PROJECT PROFILE

2T302: Masks through users supply chain: leadership by excellence (MUSCLE)

LITHOGRAPHY

Partners:

Alcatel Vacuum
Altis Semiconductor
AMTC
ASML
Atmel
Carl Zeiss
CEA-LETI
De Clercq Engineering
DMS
DNP
Entegris
iCADA
IMEC
Infineon Technologies
Nikon
Philips
Photronics
Qimonda
Schott Lithotec
STMicroelectronics
Toppan Photomasks
VISTEC Semiconductor Systems

Project leader:

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Key project dates:

Start: January 2005
End: December 2007

Countries involved:

Belgium
France
Germany
Greece
Italy
The Netherlands
UK

The quality of lithographic photomasks for chipmaking is critical to the performance and success of the semiconductor industry. The MEDEA+ MUSCLE project has therefore undertaken to reduce the cost of ownership and cycle times while maximising quality of the advanced photomasks. It will achieve this by improving standardisation and automation of the photomask supply chain. It is focusing particularly on mask data flow, photomask carrier, photomask defect characterisation and photomask data handling. Success of the project will ensure European photomask shops stay competitive and European chipmakers keep their lead in application-specific integrated circuit (ASIC) prototyping and manufacturing.

Developments in the information society depend on the continuous evolution in the semiconductor industry that enables halving of the cost of chip functionality every 18 months. However, there are dramatic cost increases in lithography – a key element in the manufacture of microelectronics devices – from one technology generation to the next. It is therefore essential to reduce production costs despite technologies facing ever-increasing challenges in terms of feature sizes, complexity and cycle times.

To maintain leadership in the lithographic area and stay competitive with manufacturers in the Far East and the USA, European chipmakers must have access to lithography processes with the highest possible quality and at reasonable prices. One condition for this is the availability of photomasks – including new reticle-enhancement technologies (RETs) – that meet requirements for zero-defect, lower costs and short cycle times effectively.

Improving supply chain

The MEDEA+ 2T302 MUSCLE project undertook to reduce photomask costs and help to safeguard European autonomy in mask supply for future deep submicron processes. It combines broad common efforts from device designers, mask makers, material providers, software houses and mask users to create a leading edge supply chain for very highly advanced masks with zero-defect quality.

It is essential to reduce mask fabrication cycle times, particularly for fast prototyping. IC production process costs can also be reduced drastically if complex new masks can be produced with fewer learning cycles or, optimally, right first time. MUSCLE intends to improve the overall mask supply chain by focused work in three areas: data flow, material flow and fabrication excellence. It will develop reliable indicators for key European partners to manage better their supply chain parameters.

While some technical effort is being dedicated in the project to improving quality, the main focus is analysis, standardisation and automation of hardware and data communications across the whole mask fabrication and use processes, leading to a competitive European mask supply chain.

Cycle time and cost of quality will be improved by:

- Standardising and automating data flows

and communications from IC designers to end-users in semiconductor production;
- Reducing the cost of defects and failures in logistic and handling hardware, including benchmark activities and specific hardware development where necessary;
- Investigating and identifying sources of defects that lead to low printing quality and degradation in use, eliminating these sources and/or developing measures to minimise their influence; and
- Mask process correction within photomask houses.

An important overall goal is to provide a measurement tool for the European photomask supply chain that focuses on the project goals.

Expensive tools

Lithography is the key to circuit miniaturisation. However, it needs very expensive tools and photomasks. In particular, ensuring zero defects in the masks leads to increasing technical difficulties and, as a consequence, to high cost. Overcoming these difficulties requires research into not only photomask technology but also wafer lithography itself as well as production methodology and whole supply chain.

MUSCLE focuses on improving the competitiveness of the European mask supply chain for the next semiconductor generations and gaining leadership in on-time delivery at competitive costs. This requires:
- Very sophisticated RETs for the masks as long as optical lithography is used for new technology nodes – 90 nm, 65 nm and below – to allow integration of a huge number of functions onto one chip in very complex designs;
- More sophisticated data, materials and processes interaction loops from circuit designer to final circuits on a chip; and
- Dramatic progress towards the zero-defect level as increased sensitivity of photomasks to defects would otherwise reduce yields.

Essential element

Photomask supply is an essential part of the lithography process and a key element for semiconductor manufacturing. This MEDEA+ project will help to secure the competitiveness of European chipmakers against their Asian competitors.

As the project consortium represents nearly all relevant companies in the European high-end mask business, the new standards and methods developed will have a very good chance of being accepted by the broad majority of European companies. And, as major project participants operate globally, acceptance in the rest of the world is also expected to be high.

All project partners plan to use relevant results. And further marketing of the transferable tools developed is planned to enlarge the working base. This will be supported by links with the international SEMI organisation. Existing SEMI standards will be used as far as possible and new standards will be transferred to SEMI to become accepted worldwide.

If the project results show that existing hardware or software is not sufficiently well suited to future mask quality requirements, then the European companies involved will start development of new hardware and methods to ensure defect-free masks, leading to the availability of patents, licences and new products. Dissemination of the results will be carried out at conferences, through workshops and by links to other lithography projects.

Stable and robust

Overall, the MUSCLE project will guarantee stability and robustness of a very advanced photomask supply chain in Europe and will improve the position of European photomask shops by standardisation and by technology platforms. And the powerful consortium involved in the project will be able to influence equipment and software suppliers to support the resulting European standards.

There is a worldwide effort to extend optical lithography to the next IC node by using more accurate RETs that require production of more complex masks in terms of data processing and features. Because of mask complexity increases and low mask yields, the cost of a photomask set can be prohibitive for prototyping or where only a few thousand wafers are to be produced.

Through joint public-private resourced efforts, it will be possible to limit photomask costs without sacrificing use of latest advanced mask generations, while reducing photomask supply cycle times. This will allow European mask shops to stay competitive and European chipmakers to maintain their lead in rapid prototyping and manufacturing of application-specific devices.

In addition, supply chain improvements will guarantee on-time availability of new photolithography processes ready for 90 nm and future 65 and 45 nm nodes. This will ensure European system producers have access to the technologies necessary to build competitive products with short times to market and safeguard employment.

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MEDEA+ focuses on enabling technologies for the Information Society and aims to make Europe a leader in system innovation on silicon for the e-economy.