EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** **New imaging methods at ID19 – computed laminography and tomosynthesis, rapid CT and ultrafast radioscopy**	**Experiment number**: MI-576
Beamline: ID19	**Date of experiments**: from: 07/05/03 to: 11/05/03	**Date of report**: 19th Dec 03
Shifts: 12	**Local contact(s)**: Lukas Helfen	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

L. Helfen*, T. Baumbach*, P. Mikulík* *Fraunhofer Institut IZFP EADQ, Dresden, Germany*

P. Pernot *Fraunhofer Institut IZFP EADQ, Dresden, Germany; ESRF, Grenoble, France*

Report:

In the first year of the long-term project we had used only 6 shifts from the 30 allocated. This delay was caused by a) the long-time unsuccessful negotiations with two suppliers asked to fulfil our technical requirements for the synchrotron laminography set-up, b) a considerable effort devoted to the development of the adequate simulation and reconstruction programs. At the time being, all these difficulties are overcome (negotiations with the companies HUBER and AZ-Systèmes of the final contract are in a final stage and programs are available). The new set-up will presumably be implemented on the ID19 beamline at the end of the year 2004.

In the second allocation of beam-time for MI-576, further test experiments on the prototype sample manipulator (as already described in the first report) for synchrotron laminography (SL) were carried out. As for the first experiments of May 2002, the alignment procedure was difficult and time consuming. It was carried out with a 50 µm thick W wire and a Cu mesh (i.e. a Cu mesh 351", corresponding to a periodicity of 73 µm). The final sample manipulator is conceived to facilitate the alignment procedure by stringent requirements on the perpendicularity of the axes.
Working energies were 14.7 keV and 35 keV obtained using wiggler radiation and multilayer as a monochromator. The detector used was FReLoN camera with 2048×2048 pixels, having pixel size of 1.4 µm with a resulting field of view of width 2.87 mm.

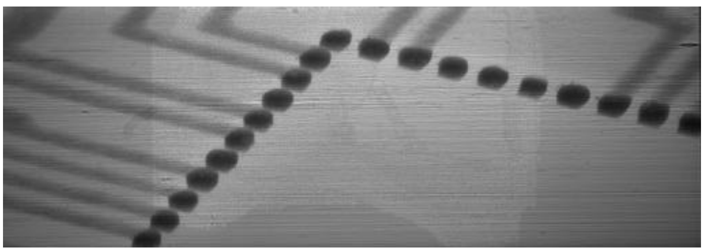

Fig. 1: Raw radiograph of an electronic device which is flip-chip bonded to the printed circuit board.

A variety of samples was investigated performing the laminography scans, i.e. the tomography-like projection data sets were recorded when rotating the sample by 360º. The typical parameters of the scans were: 900 images, measuring time 3 s/image, step 0.4°, distance sample-to-scintillator 26 mm.

Fig. 1 show an example of obtained data, it corresponds to a single projection image of a flip-chip bonded device.

The implemented laminographic reconstruction program was employed to reconstruct 3 dimensional data sets which give evidence of the sample structures. Fig. 2 exhibits two mutually perpendicular slice through solder bumps of the flip-chip bonding. Voids in the 80 to 100 µm thick solder bumps are clearly visible. Furthermore, we see the faint outline of the Si chip and pores in the printed circuit board. The corresponding reconstructed 3 dimensianal rendering is shown in Fig. 3.

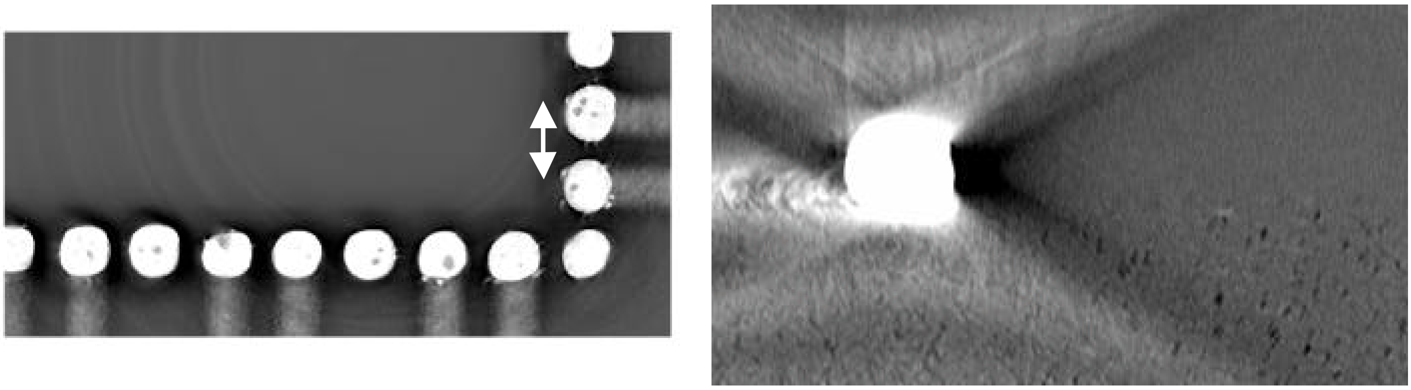

Fig. 2: Mutually perpendicular reconstructed slices of the flip-chip device. Left: Slice parallel to the chip surface, showing the bottom right corner of the bonding wires. Voids within the bumps and smaller satellite solder balls are clearly visible. Right: slice perpendicular to the chip surface through one bump. The metallisation layer and the chip are visible. The dark points in the bottom half of the images stem presumably from pores in the printed circuit board. The X-shaped patterns are reconstruction artefacts.

The experiments have encouraged our decision to invest in a dedicated laminographic manipulator. If the required precision can be met, an image quality better than currently available by laboratory laminographic set-ups is expected. Futher methodic advantages are likely to arise from the use of phase contrast imaging exploiting partially coherent synchrotron radiation.

Fig. 3: 3 dimensional renditions of the reconstructed segmented solder bumps of the flip-chip device.