Project profile

Cluster for Application and Technology Research in Europe on NanoElectronics

CT301 | Extreme UV lithography entry point technology development [EXEPT]

PROJECT CONTRIBUTES TO

Communication	
Automotive and transport	
Health and aging society	
Safety and security	
Energy efficiency	
Digital lifestyle	
Design technology	
Sensors and actuators	
Process development	✔
Manufacturing science	✔
More than Moore	
More Moore	✔
Technology node	22 nm

MANUFACTURING SCIENCE: CROSS-CUTTING TECHNOLOGIES, EQUIPMENT AND MATERIALS

Partners:

Adixen Vacuum Products
AMTC
ASML
Bruker Advanced SuperCon
Carl Zeiss SMS
Carl Zeiss SMT
Dynamic Micro Systems
FOM
Fraunhofer IISB
HamaTech APE
IMEC
IMS CHIPS
Media Lario Technologies
NaWoTec
Sagem Défense Sécurité
Xenocs
XTREME technologies

Project leader:

Gerold Alberga,
ASML Netherlands

Key project dates:

Start: February 2009
End: March 2012

Countries involved:

Belgium
France
Germany
Italy
The Netherlands

The 32 nm node has long been seen as the entrance point for extreme ultra-violet (EUV) lithography into volume chip manufacture. Yet EUV has not been the preferred photolithographic method for economic reasons. However, if EUV capabilities can be pushed to the 22 nm level for volume production, then the technology becomes much more interesting. The CATRENE EXEPT project is focusing on the development of technologies, tools and infrastructure components needed for high-volume EUV lithography at the 22 nm node by 2012. This is when it is expected that its introduction for high-volume semiconductor production should open a range of new business opportunities for the European equipment industry.

Optical photolithography is the current standard for volume semiconductor manufacturing. By using double patterning technologies it has been possible to extend the application of optical lithography to the 32 nm node. EUV lithography needs to take place in a vacuum. These and other factors have limited the economic argument for EUV in mass-production applications.

However EUV has the potential to offer far higher feature density and thus enabling more functionality in a standard chip package. If current EUV capabilities at 32 nm can be pushed to the 22 nm level and beyond, then EUV lithography becomes a much more viable proposition. The CATRENE CT301 EXEPT project has therefore set out to develop the necessary technologies, tools and infrastructure components for high-volume EUV lithography at the 22 nm node.

By 2012, the expected introduction of EUV lithography to high-volume semiconductor production lines should open a range of new business opportunities for European chipmakers. EXEPT should position the industry at prominent international levels in their fields of activity, and help safeguard the international semiconductor industry in realising their technology roadmap in lithography in line with the International Technology Roadmap for Semiconductors (ITRS).

The project has two main goals, to:

1. Extend EUV lithography-tool technology to enable imaging at the 22 nm node, at a cost that is viable for industrial chip production; and
2. Develop EUV lithography infrastructure components for which the competences and an industrial base exist in Europe – such as in mask technology – in addition to integrating the whole infrastructure into a manufacturable process flow.

Retaining European leadership

EXEPT is playing a key role in supporting the European effort to retain leadership in EUV lithography. It is a logical follow-up to the results of previous EUV-related projects such as the MEDEA/MEDEA+ EXTUMASK, EXCITE, EXTATIC and EAGLE, and ESPRIT/IST projects – EUCLIDES/more Moore. It will also underpin better exploitation of results from these initiatives.

The CATRENE project will build directly on the results achieved by the MEDEA+ EAGLE project. However the pre-production tool developed under the EAGLE project was designed for the 32 nm technology node. To write at the 22 nm level and finer, EXEPT is reviewing the system layout and various components, and developing the additional functionality required for this more demanding target.

Project partners include major companies in the European semiconductor equipment industry, leading research institutes and a mask shop. In addition, a large number of other research institutes and small and medium-sized enterprises are participating as subcontractors. Once EXEPT has successfully finished, all the partners involved expect to be able to gain a strategic advantage in the market for European EUV expertise, tools and components.

Upgrading the optics

Upgrading of EUV optical system capabilities from 32 nm imaging in the pre-production phase to the 22 nm level requires a totally new optical system, as well as improvements in all system sensors. Key tasks therefore include developing a new projection lens, a new illumination system with additional features adapted to the projection lens, high-accuracy wafer and reticle-stage systems, and sensor systems with much greater precision.

Increasing the resolution of the optical system is not just a matter of simple scaling but requires substantial improvements in several technology areas. EXEPT plans to stay with a six-mirror optical design, in order not to affect the optical transmission of the system. As a consequence, the dimensions of the mirrors will increase and stronger aspherical shapes will become necessary. Various optical designs are being tried and evaluated with respect to optical characteristics, manufacturability, cost and imaging behaviour.

Building a successful EUV high-volume system also requires a vast improvement in the lifetime of the optics, making necessary improved monitoring and cleaning technology, early and fast detection methods for damaging species, proper materials selection and new diagnostics tools. The team is aiming for an optics lifetime of greater than seven years.

Supporting volume production

Due to the huge challenges involved in a developing a production-ready system of this kind, the partners are also collaborating in key technology areas outside of EXEPT to ensure that the relevant enabling technologies are available within the project when they are needed. One example is the EUV source technology, which has to be capable of greater than 100 wafers per hour throughput.

The CATRENE project has completed a first production-system design and commenced manufacturing the various modules of the system. Lead partner ASML has already received six orders for EUV pre-production tools; shipping commenced at the end of 2010. ASML is a world leader in lithography tools for chip writing, and a successful conclusion to EXEPT will establish the company as the main supplier of lithography tools at the 22 nm node.

A successful pilot for EXEPT will also benefit the multiplicity of partners for the company and its supply chain. On project completion, the 22 nm system is slated to become the first high-volume EUV manufacturing tool.

Generating high-quality jobs

For the 22 nm node, EUV lithography is the only viable option for high volume production. Under this scenario, mass production will start in 2012. ASML and its supply base will keep market leadership in lithography and even enforce this position in the world resulting in an increase of turnover.

A successful conclusion to this CATRENE project should also deliver cost reductions for the end-user. Above the 50 wafer-per-hour production threshold, EUV can be a more efficient manufacturing solution than double imaging. EUV technology also offers the potential of reduced critical dimensions in 22 nm production; future development down to the 16 nm and 11 nm levels is realistically achievable.

Overall, successful development of EUV technology for volume semiconductor manufacturing has the potential to generate many high quality jobs in Europe, while the technology base can be further developed to provide know-how for other application areas. These include lithography at wavelengths other than EUV, biomedical microscopy development, metrology and elemental analysis equipment development, as well as advanced research on solar energy.

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EUROPEAN INNOVATION INSIDE

CATRENE (Σ! 4140), the EUREKA **C**luster for **A**pplication and **T**echnology **R**esearch in **E**urope on **N**ano**E**lectronics, will bring about technological leadership for a competitive European information and communications technology industry.

CATRENE focuses on delivering nano-/microelectronic solutions that respond to the needs of society at large, improving the economic prosperity of Europe and reinforcing the ability of its industry to be at the forefront of the global competition.