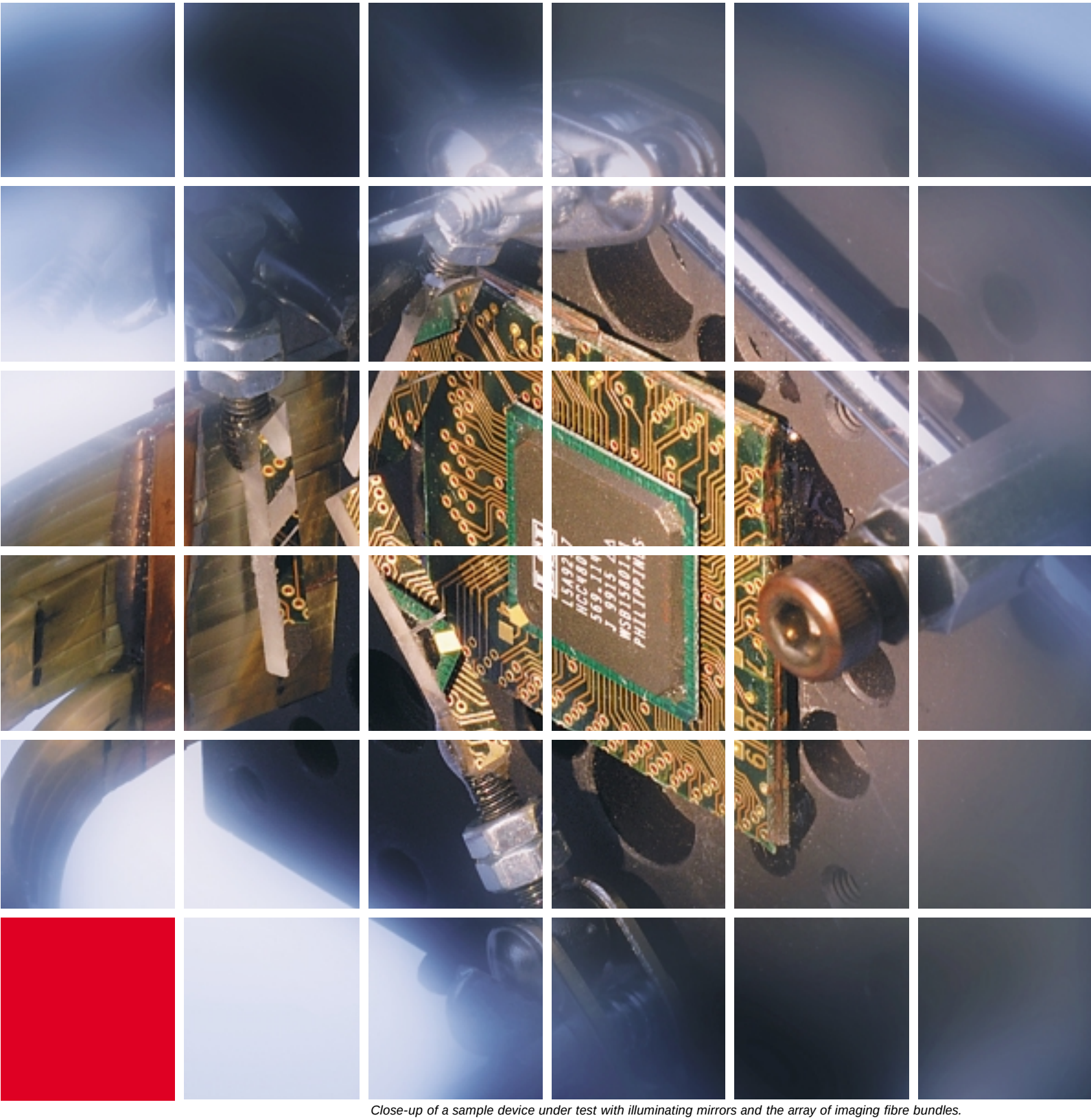
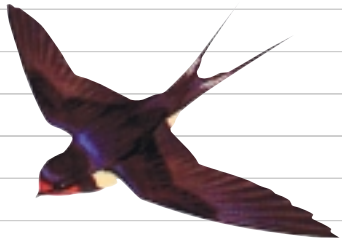
HIRONDELLE

High Resolution Optical Non Destructive Evaluation for Electro-Optical Leading-Edge Microsystems



Close-up of a sample device under test with illuminating mirrors and the array of imaging fibre bundles.

MOTIVATION



The HIRONDELLE [1] instrument is a high-resolution laser-optical measurement system for the in-situ and in-operation analysis of deformation and strain, as well as detecting flaws in microelectronic devices. Thermo-mechanical stresses due to thermal loading induced by the reflow process or by operating conditions can adversely affect the reliability of Ball Grid Arrays (BGA) and similar systems. The main challenge is the small size of the individual joints with, at the same time, a large number of joints lined up beneath a chip (Fig.1). If inspection is done with a microscope, the sample must be destroyed to give access to the solder balls. Bulk, circular lenses and endoscopes are not adapted to the measurement problem.

The HIRONDELLE instrument uses innovative observation optics (fibre bundle imaging, Fig. 2) to view an entire row of solder balls in a single frame of the camera. This speeds up inspection and facilitates the comparison of quality indicators.

Fig.1 Ball Grid Array (BGA) viewed from the side.

Fig. 3 Overall view of the laboratory prototype.

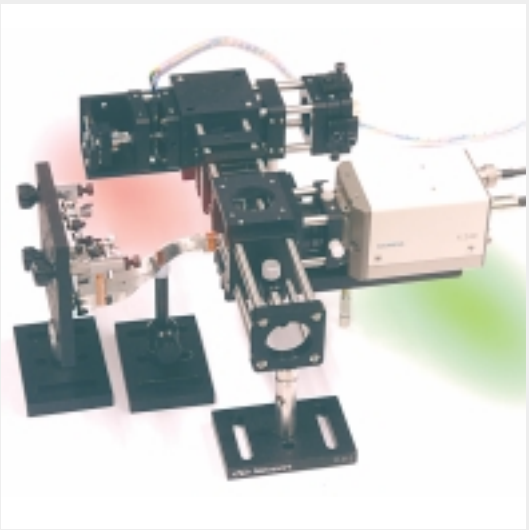


Fig. 2: A coherent fibre bundle transfers an image from one end to the other.

HIRONDELLE

An ESPI Interferometer Based on Fibre Optic Imaging

Contact:

Dr. Erwin Hack,
Project Leader HIRONDELLE
Telephone: +41 44 823 42 73
Fax: +41 44 823 40 54
Email: erwin.hack@empa.ch

Dr. Urs Sennhauser,
Head of Laboratory
Electronics/Metrology
Reliability Centre (ZZT)
Telephone: +41 44 823 41 73
Fax: +41 44 823 40 54
Email: urs.sennhauser@empa.ch

Swiss Federal Laboratories for Materials Testing and Research (EMPA)
Ueberlandstrasse 129,
CH-8600 Dübendorf, Switzerland

The instrument, Fig. 3, uses a laser diode to illuminate the device under test. The illumination optics consist of a beamsplitting assembly, a four-way liquid crystal shutter, beam steering and expansion elements, and illuminating mirrors. The beam expanders were designed by CRF together with the near-parabolic mirrors to create a uniform light sheet for illuminating the area of interest from three different directions. This allows the measurement of all three cartesian components of the surface deformation field of the device under test. Fig. 4 shows the design, Fig. 5 the implementation.

The observation optics consist of an array of rod lenses which image the solder joints via a right-angle reflector onto the input faces of a linear set of imaging fibre bundles. The front cover shows a close-up of the device under test and three mirrors used for testing purposes.The fibre bundles, carefully selected based on their optical properties [2], are used to transfer the image of the BGA to the camera. They are interleaved to give a 3 x 5 array at the object plane of the camera lens.

The camera records interferograms obtained by superimposing a reference beam from the laser source on the observation beam. Electronic speckle pattern interferometry (ESPI), and Image Correlation are used to evaluate the deformation field.

The measurement system is controlled by a LabView® interface.

Fig. 4 Design of beam expanders, mirrors and imaging fibre bundles

Fig. 5 Implementation of the illumination system

PARTNERS

CENTRO RICERCHE FIAT

ALCATEL SPACE

IXL BORDEAUX

DANTEC ETTEMEYER

Chemnitzer Werkstoffmechanik GmbH

REFERENCES

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Creative interface:
Research, Development, Testing and Knowledge Transfer

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EMPA

Ueberlandstrasse 129
CH-8600 Dübendorf
Phone +41 44 823 55 11
Fax +41 44 821 62 44
www.empa.ch

Lerchenfeldstrasse 5
CH-9014 St. Gallen
Phone +41 71 274 74 74
Fax +41 71 274 74 99
www.empa.ch

Feuerwerkerstrasse 39
CH-3602 Thun
Phone +41 33 228 46 26
Fax +41 33 228 44 90
www.empa.ch