PROJECT PROFILE

2T210: Materials for next-generation capacitors and memories (MaxCaps)

TECHNOLOGY PLATFORM FOR PROCESS OPTIONS

Partners:

Air Liquide
Aixtron
Analog Devices Ireland
ASM International
Bronkhorst
CEA-LETI
Conti Temic
IHP
IMEC
Infineon Technologies
IPDiA
NXP Semiconductors
Oxford Instruments
R3T
SAFC Hitech
STMicroelectronics
Tyndall National Institute
Uni Eindhoven (TU/e)
Uni Helsinki

Project leader:

Hessel Sprey
ASM Belgium

Key project dates:

Start: January 2008
End: August 2011

Countries involved:

Belgium
Finland
France
Germany
Ireland
The Netherlands
United Kingdom

European microelectronics manufacture has been hit hard by the large Asian and US systems houses. MaxCaps aims to develop techniques enabling the integration of higher performance capacitors on CMOS chips to reduce the number of discrete components that are currently mounted on printed circuit boards. This will help to decrease system sizes and also improve reliability. In addition, the MEDEA+ project will evaluate new memory structures for integration in system-on-chip devices. The successful outcome of this key project will boost the competitive position of European chipmakers and their materials and equipment suppliers as well as supporting end users such as the automotive components sector.

The global position of the semiconductor industry has changed over the past decade, as volume manufacturing of DRAM memories and generic CMOS processes is now largely outsourced to Asia. However Europe has maintained a strong position in technology development and in the highly specialised, value-added, consumer-oriented systems market. In addition, Europe has an advantage in engineering the production and research systems for new materials.

Continuous research into manufacturing techniques, materials and production equipment is essential in the drive for miniaturisation if European electronic device manufacturers are to remain competitive. The time, cost and effort required to carry out the development of new technologies places an enormous burden on systems makers. Consequently, the pooling of expertise is essential in the resolution of this dilemma.

Greater integration

The MEDEA+ 2T210 MaxCaps project set out to develop techniques for the integration of higher value capacitors on silicon chips to reduce the number of discrete components and so improve system reliability. At the same time, it is developing a range of innovative deposition techniques to improve memory structures in system-on-chip (SoC) devices.

MaxCaps brings together a strong consortium representing the complete production value chain. Partners include dedicated five major European integrated device manufacturers, key chemical and equipment suppliers, universities and major research institutes specialising in this field, and, finally, an automotive manufacturer as representative end user.

The project will also evaluate new dynamic random access memory (DRAM) structures and phase-change random access memory (PCRAM) materials, to be deposited using atomic layer deposition (ALD) techniques. New dielectric materials and associated production processes will also be developed.

Targeted applications cover both the 'More Moore' and the 'More than Moore' domains. With regard to More Moore technologies – supporting the continuing miniaturisation of devices following Moore's law – MaxCaps incorporates developments such as ultra-high dielectric constant (UHK) materials and corresponding electrodes for DRAM

and phase-change materials and electrodes for PCRAMs.

Under the More than Moore umbrella which enables integration of digital and analogue functions, the project will deal with new materials in metal-insulator-metal (MIM) on-chip capacitors for radio frequency (RF), decoupling and automotive applications as well as back-end interposer structures with trench capacitors.

The aim is to cover this wide scope of applications by different deposition methodologies such as ALD, plasma-enhanced or plasma-assisted atomic layer deposition (PEALD or PA-ALD) and metal-organic chemical vapour deposition (MOCVD)/atomic vapour deposition (AVD). In addition, a post-deposition treatment will be evaluated with radicals in a batch reactor. Partner ASMI will evaluate both single-wafer and batch-equipment ALD technologies. Tooling decisions will be based on process feasibility and partner requirements such as cycle time and cost of ownership.

Extensive opportunities

Areas targeted are extensive, starting with the synthesis of new precursors for ALD and PEALD processing of UHK and associated electrode materials. A similar development of materials for AVD will also be carried out. Furthermore, new precursors will be established to be able to provide adequate ALD/PEALD solutions to manufacture PCRAM devices.

Equipment and processes will be developed to create the components for the targeted technologies: MIM on-chip capacitors, DRAM storage capacitors and back-end interposer capacitors as well as PCRAM memory cells. Finally, these structures will be incorporated and electrically characterised in the relevant technologies. An end-user will perform device-level evaluation in an automotive application.

MaxCaps supports European efforts to build a value-added technology platform for More Moore and More than Moore technologies. In addition, it will have access to the ALD chemistry expertise of Finnish partners as well as that of MOCVD and AVD held by German partners and other speciality chemicals innovators in the mainstream European process options platform.

The development and optimisation of ALD and AVD equipment for advanced UHK and electrode materials will strengthen the position of Europe's ALD/AVD equipment manufacturers against international competition.

Facing up to competition

The main competitors in the equipment and speciality chemicals sectors are located in the USA and Asia. It is, therefore, imperative that Europe's materials and equipment industry retains an intellectual property advantage in the process options for integrated SoC and system-in-package (SIP) devices. The main competitors in chipmaking and automotive electronic parts supply sectors are also located in Asia and to a lesser extent in the USA.

Europe's integrated systems manufacturers will benefit from the intellectual assets developed. Value-added process modules will enable Europe to differentiate itself in the integrated systems field from global competitors. A key benefit will be a decrease in the die area for many components and the creation of lower-cost components in an increasingly cost-driven marketplace. The project will also enhance abilities in the DRAM domain.

The specialist consumer-oriented systems market is precisely the area in which the results of this project can benefit Europe greatly. In addition, the successful outcomes will be directly applicable to stand-alone DRAM manufacture, creating licensing and royalty income opportunities.

Increased employment

For the major chipmakers, MaxCaps will contribute to new business development as they will expand their market presence in advanced applications. Since the costs of the CMOS core process will decrease with the introduction of eco-systems, efforts will be put to differentiation for added-value or even new products.

This effect of business increase will also be of benefit to suppliers since new fabrication and tools methods will bring about positive growth of the number of employees in European countries. The MEDEA+ project will therefore strengthen the position of suppliers in the equipment market and further expand their product portfolio to include silicon industry applications in either stand-alone or embedded products.

Overall, MaxCaps will secure competitive power in the European semiconductor industry and the semiconductor equipment industry as well as in the speciality chemicals and automotive components sectors. Furthermore, the new class of materials and techniques developed will attract interest from other industrial partners for future joint development programmes – key to future European prosperity.

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