EMERGING NON-VOLATILE MEMORY 2017
Market & Technology report - June 2017

Introduction of products by big players, emergence of new Storage Class Memory (SCM) applications and entry of the top five logic foundries will drive the market.

WHAT’S NEW
• New market segments: embedded high-performance static RAM and embedded non-volatile systems-on-chips
• One microcontroller (MCU) segment, combining ‘low-power’ and other devices
• In depth analysis of MCU automotive applications
• Updated market forecast for phase-change memory (PCM), magnetoresistive RAM (MRAM), including spin-transfer torque (STT) MRAM, and resistive RAM (RRAM)
• In depth analysis of China’s memory market
• Mapping of the main R&D labs
• In-depth analysis of embedded markets for MCUs and mobile CPUs
• Deep analysis of foundry positions in the supply chain
• Start-up funding analysis
• Analysis of new entrants
• Analysis of technical trends for MRAM/STTMRAM, RRAM, and PCM

FAVORABLE MARKET CONDITIONS FOR ADOPTION OF EMERGING NON-VOLATILE MEMORY (NVM)

The key emerging non-volatile technologies like phase-change memory (PCM), magnetoresistive random access memory (MRAM) and resistive random access memory (RRAM) have long development histories. Yet, their adoption remains restricted to niche markets due to various factors. Available products have limited density, and the introduction of high density products by emerging NVM pioneers has been delayed. There are manufacturing challenges due to the introduction of new materials and process steps. Meanwhile, mainstream memory technologies are continuously improving in terms of density and cost. Finally, there has been an absence of a killer application that would challenge dynamic random access memory (DRAM) and NAND flash memory.

However, favorable factors are now emerging that will propel the emerging NVM business onto a rapid growth trajectory. These include:
- The appearance of new storage class memory (SCM) business segment. This is an additional memory hierarchy in system architectures between working memory and data storage. Its aim is to reduce latency by increasing system speed. It will support and co-exist with DRAM and NAND.
- Big players like Intel introducing PCM-based 3D XPoint memory to the market in 2017 for SCM applications. Micron will introduce a 3D XPoint memory product by the end of 2017.
- Investors are still upbeat about the emerging NVM business, as evidenced by >$100M funding in 2016.
- Big foundries like TSMC, Samsung, GlobalFoundries, UMC and SMIC are entering the emerging NVM memory business. They will introduce MRAM and RRAM technology for embedded MCUs in the 2018/2019 timeframe. Emerging NVM is a good opportunity for foundries to significantly grow their memory business as it is CMOS compatible technology.

KEY FEATURES OF THE REPORT
Get the sample of the report on www.i-Micronews.com
• Market forecast 2016-2022 in units, in Gbit, US$, and number of wafers
• Competitive landscape and market dynamics
• Emerging NVM potential applications and market drivers
• Technological roadmap with time-to-market
• Price evolution by application and technology
• Technology description, main technical trends by technology, main players, roadmap

Time to market for emerging non-volatile memory is often delayed for standalone memory

Chip maximum density (bit)

<table>
<thead>
<tr>
<th>Density (Gb)</th>
<th>PCM</th>
<th>RRAM</th>
<th>MRAM</th>
</tr>
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<tbody>
<tr>
<td>100</td>
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Sampling Time-to-Market (non exhaustive list)

(Yole Développement, June 2017)
MARKET GROWTH FOR EMERGING NVM IN THE NEXT FIVE YEARS WILL BE LED BY SCM AND EMBEDDED MICROCONTROLLERS (MCUS)

The market for emerging NVM will grow at a 106% compound annual growth rate from 2016-2022 (CAGR 2016-2022) to reach around $3.9B by 2022. The new SCM hierarchy and embedded MCUs will drive this. Creating a new memory category is a sea-change that will require numerous hardware and software developments by all memory ecosystem players. SCM will be adopted in enterprise storage and client applications, and later in mobile. The introduction of XPoint memory product by Intel in early 2017, targeting the SCM application, is the game changer.

EMERGING NON-VOLATILE MEMORY 2017

Emerging non-volatile memory potential applications, density and price positioning

(Yole Développement, June 2017)

The emerging NVM market is mainly led by three technologies: PCM, RRAM and MRAM. In the stand-alone market, which is mostly focused on SCM for the next five years, the big players’ technological choices are now quite clear. Micron/Intel has chosen PCM. SK Hynix and Sandisk/Western Digital have selected RRAM as the competitor to PCM for SCM applications. Samsung seems also to favor RRAM thanks to its compatibility with the vertical 3D approach used for 3D NAND. The SCM market will initially be led by PCM but later RRAM will take the lead.

For embedded applications, the battle will be intense between the different emerging NVM technologies. However, we expect that multiple solutions will coexist depending on application requirements. STTMRAM has been adopted by the top foundries including TSMC, GlobalFoundries, Samsung and Sony. STTMRAM’s initial focus is the development of the MCU eFlash market followed by substitution of SRAM in mobile and high performance computing. For RRAM embedded applications, key adopters are TSMC, UMC, SMIC and Samsung. RRAM’s initial focus will be for low cost applications like embedded MCUs for smart cards, IoT and general purpose applications. The ultimate target for RRAM is to replace 3D NAND in high performance MPUs, enabling integration into a single SoC. PCM is still in the race, with STMicroelectronics as the main promoter, having selected PCM as the best emerging NVM solution for the 28 nm node in the automotive market.

This report provides a precise memory roadmap in terms of technological nodes, chip density, and pricing.

THE STANDALONE EMERGING NVM MARKET IS MAINLY LED BY PCM AND RRAM, AND THE EMBEDDED MEMORY BUSINESS IS DRIVEN BY MRAM AND RRAM

Memory market players: cannibalization trends

(Yole Développement, June 2017)
One big technological transition occurring right now is the substitution of hard disk drives with semiconductor NAND solid-state drives. The next revolution will be emerging NVM’s arrival. We have analyzed the supply chain’s dynamics to understand who today’s key market players are in each application and technology, and how the competitive landscape will evolve with the arrival of emerging NVM. We have also conducted a special analysis of the Chinese memory supply chain, which is growing rapidly thanks to huge Chinese government financing plans and the country’s substantial memory needs.

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OBJECTIVES OF THE REPORT
- Present an overview of the semiconductor memory market: NAND, DRAM, embedded MCU, and mobile MPU
- Provide an understanding of emerging NVM applications for nine applications in standalone and embedded, covering technologies, market trends, players, challenges, and drivers
- Offer market forecasts for the emerging NVM business for seven applications and three technologies, which are: PCM, MRAM/STTMRAM, RRAM
- Describe emerging NVM technologies and players: roadmap, technical trends and key products

AUTHORS
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Yann de Charentenay has worked for Yole Développement, the «More than Moore» strategy consulting and market research company, in the field of MEMS, materials and compound semiconductors since 2003. He has contributed to more than 60 marketing and technological analyses.
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