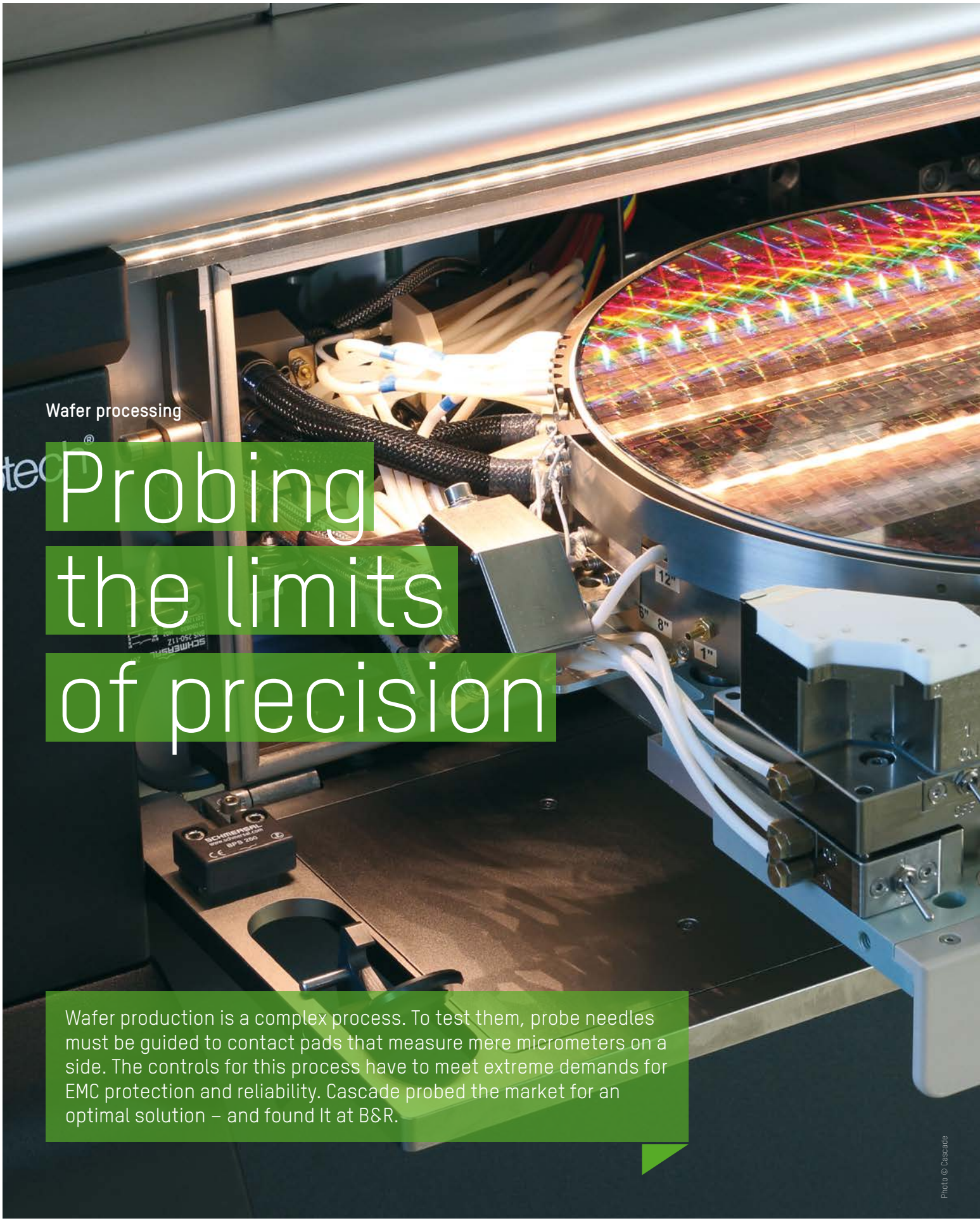


Wafer processing

Probing the limits of precision

Wafer production is a complex process. To test them, probe needles must be guided to contact pads that measure mere micrometers on a side. The controls for this process have to meet extreme demands for EMC protection and reliability. Cascade probed the market for an optimal solution – and found It at B&R.

Photo © Cascade

Wafer chuck with wafer in loading position

Cascade Microtech CM300 Dual Prober

What do a multi-function oven, a digital clock, a toaster and a GPS navigation device have in common? Simple: they all rely on microchips built from silicon wafers. In today's consumer market, it's almost a challenge to find a product without one. The huge bandwidth of applications presents a substantial challenge for developers of semiconductor components. They face constant pressure to integrate a growing range of functions on permanently shrinking chip sizes, while at the same time reducing production costs. Already, the smartwatch on your wrist is both cheaper and more powerful than the office PC you used just 10 years ago.

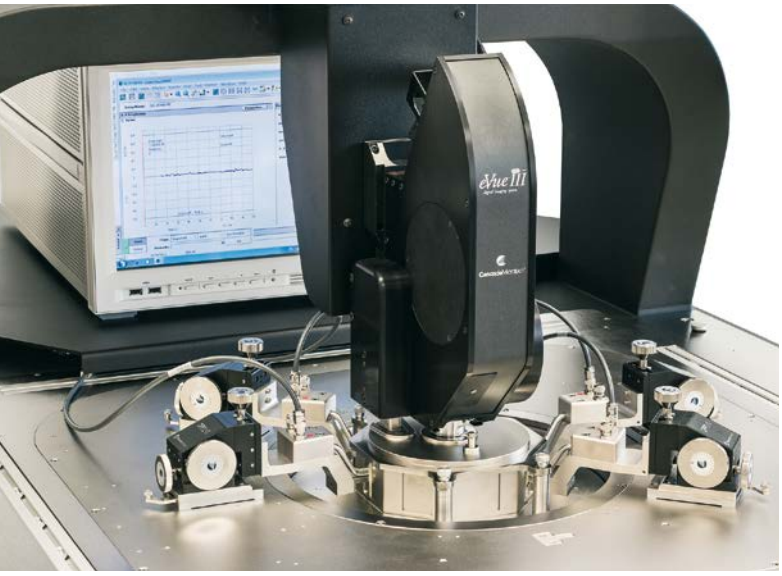
Thin slices of semiconductor material – known as wafers – contain more than 1,000 chips with billions of transistors and other components and currently measure up to 300 millimeters in diameter. This complexity makes developing and validating new designs and production methods a very important process. Nevertheless, the amount of time allotted for development is shrinking rapidly.

Thorough testing ensures quality

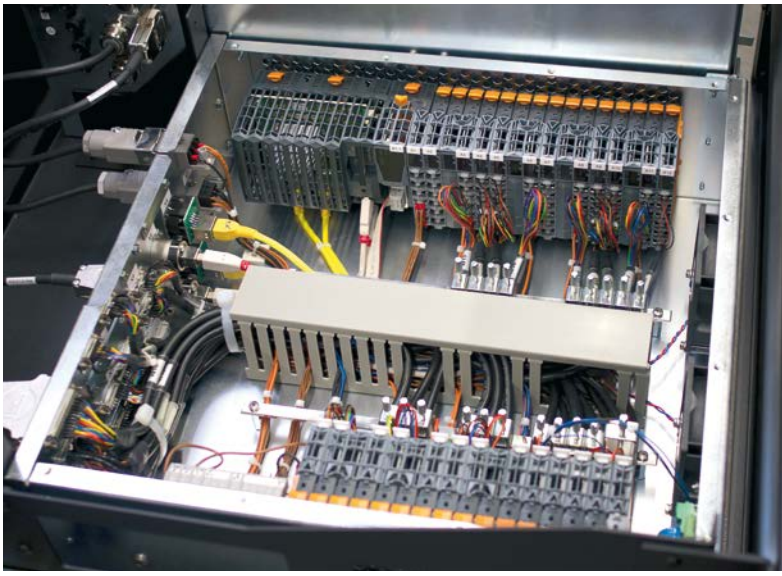
To validate the functionality of newly developed components and ensure consistent quality once they reach serial production, wafers are subjected to extensive testing in probe stations immediately after they are produced. Each wafer is fed into a measurement chamber, fastened into position with micrometer precision using a chuck and brought to a specific temperature. Then probe needles are guided to specially designated contact points on the chip. External measurement and testing instrumentation, which itself can fill entire control cabinets, dictate the positions based on the test program and then initiate the measurements. Testing is performed at temperatures ranging from -55°C to 300°C. Depending on the application, the currents measured can range from several femtoamps (a number with 15 zeros after the decimal point or 6,250 electrons per second) up to 400 amps. It's not uncommon to have measurement frequencies in the gigahertz range – on chips used in car radar systems for example – or to measure charge/discharge capacitance values as low as several femtofarads. A prominent feature of the requirements specifications is therefore the exclusion of all sources of electromagnetic interference.

High-tech measurement chamber prevents interference during testing

Cascade Microtech GmbH, a subsidiary of Cascade Microtech Inc. with headquarters in Beaverton, Oregon, is familiar with these requirements. As a worldwide leading manufacturer of wafer probing solutions, the company first introduced its patented probing station in 1992 and has been improving it ever since. With over 50 years of experience developing precision positioning technology, mastery of the processes involved is an integral part of day-to-day operations. "Under the given conditions, there are several factors to be considered in order to guide the probe needles to the contact pads, which measure just 30 micrometers on a side," explains Dr. Jörg Kiesewetter. Kiesewetter is the R&D manager for probe systems at Cascade Microtech's Dresden office. Here, 140 employees develop and build these systems for more than 800 customers around the world, including semiconductor producers such as IBM, Intel and Infinion, as well as many organizations like the Interuniversity Microelectronics Center (IMEC), Europe's largest research center for nano- and microelectronics.



DC test setup for low-leakage measurements



Arranged in tight quarters and protected against electromagnetic emissions: the machine controller with B&R components

Dr. Jörg Kiesewetter
R&D Manager, Cascade Microtech

"The complete modularity we have gained has helped us reduce development times considerably," reports Kiesewetter. "Outstanding support from B&R's expert engineers in Leipzig saved us valuable time."

Precision positioning

When it comes to achieving the necessary precision, the experts at Cascade Microtech have a number of mechanical and electrical solutions up their sleeves – as evidenced by their impressive 190 patents. For example, several of the 25 axes for the positioning stage, digital camera and other auxiliary equipment require cooling. "It's not possible to measure the quality of electrical contact to the chip directly," Kiesewetter points out, "so it's important that this process is intrinsically reliable." A single positioning error of only a few micrometers could render an entire wafer or a probe card with over 10,000 contacts unusable. This would lead into hundreds of thousands of euros in damages, not to mention tarnishing the company's reputation. Yet the requirements continue to intensify rapidly. "The contact pads occupy valuable surface area, so they are being made smaller all the time. Soon they will be 20 micrometers on a side – less than a quarter of the cross-section of a human hair." On top of that are the numerous special requests posed by device users. To keep pace with the mounting requirements, Cascade Microtech began evaluation of a new controller design concept three years ago.

Modularity accelerates development

In addition to long-term product availability, EMC protection and access to a global sales and support net-work, the modularity of the control system was a key criterion. It would also be necessary to continue development of existing C++ program code. B&R offered the most compelling solution, and Cascade Microtech already has plans to implement it in additional devices. The designers were free to decide whether to use DC or stepper motors for the various motion control tasks. Using B&R's Generic Motion Control software solution for axis control allowed Cascade Microtech to keep hardware and software separate and accommodate different types of motors without requiring any code changes. "The complete modularity we have gained has helped us reduce development times considerably," reports Kiesewetter. "Outstanding support from B&R's expert engineers in Leipzig saved us valuable time." ←