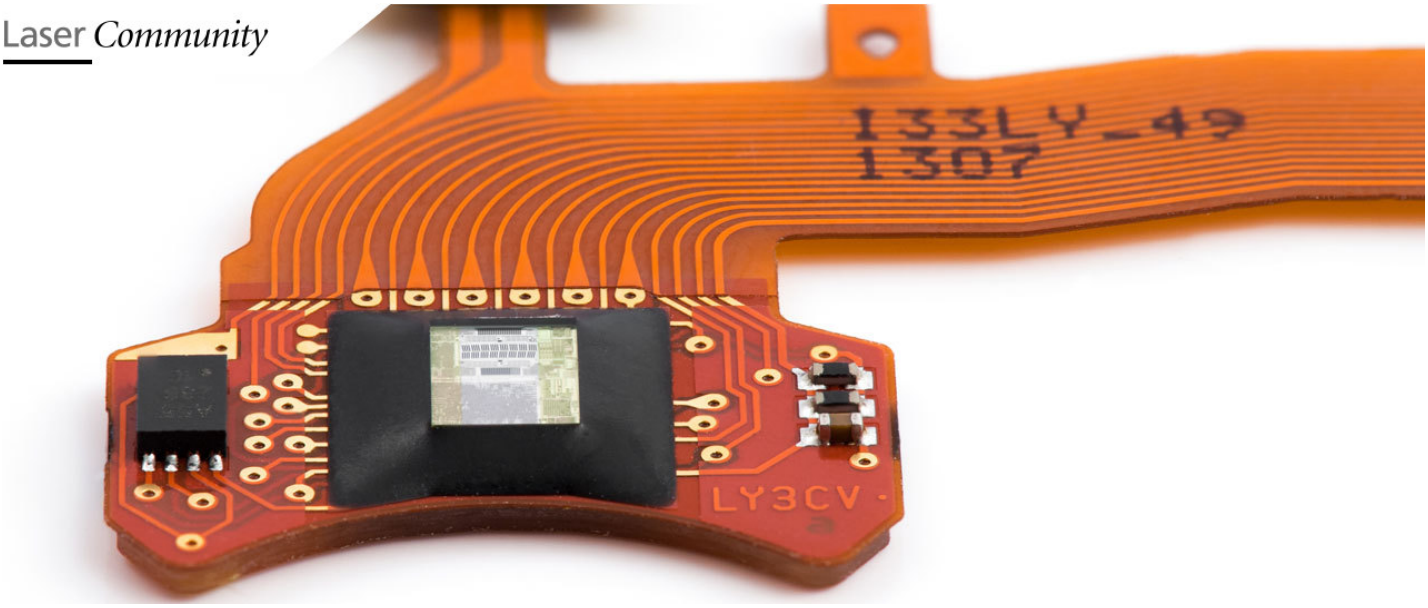


© iC-Haus

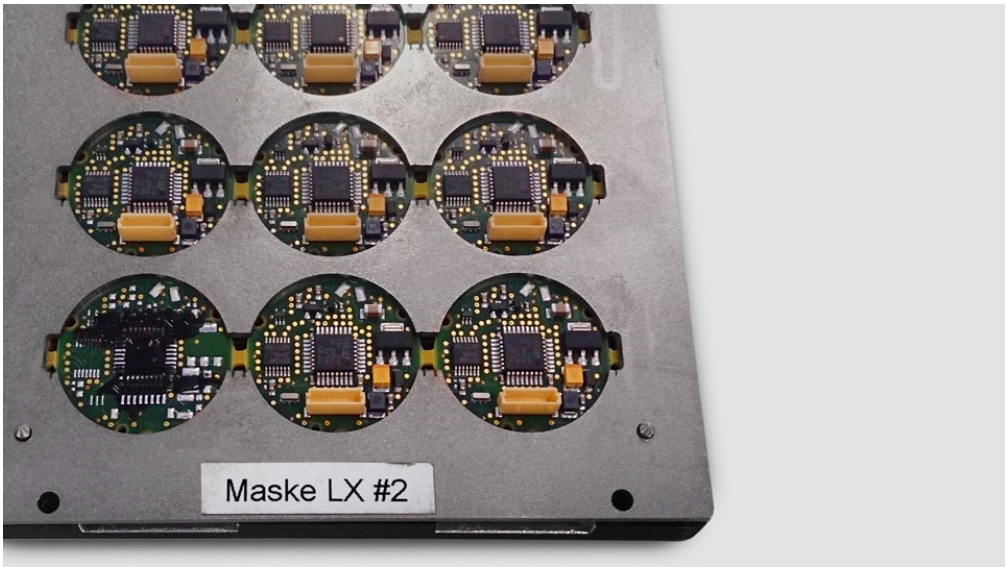
LIGHT FOCUSES LASERS

2016-07-22

When chips are disassembled, a process known as depaneling, precision down to the micrometer is required in both processing and positioning. iC-Haus meets this challenge with a combination of confocal optical measuring sensors and an ultrashort pulse laser.

The unit quantities in the production of optical and magnetic sensor modules are in the seven-digit range in some cases. But even with this volume, a 100% inspection is conducted for quality assurance purposes. This is a comprehensive inspection of the entire quantity of all products in a production lot, during which optical measuring technology is used at numerous points.

Contactless metrology systems ensure that the components are correctly positioned on the printed circuit boards in the production of iCs. In the assembly of optical chips, which have a sensor on the top side, this position tolerance is often in a range of just a few micrometers. This is also true of the chip-on-flex production, a special form of the chip-on-board technology that is often used for sensors. Thanks to the flexible base material, complex 3D forms can also be produced.



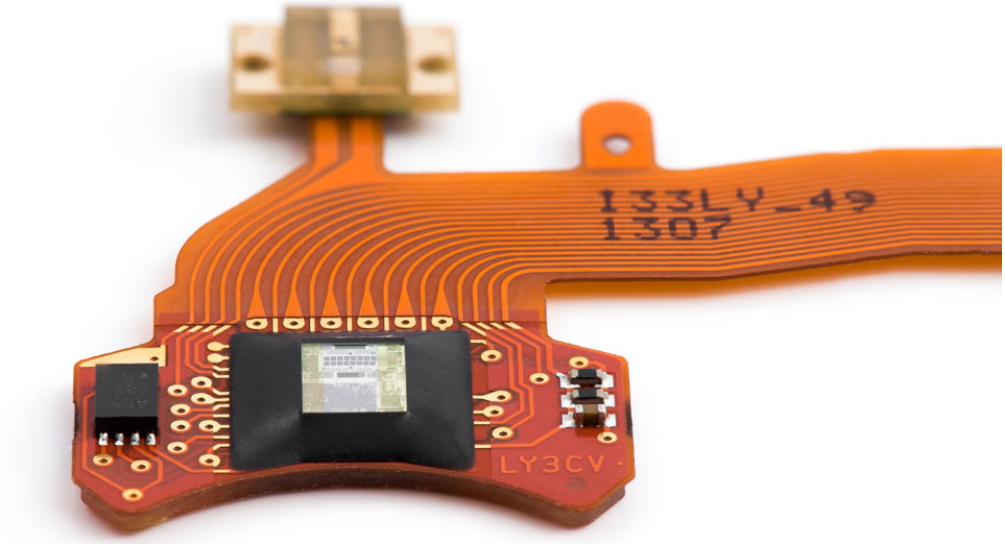
Nine panels. The components must be cut out in circular form. An ultrashort pulse laser is being used for this for the very first time. Photo | iC Haus

Camera-based measuring systems integrated in the production lines determine the exact XY-position of the printed circuit board, so that the components can be positioned with the required position. These fully autonomous sensors will later be used in tiny drives and motors, where they measure speeds and angles; some of them no longer require their own power supply, as they generate the energy required for measuring from their own movement.

Sawing, punching, milling, lasering: what's important in depaneling

Up to now, punches, mechanical saws and mills, and later laser systems as well were used in depaneling (the mechanical separation of identical components on a printed circuit board). The more advanced laser systems facilitate separation according to more complex cutting patterns, while sawing is limited to applications in which rectangular structures must be cut out quickly. Laser-cutting systems have the advantage that they can minimize mechanical stress.

But even the more advanced UV laser systems that are able to work with minimal cutting widths thanks to small focus diameters subject the printed circuit board material to thermal stress, although to a lesser degree than the common, attractively priced CO_2 laser systems.



Chip-on-flex microsystem for positioning on a Starrflex printed circuit board. LED (top) and sensor (bottom) will face each other later, with a code disk rotating between them. Photo | iC Haus

Traces of smoke or soot can frequently be seen on the cut edges, indicating thermal stress. This carbonization consists of a layer of carbon deposited on the cut edge, which can severely impair the functionality of the optical sensors on the printed circuit board. It thus constitutes a quality problem and must be prevented at all costs.

For this reason, research has been conducted for a long time on lasers with much shorter pulses, as the uncontrolled heat dissemination during processing is an extreme disadvantage for other laser applications as well.

Keep cool: processing with ultrashort pulse lasers

Conventional high-performance lasers have been used for a long time for cutting and welding, e.g. for welding car doors or cutting sheet or plate metal. As universally and precisely the power of the laser can be used today, there are still tasks that pose challenges, such as cutting heat-sensitive materials or generating ultra-fine structures with smooth walls and sharp edges. These challenges can be met with ultrashort laser pulses.

In 2013, an ultrashort pulse laser system developed for industrial use by Bosch, TRUMPF, the University of Jena and the Fraunhofer Institute for Applied Optics and Precision Mechanics was awarded the German Future Prize (Deutscher Zukunftspreis) by the German President.

Such laser systems, now widely used in industry, facilitate “cold” processing of materials with their ultrashort flashes of light, from drilling micro-fine spray holes in injection nozzles for motors or cutting biocompatible materials for medical implants. Inline optical metrology in conjunction with the ultrashort laser pulses permit the use of these systems on components that do not tolerate any heat and/or are so tough that other machining tools would break during processing, e.g. when cutting tempered display glass for smartphones.

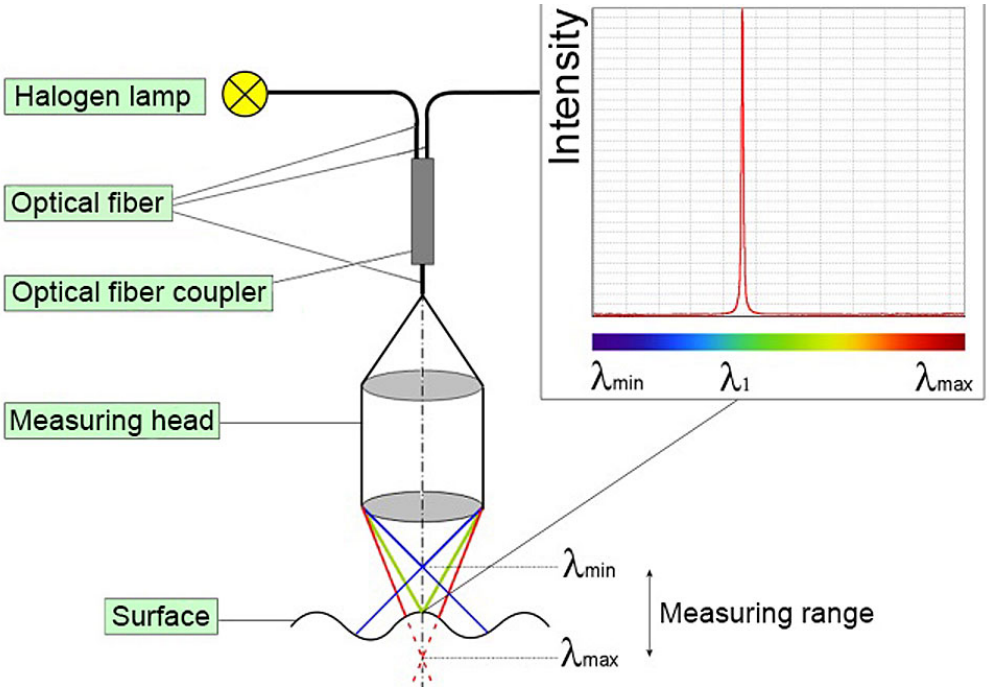
For the first time, a printed circuit board depaneler using an ultrashort pulse laser has been put into operation at iC-Haus in Bodenheim. However, several measuring challenges had to be met beforehand.

The engine of the laser depaneler: the ultrashort pulse laser by TRUMPF with 30 W and 150 µJ pulse power. Photo | ic-automation

Contactless measuring in the third dimension

Two dimensions are not always enough in metrology, even for depaneling printed circuit boards. Only the addition of the measurement of the Z dimension using confocal sensors enables the precise monitoring of the production parameters that facilitate the use of ultrashort laser pulse cutting systems in the picosecond range.

A measuring technique based on the chromatic confocal principle has proven useful in laser depaneling. As a rule, this measuring technique in this application is considerably more reliable than conventional laser triangulation. In contrast to other optical processes, confocal measuring systems work equally well on surfaces such as gold, conductive material and solder resist; even reflective surfaces pose no problems for them.



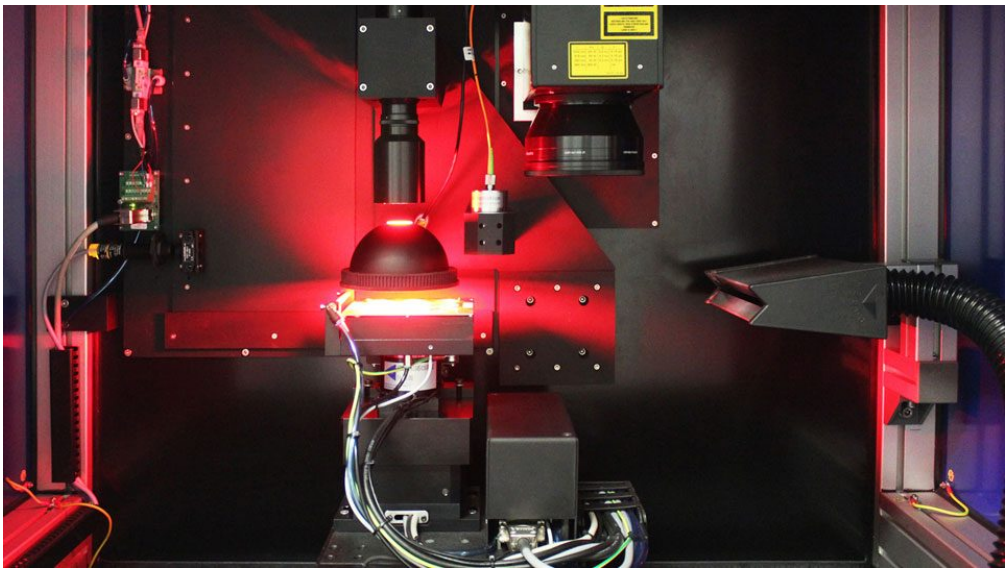
Chromatic confocal measurement. The position of the peak represents the measured distance. Illustration | Precitec Optronik

Chromatic confocal sensors use the property of an optical system that doesn't focus white light in a single point, but separates it by wavelength into a range of distances. The blue focus is closer to the optics unit, while the red one is farther away. All other visible wavelengths are focused in between. A familiar area of use is contactless glass thickness measurement by inspection machines for container glass (glass bottles).

The measurement of the third dimension is required for the cutting process itself: a contactless confocal height measurement with the precision of 4 µm is used to set the focus of the ultrashort pulse laser. Figuratively speaking, the laser focus is continuously tracked, so that it can knock out atoms layer by layer from the composite materials of the printed circuit board without influencing the surrounding area and the neighboring atoms outside of the cutting channel – because the light pulse is extremely short.

The printed circuit board material that is hit by an ultrashort laser pulse is literally blown away in a small explosion and evaporates into a melt with no transition. The ablation takes place only where it should, micrometer for micrometer. This makes it possible to depanel the printed circuit boards without heating, melting or only partially evaporating the processed component. The undesirable carbon residues on the cut edge and burr formation on the printed circuit board are quasi eliminated by the cold processing.

Compact machines for use in production



Laser cutting machine for printed circuit boards with inline measuring technology: the transport system with a magnetic mask for clamping the components is shown at center. Above it: the vision system with the confocal sensor connected via light cables. Above this at the right is the scanner mirror of the ultrashort pulse laser system with the telecentric optics unit. Photo | ic-automation

Laser cutting system from ic-automation. Photo | ic-automation

The ultrashort pulse laser depaneler built by ic-automation GmbH in Mainz is extremely compact, and with a footprint of only 2 square meters only slightly larger than the ultrashort pulse laser itself, which is used for the depaneling. An air-cushioned granite bed with granite-based direct drives ensures outstanding precision with an absolute positioning accuracy of less than 10 µm.

The measuring systems integrated in the machine cover all three dimensions; in addition to high-resolution XY measurement via a vision system with dome illumination, a measuring head made by Precitec Optronik in Neu-Isenburg that uses the chromatic confocal measuring technique supplies the height data of the component for the height focusing of the laser. Height fluctuations and twisting of the components are measured and, if necessary, compensated in four levels of freedom.

The criteria that had to be met included an absolute system accuracy under 10 micrometers and a repeat accuracy that was more precise by a factor of two. With the TruMicro 5000 by TRUMPF in Ditzingen, in the “green light” wavelength range, ic-automation found a suitable ultrashort pulse laser system in the picosecond range. With a telecentric scanner optics unit, the laser system likewise achieved an absolute accuracy of under 30 micrometers.

Dr. Flocke, CEO and one of the two founders of iC-Haus, explained, “Today, mass production of electronic components takes place in Asia, but in our case, where analog, digital and optical sensors are combined in a microsystem, we wanted to keep the control of the manufacturing expertise here in the company.

As a specialist for optical and magnetic sensors, we made sure that our production systems are equipped with the corresponding inline measuring technology for quality assurance, as we supply markets with extremely high quality standards. And for our cleanroom we needed the systems to be as compact as possible. Thanks to the high level of automation, production in Germany is profitable.”

Author:

Andreas Friesenecker
ic-automation GmbH
Phone: +49 (0)6131 62718-23

eMail: a.friesenecker@ic-automation.de