PROJECT RESULT

Technology platform for next-generation core CMOS process

MEDEA+

2T102: High yield driven manufacturing excellence in sub 65nm CMOS (HYMNE)

Improvements in manufacturing science show way ahead for European chipmakers

The MEDEA+ HYMNE project has boosted the competitiveness of European chipmakers and their suppliers by improving the way sub-65 nm CMOS chips are processed. This has been achieved by optimising process control and improving the knowledge of yield detractors and possible recovery actions. The success of the project has made it possible for European chipmakers to face the competition from the giant Asian foundries, enabled equipment suppliers to widen their portfolio of methods and tools to meet worldwide demand, and allowed the establishment of a European expert network in manufacturing science.

European semiconductor fabrication plants – or 'fabs' – face tough competition from giant chip foundries in the Far East. Asia can achieve major economies of scale in manufacture and also introduce new processes very quickly as they have much material to help them learn about the yield detractors and process issues involved.

Europe needs to rely on methods and tools that compensate for the economies of scale in the Asian foundries. This requires Europe to become expert at the top level of manufacturing science.

Introducing new processes fast

For Europe to stay competitive, chipmakers must introduce new processes quickly with smaller quantities of product to analyse. The MEDEA+ 2T102 HYMNE project achieved faster yield learning by developing new tools and methods for fabs. This has resulted in shorter cycle times, faster yield stabilisation and more efficient approaches to optimise processing and control in-line contamination.

HYMNE focused on shortening the learning curve for sub-65 nm processes currently coming into production. This concerned pure manufacturing science dedicated to the most advanced CMOS technologies but not linked directly to final products.

HYMNE involved several major European chipmakers. The main actors were the then members of the Crolles 2 Alliance – STMicroelectronics and NXP Semiconductors – in France, together with NXP in the Netherlands, STMicroelectronics in Italy and Atmel in France. The end of the Crolles 2 Alliance in 2007 could have affected success, but the consortium made a big effort to adapt.

Other partners were universities and institutes providing theoretical approaches to the problems involved. CMP-GC focused on manufacturing scheduling, while CEA-LETI was involved in methods for characterisation and controlling in-line contamination.

The consortium included equipment suppliers, mainly small and medium-sized enterprises making characterisation and contamination-monitoring equipment. It was crucial for them to develop new tools and new methods to use existing tools to move from off-line to in-line use. Finally, solution providers developed statistical algorithms and software prototypes to support the introduction of new production and process-control methods.

Improving working processes

Chipmakers gained much in terms of managing the working process. This involved optimising fab loading without affecting working processes or the cycle times with a wide

mix of products – prototypes with very short cycle times and standard production in the same line.

Much effort was spent on redesigning dispatching strategies and batch optimisation. These strategies are already being applied on the different lines involved. New approaches were developed in advanced process control (APC) – such as in the way batches are controlled to enable merging of different recipes. Control limits for different batches have also been standardised for the various recipes.

A major achievement is a significant leap in zero-defect and advanced yield learning for sub-90 nm technology processes. This involved joint efforts by device manufacturers, technology institutes and suppliers of cleaning equipment and characterisation equipment. It led to a substantial innovation in key characterisation methods for reliable and fast problem solving in sub-90 nm technology, as indicated by the International Technology Roadmap for Semiconductors (ITRS). To sustain these methods, several tools were developed or deeply enhanced and, as a consequence, now meet ITRS specifications.

Knowledge was also improved on the effect of different contaminants in the line and how to reduce them – leading to a yield improvement of several percent.

Finally, for other partners – particularly the SMEs – benefits include proving viability of new solutions in their portfolio that have helped enhance competitiveness. The success has helped them gain new markets – some of the solutions have already been sold to other chipmakers outside the consortium, including customers in Asia.

Equally important for Europe is that the academic partners have become recognised actors on the worldwide scene – for example, the CMP-GC laboratory is appreciated as a point of expertise at global level in manufacturing science.

During the four years of the project, more than 85 publications related to HYMNE work have been accepted in international conferences or published in technical reviews.

Part of continuous process

HYMNE was something of a first in European co-operative research as it focused on manufacturing science rather than on design or technology. As a result it has become a prototype for a series of new projects crucial to maintaining critical semiconductor knowledge and high level manufacturing skills in Europe

The MEDEA+ project was a first step on the road. Further projects are already underway or planned that will ideally also involve chipmakers Infineon and possibly Intel Ireland as well as the Fraunhofer institute in Germany.

A key advantage for chipmakers working at the level of manufacturing science is that intercompany co-operation is easy. Developing a process can lead to problems of intellectual property. In manufacturing science, very open-minded collaboration is possible.

In HYMNE, the different companies quickly appreciate this collaboration and, by the end of the project, were exchanging solutions between the two main fabs involved. A solution was tried on one line, and then moved to the other. This is what the consortium hopes to achieve in future projects – and at the same time to build a network of European experts in manufacturing science.

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CMP-GC
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KEY PROJECT DATES:

Start: February 2005
End: January 2009

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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.