3D Lightfield Inspection System for Zero-defects Manufacturing

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State-of-the-art MEMS devices are found in many applications with various functionality. One thing all these MEMS devices have in common is their three-dimensional nature. There is a strong need for automated inspection tools that can inspect such 3D micro structures. CSEM is working within the European funded project CITCOM [1] together with partners on a potential solution implementing a 3D Lightfield camera. The system is based on a commercial wafer prober and therefore simple to implement into existing manufacturing environments.

Quality control in manufacturing is a vast field and we cannot cover all of its aspects here but concentrate on microsystems and MEMS. Whereas the IC industry has developed many planar inspections tools, there is an urgent need for structural inspection of 3D microsystem as shown in Figure 1 and Figure 2. The first image shows a "flex-to-rigid" structure which was designed to assemble a complex electronics and MEMS transducer system into tips of smart catheters [2], by folding the connected segments into the catheter tip. The second shows a dispensed dot of conductive adhesive used to bond an ASIC onto a PCB.

CSEM is working within the European project CITCOM to fill this gap in the manufacturing cycle by developing a fully automated 3D inspection system based upon two 3D light-field cameras, provided by the CITCOM partner company Raytrix [3] (see Figure 3).

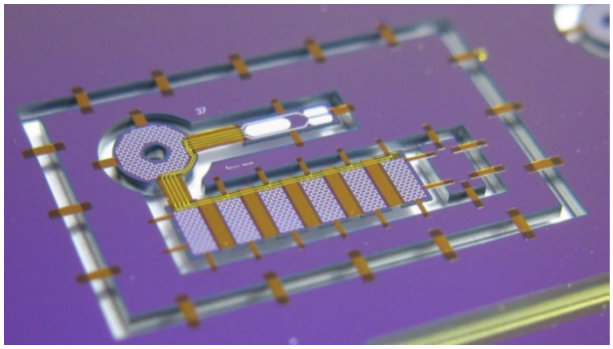

Figure 1: Flex-to-Rigid structures are fabricated wafer scale in a planar technology and are highly 3D structured (Image by courtesy of Philips Electronics Nederland B.V.).

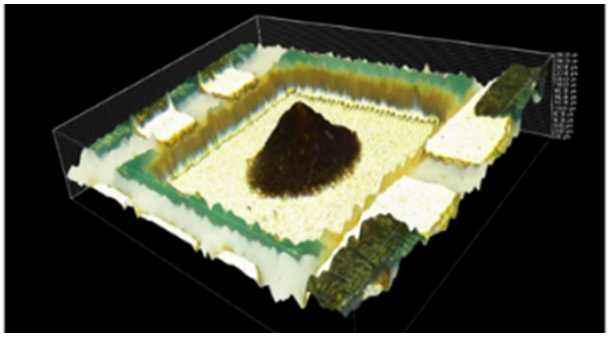

Figure 2: Image with correctly dispensed dot of silver epoxy adhesive for later ASIC placement (Image by courtesy of Microsemi Semiconductor Limited UK).

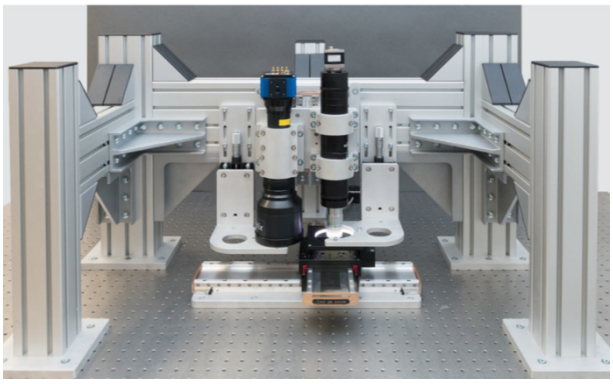

Figure 3: 3D Lightfield development setup.

The two cameras are combined to allow for fast low-resolution and slower high-resolution inspections (see Table 1). Two stacked linear stages enable the scanning of substrates up to 200 x 200 mm^2. This system represents an intermediate step towards a fully integrated wafer prober setup (in collaboration with CITCOM partner aixACCT) [4]. All hardware components are driven by the modular software framework CSEM VISARD [5].

Table 1: Main features of 3D optical inspection system.

	"R26 CITCOM" & Sill S5LPJ1268 3x	**"R12 CITCOM" & Mitutoyo 20x**
working distance	48 mm	20 mm
field of view	7.8 x 7.8 mm^2	0.65 x 0.44 mm^2
lateral resolution	3 um	0.7 um
depth of field	1.1 mm	60 um
depth resolution	2.5 um	0.4 um
frame rate (max)	81 fps	30 fps

The software will implement various access levels. A process engineer for example will be able to set up inspection processes and has access to data such as processed 3D images while an operator may only start a predefined process and receives abstracted detection results. Image processing for defect recognition will be based on convolutional neural networks, implemented in collaboration with partner BIC [6] while metrology tasks could be based on traditional image processing algorithms. Data in- and output for, *e.g.*, found defects will be based upon industry-standard wafer map files.

Finally, the entire system including metrology and defect recognition will run fully automated once the workflow has been properly implemented.

[1] www.citcom.eu; This project has received funding from the European Union's HORIZON 2020 research and innovation program under Grant Agreement no. 768883.

[2] http://informed-project.eu/downloads/F2R.html

[3] Raytrix GmbH, Schauenburgerstraße 116, D-24118 Kiel, Germany.

[4] aixACCT Systems GmbH, Talbotstr. 25, 52068 Aachen, Germany.

[5] M. Höchemer, I. Kastanis, P. A. Schmid, "VISARD - Vision Automation Robotics Designer", CSEM Scientific and Technical Report (2016) 95.

[6] Brunel Innovation Center, Granta Park, Great Abington, Cambridge, CB216AL, United Kingdom.