PROJECT PROFILE

2T201: Non-volatile embedded memory for systems on silicon (NEMeSyS)

TECHNOLOGY PLATFORM FOR PROCESS OPTIONS

Partners:

Atmel
CEA-LETI
IMEC
Infineon Technologies
Philips
STMicroelectronics

Project leader:

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Key project dates:

Start: January 2005
End: December 2008

Countries involved:

Belgium
Germany
France
Italy
The Netherlands

On-chip re-programmability and configurability is an expanding requirement in the creation of fully-integrated technology platforms with embedded non-volatile memory (NVM) functions, particularly in sub-100 nm CMOS technologies. The NEMeSyS project aims to develop technology that will improve European competitiveness in global communications, automotive and consumer electronics markets by reducing the time required to validate and industrialise novel NVM cell concepts and process options. It will encourage close co-operation between industrial and research partners in which re-use of existing technology platforms for industrial validation of new concepts and process options will be central.

Embedded NVM is becoming ever more essential in the market with increasing development of complete system-on-chip (SoC) devices. And it provides a cost effective means of implementing a large variety of products using a limited number of individual chips. Although there have been previous embedded NVM solutions based on stand-alone memory technology that can be referred to as 'embedded logic', embedded NVM is currently only available in the 0.18, 0.15 and 0.13 μm standard CMOS technologies, while the future requires embedded NVM also in sub-100 nm technologies.

The MEDEA+ 2T201 NEMeSyS project supports efforts for the integration of non-volatile memory into standard baseline CMOS technologies, creating programmable product platforms for SoC realisation. This will increase the capability of European semiconductor companies to adapt their products to specific market requirements. In practice, it will address the paradox between SoC requirements and mass production. A SoC is, by nature, application specific because it satisfies a certain set of user requirements. This limits volumes and is, therefore, in conflict with cost-efficient mass production objectives. But, with programmable NVM on-chip, the same chip can be adapted to various applications.

Increasing the added value of the new SoC products will allow European companies to position themselves with respect to lower cost manufacturing facilities that focus more on products that make use of standard technologies.

Main innovations

The main innovations and developments in NEMeSyS are:

- Integration of NVM options in sub-100 nm standard CMOS baseline technologies;
- Development of new NVM cell concepts and process options for high-k materials applied in next generation technologies;
- Bringing innovative cell options — such as silicon-oxide-nitride-oxide-silicon (SONOS) and nanocrystals — closer to industrialisation through co-operation between research and industrial partners;
- Use of existing industrial technology demonstration platforms to validate innovative NVM cell concepts and process options in an industrial environment,

prior to integration to improve time to market and reduce introduction risks; and

- Development of test structures and methodologies to characterise and verify the analogue performance of embedded NVM technology platforms.

There are competitors that use standard stacked gate NVM, such as Renesas and Samsung in Asia. In recent years, Samsung has become a serious contender in this field and is aiming at the number one position in smart cards. In the USA, Motorola and TI are the main suppliers in the automotive field.

As shrinking of the stacked gate cell concept is expected to become more and more difficult, an industrial decision has to be made regarding the industrial implementation of alternative technologies such as ferro-electric random access memory (FeRAM), phase-change memory and magnetic RAM (MRAM). With the exception of FeRAM, these options have yet to prove their industrial viability. In any case, stacked gate NVM is still considered to be the technology of choice in the NVM industry down to 65 nm and beyond.

NEMeSyS project partners also have had previous experience in the MEDEA+ T123 Crescendo and EU Information Society Technologies Adamant projects. The main developments from those projects were on embedded NVM and analogue process option generation in 0.18, 0.15 and 0.13 μm baseline CMOS.

Research in Adamant involved charge-trapping memories, SONOS and nanocrystals, and there was further co-operation between — amongst others — Philips, LETI and STMicroelectronics. The results provided considerable input to NEMeSyS. The MEDEA+ T206 Blueberries project also covers memory development. However, the main focus in Blueberries is RAM: static RAM (SRAM), dynamic RAM (DRAM) and MRAM. The main focus of NEMeSyS is on the development of non-volatile electrically-erasable and programmable read-only memory (ROM) such as Flash and EEPROM.

As in stacked gate non-volatile memory, NVM has a broad prospective market and a high level of acceptance. The main challenge will be in scaling the stacked gate technology and extending it into the next process generations. This challenge is becoming harder and harder with every new generation as tunnel oxide and programme voltages do not scale satisfactorily. From that point of view, MRAM could provide a solution in future NVM applications. MRAM could potentially be useful as it has non-volatile capability, although it still needs to be industrially proven and accepted by the market as a reliable memory technology

Increasing competitiveness

NEMeSyS is expected to secure Europe's competitive position in the telecommunications and wireless communication, automotive, smart card and consumer electronics sectors. The main global competitors are located in the USA and the Far East. Competition is strongest in the application of NVM in smart card, consumer and automotive areas.

The MEDEA+ project will enable its industrial partners to realise advanced innovative SoC solutions required by several fast growing markets. For instance, the key drivers for the mobile telecommunications and consumer market are cost, size/weight ratio, feature density, performance and component count. These can only be met using higher levels of integration and state-of-the-art process technologies, with embedded NVM and analogue options. Similarly, multi-application smart cards offering a variety of functionality such as banking, ticket card, pay-TV and electronic commerce require complex circuits.

Establishing and maintaining a strong position in these markets requires the next, non-volatile process generation supported by NEMeSyS. It is also anticipated that the technology options developed in this project will be transferred to other production sites used by the partners.

The industrial results of this MEDEA+ project will, in many respects, find immediate application in the products of the industrial partners while there will also be the new demonstrator platforms that can be used for industrial evaluation of next generation cell concepts and process options developed by the research partners.

Moreover, results of the industrial evaluation of new cell concepts and process options between European research partners and industrial partners, on proven development platforms, will have considerable impact on the possibilities for obtaining early insight into the viability of such new concepts. It is also expected to greatly reduce risks and time to market, while ensuring earlier benefit from improved efficiency or performance of the option and thereby improve the European position in the global market place.

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