MEDEA+ EUV lithography

Strong cooperation forges global advances in semiconductor processing

Focused research in the EUREKA MEDEA+ microelectronics Cluster has ensured a world lead for Europe in next generation photolithography, a key enabling technology for integrated circuit fabrication.

Cost € 400 million

Duration 48 months

Countries involved
The Netherlands, Belgium, France, Germany, Italy, Poland, Sweden, Switzerland

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PRINT STORY

A series of successful projects in the EUREKA MEDEA+ Cluster is enabling Europe to lead the way in extreme ultraviolet (EUV) lithography for the production of future generations of semiconductor chips. Strong cooperation between chipmakers, equipment suppliers and research centres has made it possible for European companies to dominate the world market for sophisticated processing equipment and production materials required in this key enabling technology for micro- and nano-electronics devices and systems. As a result of this work, the electronics industry is expected to generate some 18,000 jobs in Europe, mainly at a high technical level, as well as a healthy €1 billion turnover by 2009.

Photolithography plays a key role in the fabrication of integrated circuits, accounting for 35% of the processing cost of silicon chips. It involves projecting light through a photomask to form an image of the desired circuit on the silicon wafer, coated with a light-sensitive photoresist. Following development, unexposed areas are washed away, making it possible to etch circuit details on the wafer surface. A typical semiconductor chip undergoes over 50 such steps in the fabrication process.

As circuit details become ever smaller, the wavelength of the light has also reduced and is now reaching the limits of the deep ultraviolet (DUV). While current wavelengths are in the MEDEA+ established a group of projects to create highly innovative solutions for processes able to supersede DUV lithography that was reaching its limit in the production of circuits with details down to 65 nm. The objective was to provide NGL manufacturing capability at 45-nm feature size nodes. This required a new technology based on EUV that will continue to be suitable for another three or four technology generations subsequently.

Four main elements
The EUV projects covered four main elements of the lithography process: tools, masks, illumination sources and processing. Extensive work on optics and coating technologies in the T403 EXTATIC project led to the development of an EUV lithographic research tool essential for future research in this area. Two such 'alpha' tools are being delivered to research centres in 2006 to continue this effort.

A complete mask-making process for 45-nm circuit structures and below was developed in the T404 EXTUMASK project, based on 13.5-nm wavelength EUV. The project also developed the tools necessary for mask metrology inspection and repair.

193-nm range, the solution for future generations of much smaller dimensioned circuits is the use of EUV with a wavelength of 13.5 nm - actually soft X-rays.

Major cost driver
Over the past decade, lithography costs have grown dramatically and are now the most important cost element in the semiconductor fabrication plant. A typical wafer 'stepper' used to project the circuit images costs around €10 million, while the price of a mask set for today's 100-nm feature size processes is some €500,000. And these costs will rise for future generations of devices.

From the beginning of MEDEA+, the EUREKA Cluster focused on bringing together Europe's leading companies and research centres in wafer steppers, light sources, imaging systems and mask manufacturing to help win the global race for so-called next generation lithography (NGL) solutions.

Working in cooperation within the EUREKA MEDEA+ Cluster framework made this success possible.

Rob Hartman, *ASML, The Netherlands*

As a result, the first commercial masks have already been delivered to ASML - the Netherlands-based global leader in lithography equipment for chipmaking.

T405 EUV SOURCES examined two main approaches to EUV illumination: gas-discharge and laser excitation. The focus was on the former as lasers proved too complex and expensive. At EUV levels, optical materials are no longer transparent and so the optical system consists of mirrors that reflect only 70% of the light - the optical system has to absorb the rest. A major increase in power levels was required and the EUV SOURCES project achieved world record outputs, meaning such sources are no longer a block.

Europe is now at the leading edge of EUV technology.

Finally, the T406 EXCITE project set out to eliminate the bottlenecks related to EUV imaging for full-field patterning development, building on the results from the source, mask and tools projects.

Efforts will continue to resolve problems in collector lifetime, masks and photoresists. Good links were established with the European Union Sixth Framework Programme (FP6) MORE MOORE project, which sought to extend EUV lithography to the 22-nm feature size. Results of both the EUVL Cluster and FP6 projects are serving as the basis for the MEDEA+ second-phase EAGLE project that will extend EUV lithography to even smaller feature sizes for full scale production.

Leading edge technology
"The EUV projects are achieving remarkable results and Europe is now atthe leading edge of the technology globally," says Rob Hartman of ASML andchairman of the MEDEA+ EUV Cluster Steering Council (CSC). "It was workingin co-operation within the EUREKA MEDEA+ Cluster framework that made this successpossible."

Formation of the CSC to guide the four projects offered important advantages. It assured an optimal trade-off between individual consortium creativity and initiatives, and the closely monitored project cooperation and cross-fertilisation within the framework of EUREKA as well as speeding and intensifying the information flow within the project consortia, while avoiding the traditional European reticence over pooling knowledge between different companies and cultures.

Involvement in EUREKA also improved dissemination of project results, providing a powerful means of spreading news about Europe's achievements in EUV lithography to the world. This has made it possible to boost the impact and the image of Europe's EUV lithography engagement on the international stage, impressing US and Asian competitors and potential customers alike.

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