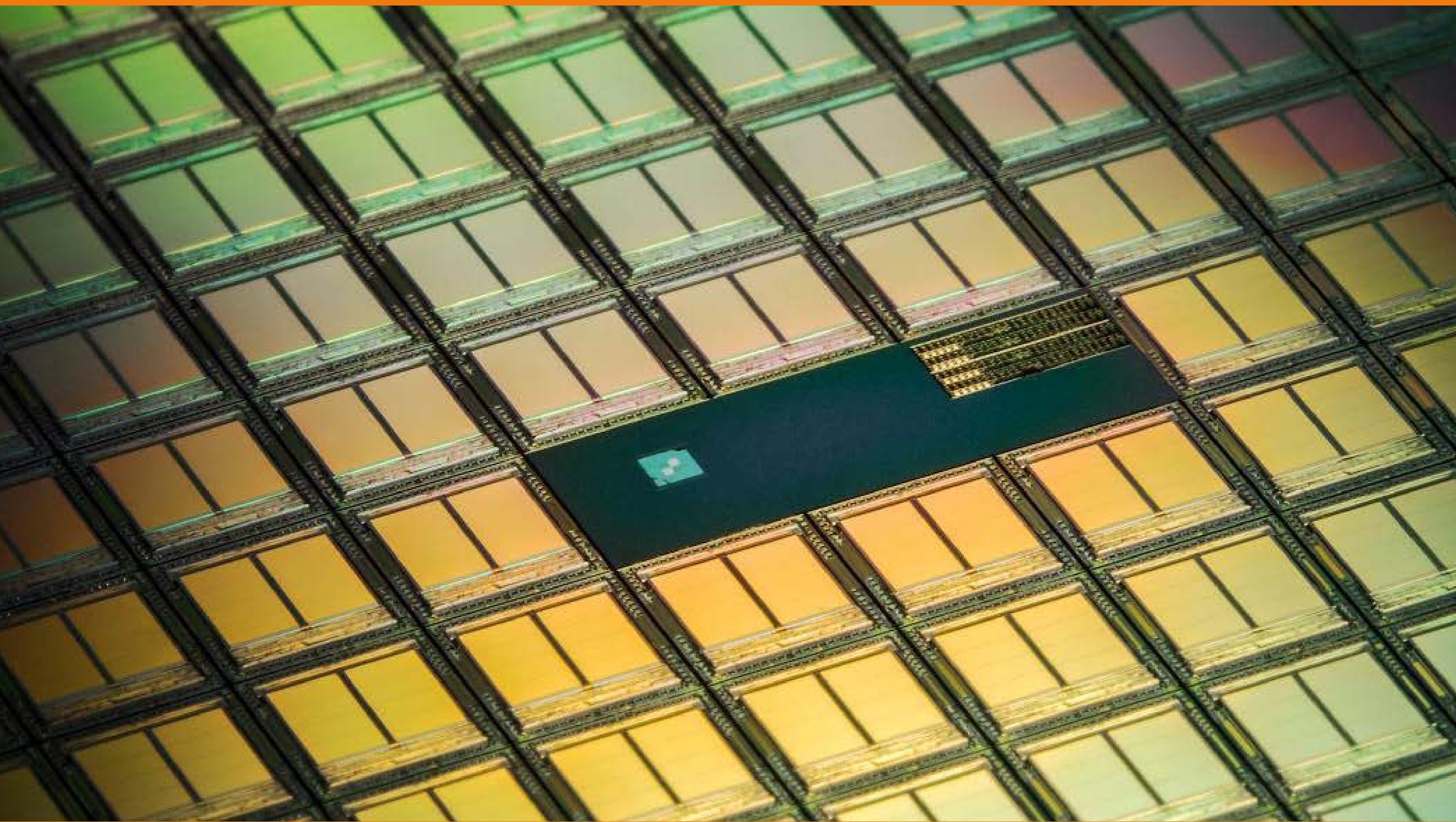
European Metrology Research Programme
Delivering Impact



Precision positioning for electronics

Europe is aiming to capture 20% of the global silicon wafer production market, with an estimated value of 11.5 billion euro by 2025. To do so, it needs to develop innovative manufacturing techniques for producing the next generation of larger silicon wafers with increased numbers of electronic circuits. Efficient production methods are needed to boost EU manufacturing productivity and create low cost electronics.

Europe's National Measurement Institutes working together

The European Metrology Research Programme (EMRP) brings together National Measurement Institutes in 23 countries to address key measurement challenges at a European level. It supports collaborative research to ensure that measurement science meets the future needs of industry and wider society.

Challenge

Producing circuits on silicon wafers relies on high-precision manufacturing processes that assemble electronic components to form multiple complete circuits on a single wafer. These are later separated into individual units for device assembly. To improve productivity and efficiency, wafer manufacturers are investigating methods to increase circuit production by fabricating more circuits on larger wafers.

During manufacture, positioning stages move wafers in 3D inside a vacuum chamber, as tiny details are etched or deposited onto them, to build-up electronic circuits. Achieving the high levels of position control required relies on accurate movement sensing techniques able to operate in challenging industrial environments. As more features are added to wafers, the distance between individual components shrinks and ever greater control over the stage's nanometre movement are essential.

Interferometry is a laser-based technique for precisely determining distances in a single direction. It is based on splitting a laser beam into two, one beam travels to and is reflected back from a target on the item that moves, while the other acts as a reference. Recombining the two creates an interference pattern that can be used to accurately determine position changes. Currently multiple lasers are needed to generate information for movements in 3D, adding complexity and introducing significant measurement errors. To overcome these problems more powerful lasers able to generate multiple intense beams for 3D measurements, coupled with system simplification, are needed to enable industrial users to benefit from highly accurate interferometry measurements.

Solution

The EMRP Project, *Metrology for movement and positioning in six degrees of freedom,* developed a powerful infrared laser, suitable for making 3D interferometry measurements.

The new laser, which was characterised in the project, is 10 times more powerful than lasers currently used in measurement applications. This increased power allows a single laser light source to be split into multiple beams of sufficient intensity for use in simultaneously determining movements in 3D.

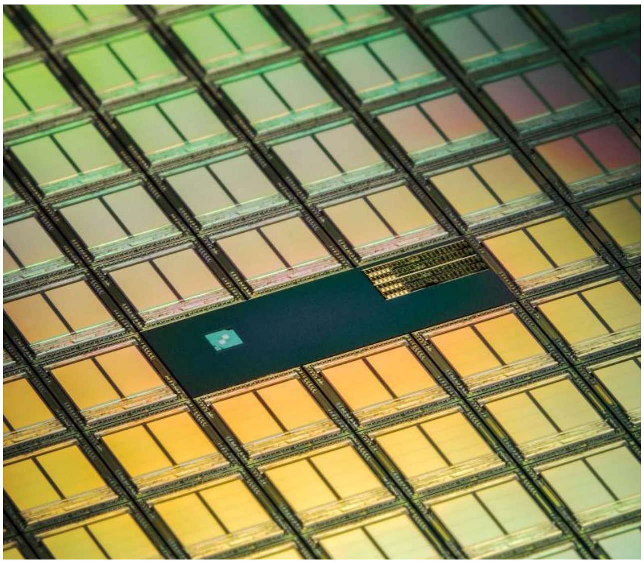
Impact

TESCAN, a Czech company manufacturing scanning electron microscopes and advanced analysis instrumentation, is upgrading the laser technology demonstrated in the project, for incorporation into a new wafer manufacturing system they are developing for electronic circuit production. Tescan's system will incorporate a positioning stage, based on their existing technology, to provide the highly controlled nanoscale movements for silicon wafer production. Determining the precise position of the stage will be achieved using the project evaluated high powered laser and an interferometry system capable of operation in 3D.

New innovations in positioning technology, such as the extension of interferometry for use in 3D, are vital for improving production speed and efficiency in many industries. Increasing the precision of nano-positioning is supporting the development of a new European silicon wafer production capability and has the potential to reduce European industrial reliance on external suppliers as the demand for more sophisticated electronics grows.

Accurate positioning in three dimensions

The EMRP project *Metrology for movement and positioning in six degrees of freedom*, has increased the accuracy for determining machine tool or positioning stage micro-movements and developed ways to increase the usability of rapid and extensive scanning probe microscopy measurements. The project developed a mobile, easy to use measurement system for characterising the motion of precision machine tools, and strategies to decrease the effects of tip wear and instrument drift during extended or rapid scanning of surface features using atomic force microscopy. Traceable nanometre measurements of position, angle and straightness, are essential in many industries and research fields, for example the precise positioning stages used in semiconductor manufacture or for manipulating samples during analysis using electron microscopy.



EMRP
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