn icosahedral quasicrystals ~ by combined synchrotron X-ray topography and phase radiography

Phase-sensitive radiography, made possible by the lateral coherence of the beams from third-generation synchrotron-radiation sources, has been combined with monochromatic X-ray topography in an investigation of structural defects and inhomogeneities in the bulk of Al-Pd-Mn icosahedral single quasicrystal grains. Loop-shaped defects previously observed by X-ray topography are thus related with holes and second phase precipitates revealed by phase radiography. The evolution of these defects after annealing provides clues on their nature and formation.

[7]: Complementary observations of defects in quasicrystals by X-ray topography and electron microscopy

Further information on defects previously [l] observed by X-ray topography in quasicrystalline grains, and that show a loop shaped contrast, was obtained by combining this technique with electron microscopic observations and chemical analyses. The experiments, carried out either at room temperature or during *in situ* and real time high temperature annealing, allowed to get clues on the relationships between these loop shaped defects, the growth process of the quasicrystal grains and the defect behaviour under the annealing treatment.

[8]: X-ray optics and imaging with hard coherent synchrotron radiation

Results obtained on the ID 19 beamline at ESRF, where particularly high coherence is associated with the long source to sample distance (145 m) and the small source size of the X-ray source (= 0.1 mm), illustrate the possibilities of imaging using coherence. These features make the imaging of phase objects extremely simple, since a propagation technique, similar to the defocusing mode of electron microscopy and to in-line Gabor holography in optics, can be used. The physical principle involved is Fresnel diffraction.

We used this *propagation* technique both to measure, via the figures obtained from a fiber and a periodic grating, the source size, and to image objects with negligible absorption for hard X-rays but appreciable variations in optical path length.

Example of the latter are two ot three-dimensional (tomographic) images of light natural or artificial materials (polymers, wood, crystals, alloys, composites or ceramics with inclusions , holes, cracks,...). The three-dimensional reconstruction can be performed eithr with a filtered back-projection algorithm designed for attenuation tomography, which was shown to be a good approximation in some cases, or with a phase reconstruction procedure similar to that used for electron microscopy. The spurious images associated with beamline components, and the conditions for coherence preservation are also briefly discussed.

[9]: Combining diffraction topography and phase imaging for materials science investigations

The deliberate combination of phase and Bragg-diffraction imaging has recently led to important results, giving a new impulse to the use of these techniques. The experiments are being carried out on several beamlines: BM5, ID1 1, ID19 and ID22.

REFERENCES:

[l] Gastaldi J., Reinier E., Jourdan C., Grange G., Quivy A., Boudard M.,Phil. *Mug. Lett. 72* (1995) 3 11.

[2] Gastaldi J., Reinier E., Grange G., Jourdan C. and Smolsky I., *Proceedings of the 5th International Conference on Quasicrystals,* edited by C. Janot and R. Mosseri (World Scientific, 1995) 287.

[3] Reinier E., Thesis (26/01/98), University of Marseille, France.

[4] Mancini L., Thesis (foreseen on 02/06/98, University of Grenoble, France.

[5] Reinier E., Gastaldi J., Mancini L., Hartwig J., Baruchel J. and Baluc *N.,Proceedings of the 6th International Conference on Quasicrystals,* Tokyo (Japan), 1997 (in press).

[6] Mancini L., Reinier E., Cloetens P., Gastaldi J., Hartwig J., Schlenker M.., Baruchel J., *Phil. Mag. A* (in press).

[7] Reinier E., Mancini L., Gastaldi J., Baluc N., Härtwig J., Baruchel J., *Physica B* (in press).

[8] Baruchel J., Buffiere J. Y., Cloetens P., Guigay J.P., Mancini L., Peix G., Peyrin F., Salomé M., Schlenker M., Spanne P., *Proceedings* of *SPZE* n. 3154, August 1997, San Diego (USA) 51.

[9] Baruchel J., Cloetens P., Drakopoulos M., Mancini L., Rejmánková-Pernot P., Snigirev A., Snigireva I., Souvorov A, *ESRF News Letter* (in press).

Postal address: User Office, ESRF, B.P. 220, F-38043 GRENOBLE Cedex, France.
Telephone: +33 (0)4 7688 2552; Fax: +33 (0)4 7688 2020; e-mail: useroff@esrf.fr.