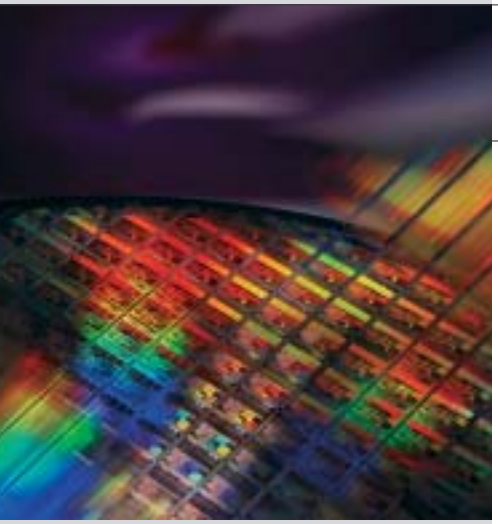
PROJECT RESULT

Process equipment



T301: 0.1 μm fabrication engineering (0.1 μm Fab)

Production advances ensure European chipmakers ready to meet global competition

Significant progress has been made in preparing the production infrastructure necessary for the fabrication of integrated circuits with circuit features down to 65 nm. The 0.1 μm Fab project has developed new processing chemicals and gases to meet ever more demanding purity levels as well as improved cleaning processes for wafer and production tools. The technology is already helping European chipmakers take on their major competitors around the world. It is also enabling their equipment and materials suppliers to improve their global market positions, boosting European exports and employment.

Every advance in technology brings distinct production challenges, and advances in silicon chip manufacture are no exception. Tighter circuit integration, new fabrication methods and advancing production efficiencies generate new obstacles such as greater sensitivity to contamination, different forms of waste to handle and the need to meet tighter environmental controls.

With wafer fabrication at 90 nm feature size becoming standard, semiconductor manufacturers are now already well advanced in the development of processes for 65 nm technology. The MEDEA+ T301 0.1 μm Fab project focused on two key areas of this development work: improving purity levels of process material required for next-generation chipmaking technology and enhancing the hardware necessary to reduce defects and increase yield.

Attention was also paid to the change from aluminium to copper interconnects in new chip generations. Copper offers several advantages over aluminium: its higher conductivity simplifies routing, as the number of interconnect levels can be reduced. Interconnect delays are less, therefore power demands are lower, allowing for better chip performance – particularly higher speeds – at equal power. Use of the damascene process for metal layer deposition reduces overall chip manufacturing costs by some 30% per interconnect level. However, it was essential to adapt copper technology to large scale manufacture.

Chipmakers and suppliers

This MEDEA+ project brought together leading European chipmakers STMicroelectronics and Philips with their equipment and material suppliers as well as research organisations and academia. In total, T301 involved 15 partners, including many small and medium-sized enterprises (SMEs), in four European countries. Several areas critical to 90 and/or 65 nm technology were resolved in the course of the project:

- Equipment front-end module (EFEM) improvements, including a novel UV light-based final cleaning technology;
- New on-line monitoring methods;
- Plasma technology for post-pump abatement of perfluorocarbons (PFCs) in etch process waste – this environment friendly development also resulted in six papers at international conferences and further external publication as well as five patents and nine patent applications;
- Continuous infra-red monitoring of organic contamination, discriminating between heavy and light organic impurities;
- The beneficial effects of supercritical carbon dioxide ($SCCO_2$) cleaning for porous low-k materials were demonstrated. Low-k

materials are needed to reduce parasitic capacitances, increase switching speeds and lower heat dissipation in future chip generations. Results of this activity also led to six publications in international conferences, a PhD thesis, a demonstrator and a patent application; and

- Proof of concept for micro-pumps for applications to the mini-environment.

Significant progress was also made in measurement techniques, modelling and understanding of the influence of airborne contamination on the various process steps.

Immediate technology take-up

Project completion was marked by a widespread publication of results, as well as an almost immediate take-up of the technology by key partners. Overall, more than 18 papers have been published at international conferences around the world.

Results of the 0.1 μm Fab project are being exploited in several new products, such as the Alcatel chamber pressure management system. This process has already been widely appreciated both for its ability to reduce defects and for its relatively small footprint that allows sub-floor integration.

Another new product resulting from T301 is the plasma technology developed to reduce PFC levels in etch process waste. Now fully commercialised, this helps reduce emissions from the cleaning chambers used in chip production, and has the lowest footprint for such equipment on the market. It is in use at large European chip production facilities – and has already been sold outside Europe.

Further advances resulting from the MEDEA+ project include:

- Development of a portable load-lock system;
- Specification for electrochemical deposition of copper interconnects, low-k dielectrics and chemical mechanical polishing (CMP) slurries; and
- Recognition of a tetramethylammonium hydroxide (TMAH) etchant diluter to ensure both central distribution of the cleaning agent and small storage volume.

Real impact in Europe

The success of 0.1 μm Fab is having a significant impact on Europe's semiconductor device manufacturing capabilities. The project has already enabled chipmaking partners to re-equip their fabrication facilities to put Europe on par with its global competitors and on time with the International Technology Roadmap for Semiconductors (ITRS).

In addition, project results have formed a major support for further European-level research. Within the MEDEA+ framework, this applies to the T207 65 nm CMOS300 project, which specifically targets the development of a 65 nm basic CMOS process on 300 mm wafers, well ahead of the ITRS, while this T301 project dealt principally with 200 mm prototype wafers.

Many of the equipment partners in the project are strong exporters. For companies such as Air Liquide, Alcatel Vacuum Technology (AVTF), ALES and RECIF, this MEDEA+ project has helped boost capabilities in the global market. AVTF has gained two levels in the microelectronics supplier rankings and 40/30, Faure Ingénierie and Mondia Quartz have been able to offer a new level of services based on what they achieved within the project.

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PARTNERS:

40-30
Air Liquide
Alcatel Vacuum Technology
Ales
Altis
CEA-LETI
EKC
Faure Ingénierie
Greca
INCAM
Mondia Quartz
Philips
Recif
Separex
Sopra
STMicroelectronics

PROJECT LEADER:

Jacques Trilhe,
then Dominique Thomas
STMicroelectronics

KEY PROJECT DATES:

Start: 1 January 2001
End: 31 December 2004

COUNTRIES INVOLVED:

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Italy
The Netherlands
UK

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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.