

Fabrication Challenges of Future 3D Storage Class Memory

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We are living the age of mobile internet, where the explosion of connected devices and digital services is generating massive amounts of new data that must be stored in the most space-consuming part of the electronic system: the Memory. We know how to create high performance processors, but feeding them with data has become the performance-limiting and most-expensive aspect of a system from both power and cost perspectives.

Over the last few years, further development of Solid-State Disks based on 2D NAND Flash has been able to offer fast On-line storage to the market, but meanwhile the latency/performance gap between Flash and DRAM increased further, opening up an application space for Storage Class Memory (SCM) concepts, whose main features are non-volatility (for low off-state power), improved performance (access rate and endurance as compared to NAND Flash), much lower cost and better scalability (as compared to conventional DRAM).

Today there are several new memory concepts (RRAM, PCM, Z-NAND, FeFET, MRAM), which are considered for SCM applications. Many of them could be programmed with lower speed compared to DRAM and exhibit long-term retention (10 years at 85C). Moreover, they could be fabricated with low temperature processes enabling stacking arrays architectures for high-density memories.

The balance of cost, power and performance trade-offs will be the key for their future success: in the long term, this new type of memory must show scalability and ability for 3D integration to enable the fabrication of the next SCM generations with even higher densities at the same cost.

We already foresee limitations for 2D scalability and (wafer-)stacking, and therefore future needs for vertical approach. This will bring various types of fabrication challenges, from materials development to new high AR patterning solutions that will be discussed in this presentation, where we will also explain imec Memory R&D vision from 2D development to 3D SCM Memory fabrication.

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