Large measurement range for the smallest structures

White-light interferometer tests flexible hybrid electronics

When testing the surfaces of the finest structures, white-light interferometers are in their element, both in electronics manufacturing and development, as well as in laboratories and research. The process is non-contact and works on almost all materials. In this respect, three-dimensional optical metrology not only provides a functional and structural analysis as a basis for quality control and production optimization, but also an image of the surface that is easy for humans to understand. This benefits all areas of electronics manufacturing, including current projects in the field of flexible electronics.

As a key technology, microelectronics forms the basis of numerous innovations in quite different areas. With the FLEXMAX project, for example, the German Federal Ministry of Education and Research is funding the development of a sensor matrix for medical applications that is both flexible and active. Such sensor foils can then e.g. improve the respiration monitoring of premature babies (cover image), be used in chronic diseases or even determine the position of the catheter during heart surgery.

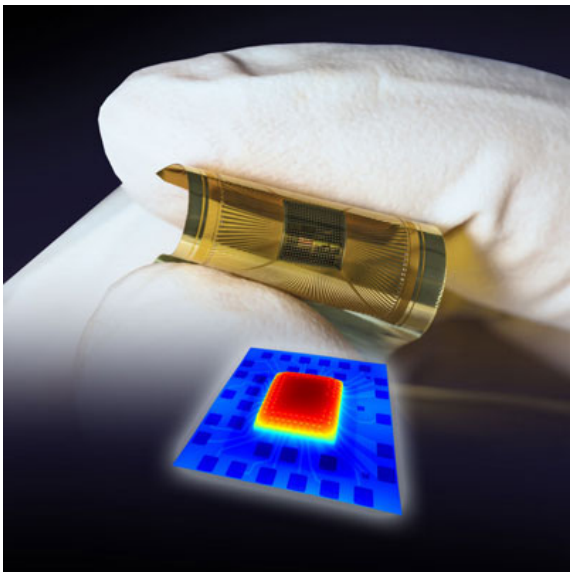

Figure 2: The hybrid systems integrate sensors and microchips directly in a flexible polyimide film. (Copyright: IMS CHIPS)

A business unit of the Institut für Mikroelektronik Stuttgart (IMS CHIPS) is currently working on the development of such hybrid systems, which integrate sensors and microchips directly in a flexible polyimide film (Figure 2) They allow a high integration density, but can also be easily adapted to a wide variety of surfaces and shapes. At the same time, however, a cost-effective manufacturing process suitable for series production must be developed for these innovative products. Only then will patients be able to benefit from the possibilities that can be realized thanks to advances in microelectronics.

Microchip embedded in the film

In this context, white-light interferometry plays an important role for the Stuttgart developers. Only with its help can the surface of the flexible hybrid electronics be comprehensively inspected on a non-contact basis. The task is very demanding because the surface and its coating have a major impact on the functionality of the hybrids and may not be damaged by measurements. The flexible electronic systems integrate standard ICs, which are appropriately thinned for the application, as well as the complete connection technology.

Chips are embedded on a polyimide film, covered and wired with lithographic structuring in a wafer-based production process. The fine structures of the four-layer construction have to be checked for quality control. The results also help to evaluate and optimize the manufacturing process. “Tactile processes are not suitable for this purpose,” explains Dr. Christine Harendt (Figure 3), head of the Semiconductor Integration business unit at IMS CHIPS. “The information about the surface is therefore only obtained two-dimensionally along a profile here.”

As a result, the Stuttgart developers opted for a modern microscope-based white-light interferometer (Figure 4) developed by Polytec (see company text box) to detect the finest structural details. The color information (RGB) from the object, which is supplied in addition to the height measurement (Figure 5), simplifies error mapping. For this purpose, the microscope-based white-light interferometer offers motorized X, Y and Z axes with a range of travel of 200 x 200 x 100 mm³, as well as a motorized nosepiece and a motorized tilt platform (tilting stage).

Figure 4: The white-light interferometer in the clean room. It detects the finest structural details over the entire measurement range.

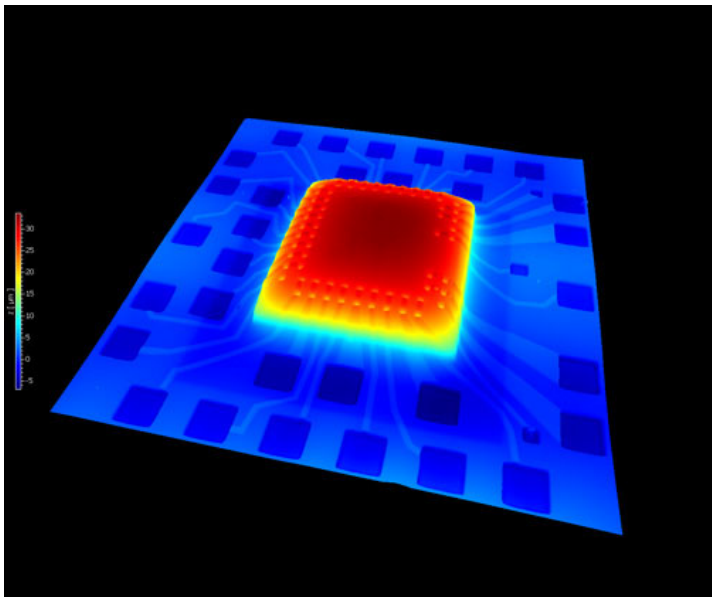

Figure 5: The 3D height measurement of the object simplifies error mapping

Four lenses are used in the described application. The test sequences can therefore be run automatically according to specific “recipes”.

> *In this way, we can measure the surface very precisely at many points and then obtain an exact overall view by stitching.*

adds Dr. Harendt. The developers of the hybrid electronics were not only impressed by the high measurement data quality, but also by the cooperative partnership with the specialists from Waldbronn.

Modular software can be individually modified

Thanks to the many export options, 3D measurement data from the white-light interferometers can be processed using any suitable evaluation software. This is particularly easy with the TMS software, which has been especially developed for these topography measuring systems and offers numerous options for evaluating the measurement results quickly and in accordance with ISO standards. “Measurement recipes”, for example, make routine tasks easier. Here, the settings for data acquisition (for example, measurement position, illumination settings, camera parameters) can be defined and stored together with evaluation parameters (for example, post-processing steps, visualization or export options) for special measurement tasks. This saves time, especially in the production environment, and avoids operating errors.

In addition, the software can be individually modified thanks to good documentation, its open structure and the modular design (Figure 6). Dr. Harendt reports: “We have adapted the software so that we can now routinely approach and measure the same measuring positions on the wafers as is necessary in series production during process control. The open software structure and the excellent working relationship with Polytec made this possible for us.” This also enabled the Stuttgart developers to tailor the user interface to their needs. “This means that internal knowledge remains within the company and we can react flexibly to changing requirements,” adds Dr. Harendt.

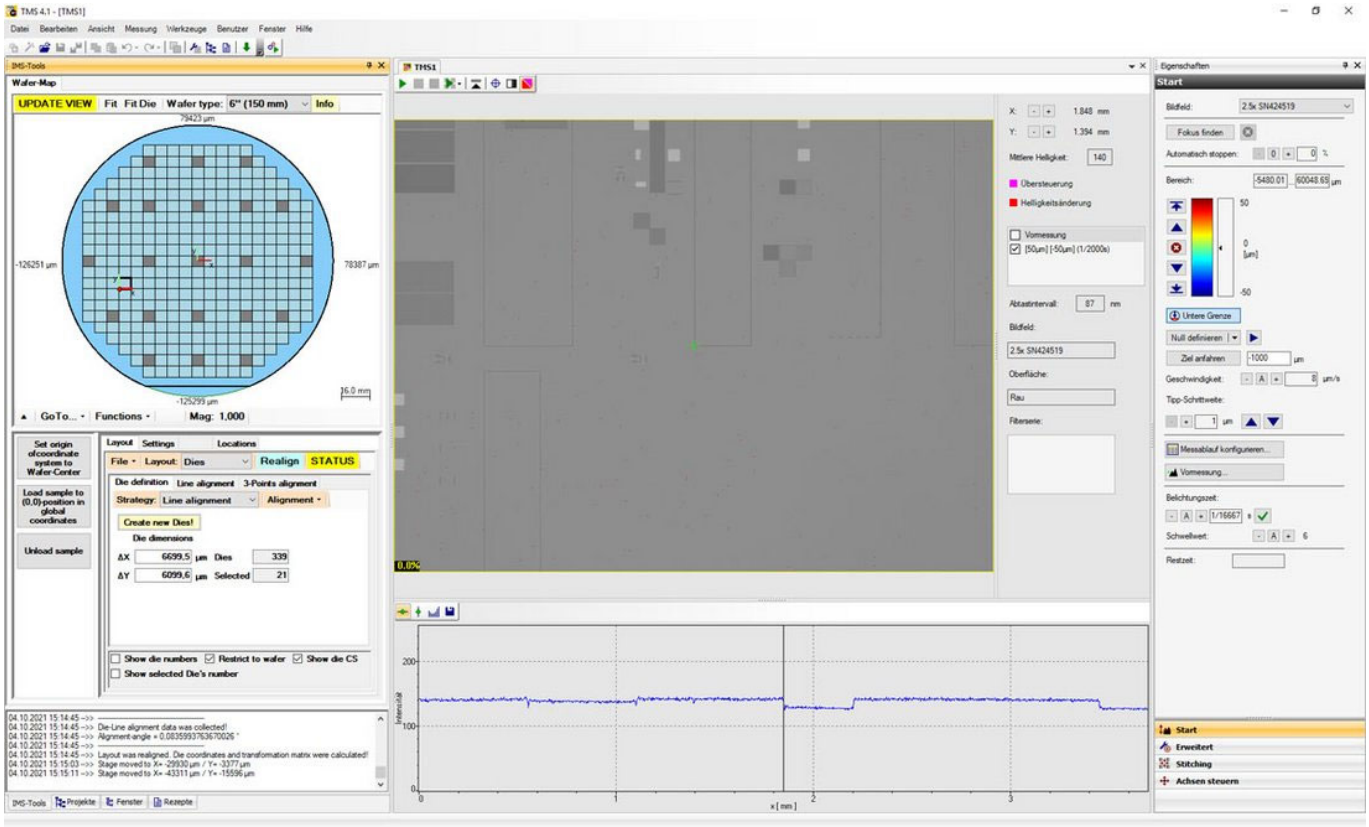

Figure 6: The TMS software has been especially developed for these topography measuring systems and offers numerous options for evaluating the measurement results quickly and in accordance with ISO standards. The software can be individually modified thanks to good documentation, its open structure and the modular design.

Numerous areas of application in electronics and semiconductor manufacturing

The versatile surface measurement systems are equally well suited for numerous other tasks in micro- and nanotechnology. For example, channel depths on a lab-on-a-chip can be evaluated reliably, highly precisely and quickly, the step height in MEMS packaging can be determined, the flatness of pressure sensors can be ascertained or MEMS analyzed on the basis of surface parameters. In addition, there are variation possibilities in design. For example, the sample height can be measured up to 370 mm and, if required, the sensor head can also be separately integrated directly in a production line.

Thanks to the autofocus function and automatic focus tracker, the measurement system always has the object or sample in sight. The test specimen always remains in focus, even if the object position varies. The optional, patented ECT (Environmental Compensation Technology) can automatically compensate for environmental conditions in harsh manufacturing environments.

Images courtesy: Images courtesy of the Institut für Mikroelektronik (IMS CHIPS), Stuttgart, Germany. Cover image: OndroM/shutterstock.com

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