



**Coordination Action to enable an effective  
European 450 mm Equipment & Materials Network**

**Enable 450 Newsletter**

**Issue 1**

**March 2013**

## **An Introduction to Enable450**

Welcome to the first newsletter for the Enable450 project. Please accept our apologies if you have received it more than once but we have tried to distribute it to as wide an audience as possible by using multiple mailing lists.

This project is funded by the European Commission under the Objective FP7-ICT-2011-8 with the objective of co-ordinating and supporting standardizations actions for preparatory work for 450 mm wafer processing, specifically targeting European material and equipment companies.

The project has five work packages, the production of this newsletter and a companion website [www.enable450.eu](http://www.enable450.eu) being part of WP4.

- WP 1 Coordination and Management
- WP 2 Collection of requirements
- WP 3 Standards
- WP 4 Dissemination
- WP 5 Link to global activities

At the current time there is little to report from the other work packages but this will obviously change over time. However this newsletter will also highlight recent activities on 450mm related work within Europe however they are funded, together with news from others working in this field worldwide.

## **Project Membership**

There are eleven members of the project consortium who are listed below.

ASM International NV (Coordinator)	ASM	Netherlands
Applied Materials Israel	AMIL	Israel
ASML Netherlands BV	ASML	Netherlands
Commissariat à l'énergie atomique et aux énergies alternatives	CEA-LETI	France
Fraunhofer IISB	IISB	Germany
Future Horizons	FH	UK
Intel Performance Learning Solutions (IPLS)	INTEL	Ireland
Interuniversitair Micro-Electronica Centrum vzw	IMEC	Belgium
RECIF Technologies	RECIF	France

SEMI Europe	SEMI	France
SOITEC	SOITEC	France

Most of these companies will be well known to you but there follows a brief overview of the companies, their main activities within the Enable450 project and other work in 450mm wafer processing technologies to date.

### **ASM International NV (Coordinator)**

ASM is a leading manufacturer of wafer-fab and packaging equipment and materials. ASM's Front-end Operations has a 40-year track record in the industry, particularly in all types of CVD technologies such as LPCVD, ALD, RTCVD, PECVD and Epitaxy. ASM Front-End-of-Line division manufactures vertical batch furnaces for atmospheric, LPCVD and ALD applications and several families of single wafer reactors, both in stand-alone equipment as in cluster platforms, dedicated to the range of processes as mentioned above.

Bas van Nooten of ASM is the Enable450 project coordinator for therefore heads up work package 1 (WP1 – Management and Coordination), co-ordinating all activities of the other work packages.

### **Applied Materials Israel**

Applied Materials (AMIL) Israel is part of the larger Applied Materials group and so will inevitably be involved in 450mm equipment development. AMIL develops and manufactures process control equipment and its products serve the silicon wafers fab manufacturing market with DUV wafer inspection, metrology SEM and defect review SEM.

Within this project, AMIL will be a major contributor to WP5 - Link to Global Activities.

### **ASML Netherlands BV**

ASML is one of the world's leading providers of semiconductor manufacturing equipment with a large R&D programme supporting the development of new technologies such as EUV lithography.

ASML works with research and development partners and a network of high tech companies and suppliers. The company leverages a high-technology network that includes Philips Research Laboratories, Philips Innovation Services, imec and Carl Zeiss SMT GmbH, enabling ASML to compete very effectively with other lithography equipment makers in the international marketplace. ASML is now the world leader in photolithography with an installed base of more than 2500 systems at customer sites around the world.

ASML is expected to be the dominant and indeed possibly the only supplier of high-end volume manufacturing lithography systems, especially those providing EUV lithography

which will become essential around the time the first 450mm full production fabs begin activities.

Within this project, ASML will be a major contributor to WP3 - Standards and WP5 - Link to Global Activities.

## **CEA-LETI**

CEA-LETI brings its wide expertise in micro- and nanotechnologies and in their integration into complex systems. Its focus on silicon-based microelectronics and microsystems leverages on its research activities in the field of communication, imaging systems and biology and health. It is strongly linked with the local academic and industrial high-tech players through the Minatec campus and through the proximity of European research facilities – like ESRF, ILL, EMBL, etc. –, of major academic teams and of significant microelectronics industrial sites like Crolles 2. These links are extended at the national level – e.g. through the Network of Research Platforms –, within Europe through its participation to many European and transnational projects and networks, and with LETI participation as research partner in the IBM Alliance in Albany.

Within this project, CEA-LETI will predominantly contribute to WP2 - Collection of Requirements and WP4 – Dissemination.

## **Fraunhofer IISB**

The Fraunhofer Institute for Integrated Systems and Device Technology (IISB) is one of the 60 Fraunhofer Institutes and conducts applied research and development in the fields of micro- and nanoelectronics, power electronics, and mechatronics. Together with its industrial partners, the Fraunhofer IISB is developing new equipment and processes for semiconductor manufacturing, assessing new manufacturing equipment, materials, and the related processes. Activities include specification, co-development, optimization, and assessment of equipment, development of processes and qualification of unstructured wafers, structured wafers, and devices. Additionally, equipment developments are supported by research, development and application of novel control methods. Members of the institute are active in and heading SEMI standardization taskforces and ITRS technical working groups.

Within this project, IISB will contribute equally to all the work packages.

## **Future Horizons**

By far the smallest company involved in this project, Future Horizons is an independent UK based European consultancy specialising in the field of semiconductors. The company is probably best known for its market presentations at industry events but also produces market research reports, industry analysis, forums and seminars, as well as custom consulting projects for a wide variety of clients. It has a far deeper technical understanding than most consultancies of this type and so can produce a more complete analysis for those clients.

Working with Decision of France, the company produced the SMART 2010/062 project for the European Commission entitled “Benefits and Measures to Set Up 450mm Semiconductor Prototyping and to Keep Semiconductor Manufacturing in Europe - The role of Public Authorities and Programmes” which is probably best known for proposing a European semiconductor consortium styled upon that used by Airbus, a concept enthusiastically adopted by the Vice President of the European Commission Neelie Kroes using the expression “Airbus of chips”.

Mike Bryant of Future Horizons co-ordinates WP4 – Dissemination, and is thus responsible for co-ordinating the work of the whole team in producing this newsletter, the associated website and arranging workshops at international conferences.

### **Intel Performance Learning Solutions (IPLS)**

Intel Performance Learning Solutions Ltd (IPLS) is an Irish incorporated Company whose function is to research and develop new technologies in accordance with Intel’s research and development agenda, and houses the majority of Intel’s research and development projects in Ireland on the campus at Leixlip, County Kildare, home of Intel's fourth largest manufacturing site. Fab 24 opened in June 2004 and was expanded in 2006 to form the high-volume 300mm semiconductor manufacturing facility Fab 24-2, the first factory of its kind in Europe using advanced 65 nm process technology.

IPLS has a team responsible for research in semiconductor manufacturing and nanotechnology in such areas as advanced process control, next wafer size generation, energy efficiency in manufacturing, self-assembly, nano-materials synthesis and integration, nano-photonics, and silicon spintronics. The team collaborates extensively with research institutes, universities, and other companies across Ireland and Europe.

Intel Corporation is involved in G450C in Albany, and is of course one of the companies leading the next wafer size transition. By creating a link between Intel Corporation in the US, and Intel in Europe on the topic of 450 mm, a cooperative and collaborative environment for innovation and creativity to overcome the specific challenges in this topic can be further developed. Such links already exist for engagement in the EEMI450 Initiative and the existing funded 450 mm European collaborations, and have proved fruitful in establishing the current European 450 mm ecosystem

Bernie Capraro of Intel will lead WP5 - Link to Global Activities, ensuring adequate linkages to 450 mm activities worldwide are created, enabling cooperation and complementary activities to be performed in support of the industry transition to the next wafer size.

### **Interuniversitair Micro-Electronica Centrum vzw**

Imec is the world-leading independent research center in nanoelectronics and nanotechnology. Its research focuses on the next generations of chips and systems as well as many other topics and its research bridges the gap between fundamental research at universities and technology development in industry. Almost every semiconductor company in the world partners with Imec on one of more of its advanced semiconductor

research programmes, as do many of the leading semiconductor equipment and materials companies.

Imec is thus positioned as one of the world leaders in development of both the processes, materials and production techniques that will be employed by future 450mm wafer fabs, and is building a new extension to its clean rooms to add 450mm processing capability to its existing 300 and 200 mm process lines.

Anne Van den Bosch of IMEC will lead WP2 - Collection of Requirements, supporting the collection of requirements for 450 mm technologies from other companies within and outside of the project team.

## **RECIF Technologies**

RECIF Technologies designs, manufactures and distributes robotic handling equipment for the semiconductor industry, supplying more than seven hundred 300mm wafer handling equipments.

The company was a leader of the 200 to 300mm transition providing the first 300mm sorter equipment, and aims to deliver the same for the transition to 450mm. To this end, RECIF has been a key player in the development of the 450 mm related SEMI Standards in this area.

RECIF has given many presentations and theoretical simulations worldwide dedicated to the topic of 450 mm wafer handling. The company is also involved in SEMATECH/ISMI 450 mm activities.

Within this project, RECIF will be a major contributor to WP3 - Standards and WP5 - Link to Global Activities.

## **SEMI Europe**

SEMI is a not-for-profit global industry association representing 2000 companies that supply equipment, materials and services for the manufacturing of semiconductors, photovoltaic, MEMS, displays and related technologies. SEMI supports 200 member companies in Europe, of which SMEs represent 90% of its membership.

Yann Guillou of SEMI will lead WP3 - Standards, assessing existing and potentially new standards with focus on European participation in definition of new standards to increase the European influence in equipment and materials manufacturing.

## **SOITEC**

The Soitec Group is the world's leading innovator and provider of engineered substrate solutions, leveraging its proprietary Smart Cut™ technology to provide solutions such as silicon-on-insulator (SoI) wafers, the first high-volume application for this proprietary technology. SoI is generating interest as the material platform of the future, capable of producing higher performing, faster chips that consume less power. Other divisions of the company use similar techniques to produce III-Vs epiwafers and gallium nitride (GaN)-based wafers for specialist applications.

Soitec produces more than 80 percent of the world's SoI wafers and after recent statements by some other wafer manufacturers appears to one of the wafer manufacturers with the most interest in supporting 450mm wafer development.

Within this project, Soitec will contribute to all the work packages.

## **Editorial**

This newsletter will attempt to cover all major news events concerning 450mm wafer development, and we will also launch our own website shortly.

The European Commission has been a strong supporter of this new wafer size, seeing it as an opportunity for Europe to regain the initiative in nanoelectronics as happened previously in the latter years of the 20<sup>th</sup> century. There are a growing number of publicly funded projects being undertaken at the moment which are summarized later in this newsletter.

Any newcomer to European 450mm technology should consult two key documents for an introduction, these being :

- EEMI450 White Paper  
[http://www.eemi450.org/White\\_paper\\_EEMI450\\_Final.pdf](http://www.eemi450.org/White_paper_EEMI450_Final.pdf)
- SMART 2010/062 project for the European Commission  
<http://cordis.europa.eu/fp7/ict/components/documents/450mm-final-report.pdf>

Both these documents contain an element of technical and marketing data, and make recommendations on how Europe should proceed in this area.

Although the key activities of the Enable450 project are in WP 2 (Collection of requirements), WP 3 (Standards) and WP 5 (Link to global activities), it might rightly be asked how WP4 (Dissemination) does not duplicate what others are already offering. Specifically there are three websites those interested in 450mm technology, including ourselves, already consult, these being :

- The SEMI “450mm Central” website <http://www.semi.org/en/Issues/450mm>
- The 450mm.com website <http://www.450mm.com/>
- The G450C website <http://www.g450c.org/>

However with all the key European E&M companies and the three main European research establishments members of this project, we do aim to offer something new and informative in this newsletter, as the following sections should illustrate over time.

**WP 2 Collection of requirements**

Results from this workpackage will appear here in future newsletters.

**WP 3 Standards**

Results from this workpackage will appear here in future newsletters.

**WP 5 Link to global activities**

Results from this workpackage will appear here in future newsletters.

**Patents**

A list of recent key patents concerning 450mm wafers will appear here in future newsletters.

## **European 450mm Projects**

Details of the key European 450mm R&D projects with which Enable450 will liaise are listed here for reference. In this first issue of the newsletter full details of each project are given whilst in future issues we hope to be able to give news on progress to date.

### **EEMI450 – European 450mm Equipment & Materials Initiative**

This was the first European 450mm initiative with the goal of stimulating a European infrastructure working on 450mm development and as a result encourage Tier 1 semiconductor companies into cooperation programs and possibly to equip 450mm fabs in Europe. This programme began in 2009 and continues working to this day, its main job being to initiate new collaborative projects, usually under the ENIAC or CATRENE programmes.

The initiative website is at <http://www.eemi450.org/>. The list of member companies is given on the Members tab.

**If your company is active in 450mm technology in any manner large or small but is not yet a member then please consider joining the initiative by e-mailing [bas.van.nooten@asm.com](mailto:bas.van.nooten@asm.com) who will supply joining information.**

### **EEMI450 Project**

An early accomplishment of the EEMI450 programme was to create an ENIAC funded project confusingly of the same name which began in May 2010 and ran until 2012. This project had a budget of €18.3 million of which the EU and national governments funded €7.8 million.

The project addressed the complete spectrum of E&M 450mm development:

- Wafer manufacturing and characterisation
- Metrology
- Waferhandling and automation
- Development of process modules, both batch and single wafer, including the supply chain.
- Lithography

This project was the first occasion that a large number of European E&M companies cooperated to achieve benefits for all and reduce development time, as well as putting 450mm on the European radar screen. The consortium aimed to lay the basics of further developments in this new arena.

- Define a common European "open" platform for 450mm, using already available standards, if needed defining new ones
- Develop modules/metrology components complying to these definitions (mechanical / electrical)
- Manufacture of 450mm wafers, first in handling quality, goal to achieve testwafer quality.
- Possible common software developments
- Emphasis on green solutions:
  - Reduced energy consumption per processed die
  - Reduced usage of resources
  - Less waste
- Emphasis on APC/virtual metrology to reduce downtime and make process outcome more predictable
- Follow ITRS roadmap for 22nm node and beyond

The final results of this project can best be viewed here :

[http://www.eemi450.org/Project\\_EEMI450\\_Publishable\\_Report.pdf](http://www.eemi450.org/Project_EEMI450_Publishable_Report.pdf)

## **SOI450 - Development of 450mm SOI substrates, related technologies and equipments**

This project operates under CATRENE and is part of the CT3 Manufacturing science: Cross-cutting Technologies, Equipment and Materials work area. It will run from November 2011 until December 2014.

The goal of the project is to develop 450mm SOI substrates and related technologies in order to bring equipments and substrates at a mature level for industrialization. The project will include tool development and SOI implementation, with feasibility milestone followed by start of a pilot line. SOITEC will lead the consortium of key equipment suppliers (EVG for bonding, Mattson for RTP), supply chain suppliers, three institutes for the evaluation of tools and technologies and IC maker Intel.

It aims to stimulate a European infrastructure which will lead the work in 450mm development on SOI materials and related advanced technologies such as bonding, cleaning and thermal treatment. Work includes tool development and SOI implementation, with feasibility milestones, followed by the start-up of an initial processing line. The overall objective is to ensure Europe will be fully-prepared to participate and contribute actively to the wafer-size transition in this innovative and technology-driven market segment.

The worldwide semiconductor industry has been driven by Moore's Law for over 40 years. During that time, it has been determined that the benefits of reduced cost per transistor, better performance and increased functionality allow for increased budgets for innovative design. However, even assuming a very moderate cost increase in the range of 10 to 15 percent from generation to generation, it is easy to calculate that the cost/cm<sup>2</sup> doubles about every ten years.

To re-establish reasonable manufacturing costs/cm<sup>2</sup>, the industry has undergone a wafer-size transition about every eight to ten years. The last wafer-size transition occurred at the beginning of this 2000s with the introduction of production lines with 300mm diameter wafers.

The next wafer-size transition is therefore imminent. The industry has already selected 450mm as the new standard. The three major global semiconductor companies have been working together for two to three years to prepare for the next wafer size to achieve the necessary manufacturing cost reductions.

Since 2007, the International SEMATECH Manufacturing Initiative (ISMI) has collected and developed requirement guidelines, reusing many 300 mm wafer guidelines to leverage learning where existing concepts are proven. Early designs in 2007 transitioned to early wafer-handling prototypes in 2008 and an effort to produce a bank of 450mm test wafers for equipment evaluation materialised in 2009. In 2010, ISMI was ready to accept process-equipment prototypes and commence demonstrations.

European activity on 450mm wafer size will interact with the ISMI process, eventually contributing to a first 450mm pilot line in 2012, as defined by the current International Technology Roadmap for Semiconductors (ITRS). The CATRENE CT305 SOI450 project brings together the experience and expertise of leading European players in the semiconductor equipment and materials environment to ensure that Europe is fully-prepared to participate and contribute to the transition.

SOI450 involves the development of equipment and materials for the next generation of semiconductor devices. These products define a huge, self-sustaining market by themselves. In these global markets, the European equipment and materials industry has achieved a world-leading position and acts as a powerful European engine for economic growth in its own right. The introduction of the 450mm wafer diameter will be a new opportunity for the European equipment and materials industry to improve its competitiveness and gain market share.

More than 80 percent of silicon-on-insulator (SOI) substrates are manufactured by SOITEC, the global leader in this domain. Its success is largely attributed to strong collaboration with key European equipment suppliers and research laboratories. As SOI substrates are one key path to nanoscale CMOS, identified by end users for digital applications, system on-chip devices and memories, large volume applications are forecast at 450mm. It is essential to capture this market with the transition to 450mm.

This CATRENE project aims to stimulate the European infrastructure concerned with 450mm development on SOI materials and related advanced technologies such as

bonding, cleaning and thermal treatment. The objective is to increase European leadership within this highly innovative and technology-driven market segment. This target requires a joint effort for the development of innovative substrates and equipment.

450mm standards are currently being established within SEMI and developments are being integrated with the ITRS, which indicates that the launch of the first 450mm pilot lines will be in 2012. European semiconductor equipment and materials companies have decided that, to secure their global business activities, they need to take an active part in these developments. Consequently, a European equipment and materials 450mm initiative was established in 2009 under the umbrella of SEMI. The main goal is to maintain a high level of competitiveness for the European equipment and materials industry.

The innovation and technical challenges deal not only with the size change but also in the higher substrate quality needed for the ultimate nodes targeted by the wafer-size transition. These nodes will be more sensitive to contamination, requiring new specifications. New technologies and equipment will have to be developed to produce larger wafers for advanced CMOS technologies far beyond 22nm.

Major objectives of SOI450 are to ensure the fabrication of SOI substrates at the right moment for time to market, and develop new business opportunities. SOI offers a powerful tool to balance power efficiency and performance: it provides increased transistor switching speed of more than 30 percent, power reductions of 50 percent or a trade-off in power/performance and superior isolation for circuit and design. It also enables compact integration of intellectual property blocks. Furthermore, SOI will play a key role in the 'more Moore' race as it answers most of the scaling challenges. These ultimate nodes are the ones targeted by 450mm transition.

The ambitious goals of SOI450 can only be reached by intensified co-operation and sharing of expertise within Europe. Close collaboration between European material vendors, equipment and subsystem suppliers, as well as with academic partners, will promote an increase of the European market share and ensure a competitive position on the global market for 450mm SOI material.

SOI450, together with other European 450mm projects, will have a significant impact on further R&D activities. It will provide access for the companies involved and European research institutes to the necessary 450mm SOI technology. Without European and national funding, worldwide co-operation and the access to 450mm would be very limited because a large part of the development work would then be performed in Asia or the USA.

Such projects are an important way for the European equipment and materials industry to participate in the next-generation wafer technology and in the worldwide market for 450mm equipment and materials. It is envisaged that, because of their huge size, there will only be a small number of 450mm high-volume fabrication facilities built around the world. It is therefore very important that Europe stakes a claim to the possibility of having at least one such facility built and operated in the region.

The companies involved are :

- Altatech
- ASM
- AVP
- CEA-LETI
- EV Group
- Fraunhofer
- IMEC
- Intel
- Mattson
- SOITEC

## **NGC450**

This is another CATRENE project and is part of the CT3 Manufacturing science: Cross-cutting Technologies, Equipment and Materials work area. The project runs from November 2011 until December 2014.

The NGC450 project aims to enable in Europe the development of sub modules (for process or metrology) around a wafer handling platform, dedicated to support the 450mm wafer size migration.

The project will be conducted in 2 steps:

- Development of a wafer handling R&D platform.
- Integration of standard base process modules into the platform.

The developments will be performed in compliance with the standards and specifications being already settled by ISMI, and will also be in line with the delineation of both CATRENE and ENIAC projects definition.

This synergy between the European companies is expected to fasten the development and reduce costs by sharing the efforts as well as the risks.

The modules and equipments resulting from the above mentioned developments will be made available and valued for a worldwide utilization, upon each European partner agreement and convenience.

The developments will be driven with the objective that part of the technology improvements will be applied to 300mm in order to sustain the competitiveness of European semiconductor Industry who work on 32/28nm and below (22/20nm).

Considerable technical support is required for the move from 300 to 450mm diameter wafers in semiconductor fabrication facilities. The CATRENE NGC450 project is developing a European wafer-handling platform to make this possible while meeting standards and specifications already established by the International SEMATECH Manufacturing Initiative.

This work is in line with other CATRENE and ENIAC projects with the resulting synergy between European chipmakers expected to accelerate development and reduce costs. The modules and equipment resulting from this work will be available for worldwide use, so strengthening the role of Europe as a leader in the field of advanced semiconductor fabrication.

State-of-the-art wafer fabrication for integrated circuits (ICs) has been based on 300mm wafers but a migration to 450mm wafers is now planned by leading chipmakers as this offers a vast improvement in production volume and the yield of viable devices. However, new machinery is needed to handle and process larger wafers, resulting in much increased investment costs to build a semiconductor fab.

Moreover, a simple increase in equipment dimensions cannot satisfy the primary expectations of industry leaders to meet the main technical challenges, and achieve the same throughput as that of a 300mm wafer fab with sub-22nm node compliance.

Such a transition requires considerable research and development (R&D) effort and presents substantial technical and financial challenges.

The combined energy of the companies involved in the CATRENE CT306 NGC450 project is expected to secure European competitiveness in the promising 450mm market as a result of sharing key skills as well as limiting redundant developments on robotics and automation.

A significant part of the R&D output will be dedicated to the improvement of current 300mm applications targeting the same 22/20nm technology node and focusing on cleanliness, throughput and yield improvement. It is, therefore, also an opportunity to sustain the European semiconductor industry in the existing 300mm market.

The 300mm IC manufacturing industry is today supported by state-of-the-art production equipment which benefits from mature and stable robotics with a sub-30nm node capability. Migrating to 450mm wafer size with sub-22nm nodes poses challenges which cannot be addressed by current designs. For instance, robotics have to transfer heavier masses over longer distances within the same period of time and also cope with increased vibration and even more challenging cleanliness.

The 450mm standards developments are supported by the Semiconductor Equipment and Materials International (SEMI) and Sematech organisations. First-level standards were published at the end of 2009 for test wafers, process wafers, carriers and load port. Earlier 2008 and 2009 standards focused on defining the physical interface and were dedicated to atmospheric robotics.

Project partners will each have specific responsibilities for :

- Systems analysis and high dynamic atmospheric robotics, with deliverables involving an atmospheric equipment front-end module with preliminary equipment made available for partners requiring automated wafer loading for process development, and a detailed state-of-the-art unit assembled for final characterization.
- Development and construction of a vacuum robot and a linear vacuum chamber.
- Development and construction of end effectors for both atmospheric and vacuum environments.
- Development of interfacing control software which will enable all equipment and modules to communicate over one commonly specified standard.
- Collaboration on the specifications of the robotics and software to ensure compatibility between the wafer-handling platforms developed within NGC450 and other current projects.
- Definition of requirements and equipment evaluation and qualification such as contamination, energy efficiency and standardisation compliance.
- Interaction during the specification review between partners involved in the integration phase, with one partner providing clean room space with the logistics and fluids needed for the tools while also accommodating personnel from other partners and helping them with evaluation of their tools.
- Participation in the review and assessment of specifications and the provision of expertise so that developments can be evaluated for their potential on the silicon-on-insulator (SOI) production line with provision also for double silicon substrates.
- Participation in the atmospheric mini-environment specification and development of both alpha and beta atmospheric wafer handling equipment.

The ultimate objective is a comprehensive package built by European semiconductor enabling solutions providers. This package will address 450mm challenges by sharing the same hardware and software interfaces. The development around a common software and robotics platform will share the risks, limit redundant development and thereby limit overall R&D costs.

NGC450 will use the findings and results from the first ENIAC 450mm project and will be a reference for the next 450mm projects, including the follow-up project of the EEMI450 ENIAC project. Some of the NGC450 outputs will be fed into other projects such as ENIAC EEM450PR. This proves the consistent continuum set by the EEMI450 initiative.

The results of this CATRENE project will consolidate the European semiconductor equipment industry's global leadership position. Indeed, European manufacturers address a worldwide market for process equipment, material, automation and robotics.

Most sales achieved by European semiconductor production equipment and materials companies are outside Europe. As an example, one NGC450 partner has secured more than a 25 percent share of the worldwide market in 300mm wafer sorters over the last decade. More than 90 percent of its turnover now comes from outside Europe, moreover, Europe accounts for only 7 percent of its worldwide installed base of nearly 700 units of 300mm equipment.

World-leading equipment supplier ranking is currently held mainly by US and Japanese companies. Equipment suppliers from these two areas have already secured a position in this new 450mm segment. NGC450 presents an opportunity for Europe to establish and develop its own share of this global market.

If European companies manage to achieve the 450mm goal in good time, they will have an excellent opportunity to share in the investments which are likely to be made in South Korea and Taiwan.

As indicated, 450mm migration raises technical and financial challenges. This CATRENE project will provide the European semiconductor materials and equipment industry with the opportunity to co-operate to optimise R&D efforts and minimise related risks. NGC450 is enabling these European companies to focus on a common target which is to reduce the time to market of European-made 450mm enabling technologies and give interoperability advantage to European equipment suppliers.

The companies involved are :

- AIS
- ASYS
- CEA-LETI
- EVG
- Fraunhofer
- HAP
- Intel
- RECIF Technologies
- Soitec

### **EEM450PR - European Equipment & Materials 450mm Pilotline Readiness**

The aim of the ENIAC EEM450PR project is to continue the engagement of the European semiconductor equipment and materials industry in the 450mm wafer size transition that started with the ENIAC JU EEMI450 initiative. It will also bring about the start of a vision to place an equipment development pilot line in the IMEC facility in

Leuven. This will provide Europe with a complementary activity for 450mm equipment, and later on sub 10nm process development.

The main objective of the work on lithography is the proof of concept at test bench level of 450mm critical wafer stage technology to get prepared for 450mm early lithography prototype realization in a subsequent phase.

Next to technology development also a 450mm equipment development pilot line facility will be prepared by developing state-of-the-art facilities readiness, including stringent energy and contamination considerations taking recent ISMI Guidelines, Semi Standards and ITRS requirements and activities into account.

Furthermore, work will be done on the development of pilotline-ready equipment and modules, and further optimization of prototypes, concerning front-end (wafer based) semiconductor processing. The companies that were involved in the ENIAC EEMI450 project will use the results obtained therein for further development of their respective equipment.

Finally, metrology equipment performance will be enhanced to improve the current 300mm cost of ownership for 12nm technology control on 450mm wafers.

The project will last 36 months beginning on 2nd February 2012. The budget has been given at €84 million of which the EC will fund €14 million.

The companies involved are

- ASML Netherlands B.V., Netherlands
- AIS Automation, Germany
- Applied Materials Israel, Israel
- Artemis control AG, Switzerland
- ASM International NV, Netherlands
- ASYS Automatic Systems GmbH & Co. KG, Germany
- Edwards Ltd, UK
- EV Group E. Thallner GmbH, Austria
- FEI Electron Optics BV, Netherlands
- Fraunhofer Institute of Integrated Systems and Device Technology, Germany
- Heraeus Quarzglas GmbH & Co KG, Germany
- HQ-Dielectrics GmbH, Germany
- Interuniversitair Micro-Electronica Centrum vzw, Belgium
- Intel Performance Learning Solutions Ltd (IPLS), Ireland
- Jordan valley semiconductors LTD, Israel

- KLA-Tencor Corporation Israel, Israel
- LAM Research AG, Austria
- Levitech BV, Netherlands
- M+W Germany GmbH, Germany
- Nationaal Lucht- en Ruimtevaart Laboratorium, Netherlands
- Netherlands Organization for Applied Scientific Research, Netherlands
- Nova Measuring Instruments Ltd, Israel
- Oxford Instruments Nanotechnology Tools Ltd, UK
- Philips Electronics Nederland B.V., Netherlands
- RECIF Technologies S.A.S, France
- SemiLev GmbH, Germany
- Xycarb Ceramics B.V., Netherlands

## **E450EDL – European 450mm Equipment demo line**

The aim of the ENIAC E450EDL key enabling technology pilot project is to continue the engagement of the European semiconductor equipment and materials industry in the 450mm wafer size transition that started with the ENIAC JU EEMI450 initiative and proceeded with subsequent projects funded with public money, amongst others NGC450, SOI450, EEM450PR. The demo line resulting from this project will be such that it will enable first critical process module development by combining imec infrastructure with tools remaining at the site of the manufacturers (distributed pilot line). Multi-site processing will allow partners to participate in the world first 450mm integration studies and will be enabled by the controlled exchange of 450mm wafers between different sites.

The consortium comprises 41 members (from 11 different European countries) with many SMEs and research institutes. The project is organized in five technical work packages and a work package on management and coordination.

In the work package on integration and wafer processing first critical modules will be developed and will demonstrate the feasibility of processing on 450mm wafers. The main objective in the work package on lithography is to develop a wafer stage test-rig, which can be implemented into the pilot line system.

In the work package on front end equipment several tools will be developed such as a plasma ion implant module, a plasma dry etch module, a RTP system and a single wafer cleaning system.

Furthermore, in the dedicated work package on metrology 450mm metrology tool types will be developed for amongst others dielectric film thickness and composition measurements, defect inspection, defect review and analysis, optical critical dimensions (CD), overlay (mask and wafer) and 3D metrology.

Finally, from the work package on wafer handling and automation a set of equipment will be provided to support the demo line operations, and facilitate the R&D dedicated to process and metrology modules.

The project will last 36 months beginning on 1<sup>st</sup> of October 2013. The budget has been given at €204.6 million of which the ENIAC JU will fund €30.8 million.

This project is still considering new members so if you are interested please contact [gerold.alberga@asml.com](mailto:gerold.alberga@asml.com)

The companies currently involved are

- ASML Netherlands B.V., Netherlands
- adixen Vacuum Products, France
- AIS Automation Dresden GmbH, Germany
- Applied Materials Israel Ltd., Israel
- artemis control AG, Switzerland
- ASM Belgium N.V., Belgium
- ASYS Automatic Systems GmbH & Co. KG, Germany
- CEA-Leti, France
- DEMCON, The Netherlands
- Entegris Cleaning Process (ECP) S.A.S., France
- EV Group E. Thallner GmbH, Austria
- FEI Czech Republic, s.r.o., Czech Republic
- FEI Electron Optics B.V., The Netherlands
- IBS ion beam services, France
- IDE integrated Dynamics Engineering GmbH, Germany
- Interuniversitair Micro-Electronica Centrum vzw, Belgium
- Intel Performance Learning Solutions Ltd, Ireland
- Institute of Scientific Instruments of the ASCR, v.v.i., Czech Republic
- Jordan Valley Semiconductors LTD, Israel
- KLA Tencor Corporation Israel Ltd., Israel

- LAM Research AG, Austria
- Levitech B.V., The Netherlands
- M+W Products GmbH, Germany
- Metryx Ltd, United Kingdom
- MFA Research Centre for Natural Sciences - Institute for Technical Physics and Materials Science, Hungary
- Mogema B.V., The Netherlands
- Nanoplas SAS, France
- Nova Measuring Instruments Ltd, Israel
- Prodrive B.V., The Netherlands
- Recif Technologies S.A.S., France
- Reden, The Netherlands
- Riber, France
- Semilab Semiconductor Physics Laboratory Co. Ltd., Hungary
- Semilev GmbH, Germany
- Soitec S.A., France
- SUSS Microtec AG, Germany
- TNO - Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, The Netherlands
- Delft University of Technology, The Netherlands
- VDL Enabling Technologies Group Eindhoven B.V., The Netherlands
- Xycarb Ceramics B.V , The Netherlands
- Carl Zeiss SMT GmbH, Germany

### **Other Initiative and Projects**

In the next newsletter we will give details of other new initiatives and projects including :

- METRO450
- SEA4KET
- BRIDGE450

## **Latest News**

Here we cover some of the latest news concerning 450mm wafer development.

### **450 mm cluster tool at Fraunhofer IISB ready for HW/SW integration**

A 450 mm cluster tool including a patented space saving design for integration of aligning and cooling station has been fully integrated into the cleanroom facility at the Fraunhofer IISB in Erlangen and is now ready for hardware/software integration of the process and/or metrology modules.

This unit offers

- 450 mm and 300 mm handling without retrofitting
- A pressure range from atmospheric to high vacuum (10<sup>-7</sup> Torr)
- Transport Max Reach (TMR) of the central robot: 545 mm
- Wafer Transfer Plane (WTP) is variable between 1100 mm and 1400 mm
- Vacuum alignment tunnel and cooling station integrated
- Versatile metrology module to evaluate metrology components is planned and part of a recently submitted proposal on equipment assessment for key enabling technologies



### **Proposal on Semiconductor Equipment Assessment for Key Enabling Technologies submitted**

Fraunhofer IISB has coordinated and submitted a proposal for the FP7 ICT10 call on Semiconductor Equipment Assessment for Key Enabling Technologies (SEA4KET). SEA4KET is a proposal for taking the consequent step from equipment R&D to equipment assessment experiments. The strategic objective is to effectively combine resources and expertise into a joint assessment of novel equipment for key enabling technologies to foster and accelerate the successful transfer of novel European equipment into the world-wide market.

SEA4KET builds on the proven principle established in previous European SEA programs and projects of taking novel, innovative and promising equipment that has left the R&D phase into a joint assessment activity. This bridges the well-known gap between the phase of having an engineered tool available and finding the 'first user' and finally success in the market for it.

SEA4KET will concentrate on process and metrology systems for important enabling technologies such: 450 mm wafer equipment, SiC materials and 3D processing.

SEA4KET is expected to significantly strengthen the European equipment and materials industry for the Key Enabling Technologies in a sustainable way by combining advanced R&D with equipment assessment involving users, institutes and equipment suppliers with specific benefit for the SME suppliers.

### **Contamination Management and Yield Enhancement Workshop**

On 21st January 2013, Adixen, a subsidiary of Pfeiffer Vacuum), hosted a Contamination Management and Yield Enhancement Workshop close to their European Headquarters in Annecy, France. The workshop specifically addressed the four themes of 450 mm, AMC contamination in microelectronic factory, advanced metrology and challenges for next generation lithography.

Fifty delegates from all over Europe and the rest of the world were in attendance at the spectacular lakeside venue of Menthon-Saint-Bernard.

To start the Workshop, presentations on the current 450mm activities in Albany and Europe were given by Dr Michael Liehr of the College of Nanoscale Science and Engineering (CNSE) and Mr Bernard Capraro representing the European Equipment and Materials for 450mm Initiative (EEMI450). Both presentations discussed the status and aspirations of their 450mm R&D programmes, as well as stating and indicating the intention to cooperate and collaborate globally in order to achieve both an effective and efficient wafer size transition for the semiconductor industry.

Carried out within the framework of European SEAL project sponsored by the European commission (FP7), this workshop was followed by a forum organized by the German IISB Fraunhofer Institute.



### **ENIAC increases its investment in 450mm semiconductor research**

The total investment in the ENIAC Joint Undertaking (JU) semiconductor research programme reached €1.8 billion at the end of 2012. New projects in 2012 were far larger than previous years due to Key Enabling Technologies (KET) Pilot Line projects.

KET Pilot Line projects accounted for €730 million being used to strengthen the European 300mm infrastructure (59 percent), support significant developments in diversification technologies on 200mm and smaller diameters (13 percent), and for equipment and materials suppliers to prepare for the transition to the forthcoming 450mm wafer size (28 percent).

Andreas Wild, Executive Director of the ENIAC JU, stated, “The stakeholders in the ENIAC JU programme - the industry, the ENIAC member States and the European Union - gain confidence in its ability to deliver, more than doubling the total investments two years in a row. This is a solid basis for future action to re-establish Europe in a leading position”.

The ENIAC JU research agenda covers three technology and five application areas with societal impact. The projects are carried out by more than 530 participating organisations among which 26 percent are large companies, 41 percent SMEs, and 33 percent Universities and research institutes.

The budget available for 2013 allows supporting R&D projects approaching €1 billion total eligible costs, bringing the total value of R&D activities generated through ENIAC JU to almost €3 billion.

### **The Strategical Conference of EU-Taiwan ICT Technical Cooperation**

This conference was held in Taipei on 11<sup>th</sup> and 12<sup>th</sup> of March and held two sessions on 450mm wafer technologies. The speakers from Europe for these sessions were :

- “Imec’s 450mm R&D Initiative in Support of the Nanoelectronics Eco-system” - Roger de Keersmaecker (Imec)

- “X-ray metrology for the advanced technology node” - Assunta Vigliante (Bruker)
- “ Equipment, Materials and Manufacturing Towards Larger Wafer Sizes in Europe” - Lothar Pfitzner (Fraunhofer)
- “Opportunities for the European E&M Industry?” - Bas van Nooten (ASM)
- “Recif Technologie” - Alain Jarre (RECIF)

Some of the presentations can be downloaded from <http://www.ncp.tw/>

## **Final Comments**

We hope this first Enable450 newsletter has been informative in drawing together information from many sources.

It is obvious that European E&M companies are grasping the opportunity of the 450mm wafer transition, and this is combined with enthusiastic support from both the European Commission and the National Public Authorities involved.

As with previous nodes, the 450mm transition was initially delayed but is now progressing in a far more orderly fashion than those previous nodes. So unless there is some catastrophic economic event then it is safe to conclude the node will enter production around the 2018/19 timeframe.

If you have any feedback on this newsletter or would like to supply information for publication, please contact the editor at [mbryant@futurehorizons.com](mailto:mbryant@futurehorizons.com)

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