

# 嵌入式和独立式 NVM：两种不同的未来？<sup>1</sup>

## 内容概览：

- **嵌入式 NVM 市场：**

市场预测：Yole Développement（Yole）预测 2026 年嵌入式 MRAM<sup>2</sup>市场规模约为 17 亿美元，相当于整个嵌入式新兴 NVM<sup>3</sup>市场的 76% 左右。

技术趋势：在 MCU<sup>4</sup>、IoT<sup>5</sup>和用于 ASIC<sup>6</sup>产品的存储器缓冲寄存器的驱动下，嵌入式新兴 NVM 已做好准备一飞冲天。

供应链：嵌入式 MRAM 市场预期将快速增长，这要归功于各家头部代工厂——台积电、三星格芯、联华电子，以及首批率先采用 MRAM 的先行者（如索尼）的共同参与。

- **独立式 NVM 市场：**

市场预测：市场规模将从 2020 年的约 5.95 亿美元增长到 2026 年的约 33 亿美元。

独立式 PCM<sup>7</sup>市场预计将在 2026 年增长至约 26 亿美元。届时它将占独立式存储器总市场的 78% 左右。

技术趋势：PCM 将成为领先技术，这要归功于英特尔与其服务器 CPU<sup>8</sup>捆绑销售的 3D XPoint 产品的销量——尤其是持久内存 DIMM<sup>9</sup>。

供应链：独立式新兴 NVM 市场将由两个主要细分市场驱动，即持久内存和低延迟存储。

“新兴 NVM 市场整体将以约 44 % 的 CAGR<sub>20-26</sub><sup>10</sup> 增长”，[Yole Développement \(Yole\)](#) 的存储器市场与技术分析师 **Simone Bertolazzi** 称：“经过几年的发展，嵌入式新兴 NVM 技术已经显著成熟，现已为市场起飞做好准备。”

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<sup>1</sup>摘自：

《2021 年新兴非易失性存储器》，Yole Développement, 2021

《英特尔 Optane 128GB DIMM》，System Plus Consulting, 2020

<sup>2</sup>MRAM：磁阻随机存取存储器

<sup>3</sup>NVM：非易失性存储器

<sup>4</sup>MCU：微控制器单元

<sup>5</sup>IoT：物联网

<sup>6</sup>ASIC：专用集成电路

<sup>7</sup>PCM：相变存储器

<sup>8</sup>CPU：中央处理器

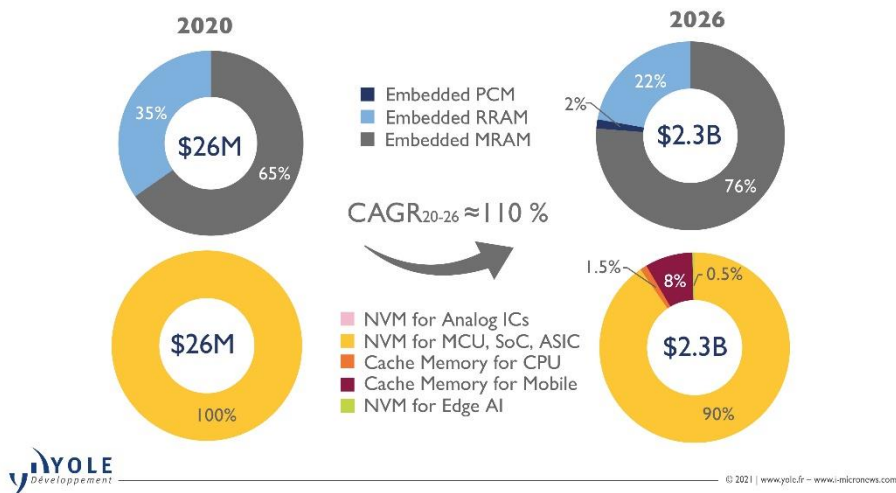
<sup>9</sup>NVDIMM：非易失性双列直插式内存模块

<sup>10</sup>CAGR：年均复合增长率

2020 年，首批基于 eMRAM 的商用产品上市，即由三星制造的索尼 GPS SoC（28 纳米 FDSOI），该产品被用于华为的智能手表，以及由台积电采用 22 纳米超低漏电工艺（ULL）制造的 Ambiq 低功耗 MCU。2021 年可能会有许多基于 eMRAM 的器件进入量产，其中包括 Greenwave 的 AI 处理器，它采用了由格芯制造的 eMRAM（22 纳米 FDSOI），以及由 Numen 和 Gyrfalcon 开发的 Edge-AI 加速器芯片，由台积电采用 22 纳米 ULL 工艺制造。2020 年也有含嵌入式 RRAM（eRRAM）的产品投放市场，新唐-松下推出了针对安保应用的新型 IC 器件，采用 40 纳米 OxRAM。

## 2020-2026 Embedded market revenues

(Source: Emerging Non-Volatile Memory 2021 report, Yole Développement, 2021)



在这样充满动态的形势下，Yole 对颠覆性的技术及相关市场进行深入调查，从而指明最新的创新趋势并突显重要商机。

今天发布的《2021 年新兴非易失性存储器》报告概括了半导体存储器市场，并带来对新兴 NVM 技术机器应用的理解。

有哪些经济和技术挑战？技术是如何发展的？有哪些值得关注的关键企业在参与竞争，他们正致力于开发什么创新技术？新冠疫情对此有何影响，中国在 NVM 业务上进展如何呢？

Yole 今天分享了其对新型 NVM 产业的见解与展望。

根据 Yole 存储器团队在其新发布的《2021 年新兴非易失性存储器》所做的分析，嵌入式 MRAM 预计将比 RRAM 更快地得到采用。Yole 的分析师们预测，在发展路线图得以有效实施的乐观情况下，2026 年嵌入式 MRAM 市场规模将达到约 17 亿美元，相当于整个嵌入式新兴 NVM 市场的 76% 左右。

然而，eRRAM 仍将是一个强大的竞争对手。事实上，领先的竞争企业一直在对 RRAM 进行投资，目标是在 40 纳米及更高尺寸上替代 eFlash：

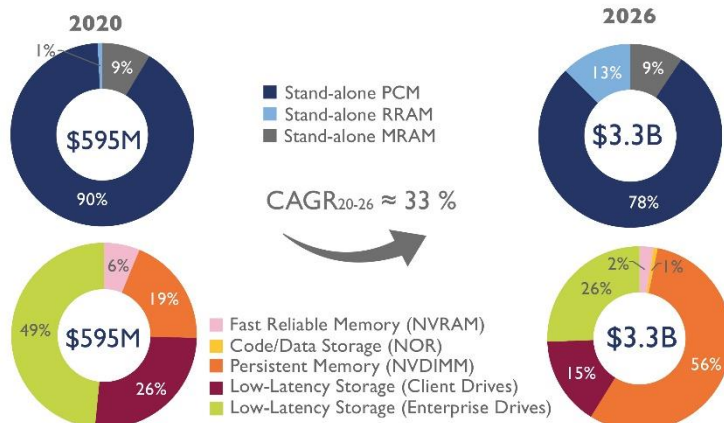
- 台积电已通过嵌入式 OxRAM 丰富了其 40 纳米 ULP<sup>11</sup> 工艺，目前以 22 纳米工艺生产 OxRAM。
- Dialog Semiconductors 授权格芯使用 Adesto 的 CBRAM™ 技术，目前格芯正将其用于 22 纳米 FDSOI 上实施，用于低功耗消费类应用。
- 联华电子正与新唐-松下合作开发 28nm OxRAM，未来几年或将瞄准智能卡市场进军。

Yole 的新兴 NVM 报告还对其他许多公司及其战略进行了深入分析.....

最后，嵌入式 PCM 仍有竞争力，并将以替代汽车 MCU 中的 eFlash 为目标。其主要推手是意法半导体，该公司已选择 PCM 作为汽车市场中 28 纳米 FDSOI 节点的最佳新兴 NVM 解决方案。

## 2020-2026 Stand-alone market revenues

(Source: Emerging Non-Volatile Memory 2021 report, Yole Développement, 2021)



**Yole 半导体、存储器与计算部门主管 Emilie Jolivet** 如是说：“这个由 PCM、MRAM 和 BRAM 组成的独立式新兴 NVM 市场将从 2020 年的约 5.95 亿美元增长至 2026 年的 33 亿美元。它将由两个关键细分市场驱动，即低延迟存储（企业和客户端 SCM 硬盘）和持久内存（NVDIMM）。”

PCM 将成为领先技术，这要归功于英特尔与其服务器 CPU 捆绑销售的 3D XPoint 产品的销量——尤其是 PM<sup>12</sup>DIMM。2020 年已有新型独立式 Optane 产品推出，市场期待已久的 Alder Stream 固态硬盘。这是第一款采用带四个 PCM 堆叠层的第二代 3D XPoint 技术的产品。

Yole 的合作伙伴 [System Plus Consulting](#) 在其专题报告中对 [英特尔 Optane I28GB DIMM](#) 进行了全面分析：

<sup>11</sup>ULP: 超低功耗

<sup>12</sup>PM: 持久内存

对 **System Plus Consulting** 的技术与成本分析师 **Belinda Dube** 来说：“3D XPoint 存储器形成了一种带多级存储单元阵列的垂直结构。采用这种策略是为了增加存储单元密度。这些存储单元使用的是一种相变材料。它不像传统存储器那样使用晶体管，而是通过材料电阻的变化来实现位存储。存储单元是一种电阻随晶体结构变化而改变的材料”。

2020 年底，英特尔确认财富 500 强企业中共有 200 家或是已经直接部署了 Optane PM，或是处在 POC<sup>13</sup>阶段，而从 POC 到部署的转化率预计将超过 85%。然而，人们发现为 PM 部署而建立一个软硬件生态系统极具挑战性且耗时，目前这是由关键参与方英特尔来承担的。

### 媒体联络人：

**Sandrine Leroy**，公共关系主管，[leroy@yole.fr](mailto:leroy@yole.fr)

**Marion Barrier**，公共关系助理，[marion.barrier@yole.fr](mailto:marion.barrier@yole.fr)

Le Quartz, 75 Cours Emile Zola – 69100 Villeurbanne – Lyon – France – +33472830189

[www.yole.fr](http://www.yole.fr) - [www.i-micronews.com](http://www.i-micronews.com) – [LinkedIn](#) – [Twitter](#)

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<sup>13</sup>POC:概念验证

### About our analysts

**Simone Bertolazzi, PhD** is a Technology & Market analyst at Yole Développement (Yole) working with the Semiconductor & Software division. He is member of the Yole's memory team and he contributes on a day-to-day basis to the analysis of nonvolatile memory technologies, their related materials and fabrication processes. Previously, Simone carried out experimental research in the field of nanoscience and nanotechnology, focusing on emerging semiconducting materials and their opto-electronic device applications. He (co-) authored several papers in high-impact scientific journals and was awarded the prestigious Marie Curie Intra-European Fellowship. Simone obtained a PhD in physics in 2015 from École Polytechnique Fédérale de Lausanne (Switzerland), where he developed novel flash memory cells based on heterostructures of two-dimensional materials and high- $\kappa$  dielectrics. Simone earned a double M. A. Sc. degree from Polytechnique de Montréal (Canada) and Politecnico di Milano (Italy), graduating cum laude.

**Emilie Jolivet** is Director of the Semiconductor, Memory & Computing Division at Yole Développement, part of Yole Group of Companies, where her specific interests cover package & assembly, semiconductor manufacturing, memory and software & computing fields. Based on her valuable experience in the semiconductor industry, Emilie manages the expansion of the technical and market expertise of the Semiconductor and Software Team. The team interacts daily with leading companies allowing semiconductor & software analysts to collect a large amount of data and integrate their understanding of the evolution of the market with technology breakthroughs. In addition, Emilie's mission focusses on the management of business relationships with semiconductor leaders and the development of market research and strategy consulting activities inside the Yole group. Emilie Jolivet holds a Master's degree in Applied Physics specializing in Microelectronics from INSA (Toulouse, France). After an internship in failure analysis at Freescale (France), she was an R&D engineer for seven years in the photovoltaic business where she co-authored several scientific articles. Enriched by this experience, she graduated with an MBA from IAE Lyon and then joined EV Group (Austria) as a business development manager in 3D & Advanced Packaging before joining Yole Développement in 2016.

**Belinda Dube** serves as a Technology & Cost Analyst at System Plus Consulting, part of Yole Développement. Belinda's core expertise is memory technology, especially DRAM and 3D NAND flash memory. At the same time, she also investigates IC technologies as well as advanced packaging. Belinda's mission is to develop reverse engineering & costing reports. She also works on custom projects, where she works closely with the laboratory team to set up significant physical & chemical analyses of innovative memory chips. Based on the results, Belinda identifies and analyzes the overall manufacturing process and all technical choices made by the memory makers. The objectives of these analyses are to understand the structure of the device, identify all materials used, and point out the link between functionality and technology selected by the memory company. In addition, a significant portion of her mission is dedicated to a strategic technology watch, where her aim is to identify innovative memory chips and manufacturing processes. Based on her expertise, Belinda updates internal simulation tools and runs custom training sessions and demos with industrials. Belinda attends many international trade shows & conferences where she collects valuable information and meets leading memory players. She regularly has an opportunity to reveal pertinent results during key onsite presentations and webcasts. Prior to System Plus Consulting, Belinda had the opportunity to work on several R&D projects dedicated to MEMS technologies and new substrates at INSA (Lyon, France). With a core Micro & Nano Electronics expertise, Belinda graduated from INSA (Lyon, France) with a master's degree in Instrumentation & Nanotechnology Engineering.

### About the reports

#### **Emerging Non-Volatile Memory 2021**

*Embedded NVM readies to take off driven by low-power applications. Stand-alone NVM continues its journey toward mass adoption, despite ecosystem slowdowns. – Performed by Yole Développement*

#### **Companies cited:**

4DS, Adesto, Ambiq Micro, Antaios, Apple, Applied Materials, ARM, Avalanche, Buffalo, Canon, CEA Leti, Cerfe Labs, CXMT, Cisco, Crocus Nanoelectronics, Crossbar, Cypress, Dell, Dialog Semiconductor, eVaderis, Everspin, Facebook, Ferroelectric Memory Company, Fujitsu, GigaDevice, GlobalFoundries, Google, GreenWaves, Gyrfalcon, H-Grace, Hikstor, HLMC, Honeywell, HP, Hprobe, Huawei, IBM, IMEC, Infineon, Intel, Intermolecular, Intrinsic Semiconductor, ITRI, JHICC, Jiangsu Advanced Memory Technology, Kioxia, Lam Research, Lenovo, Macronix, Materion, Mediatek, Merck, Microchip, Micron, Mythic, Nantero, Nanya, National Tsing Hua University, NEC, NetApp, Nike, Nokia, Numen, Numonyx, Nuvoton, NXP, Panasonic, Qualcomm, Rambus, Reliance, Renesas, Rohm, Samsung, SanDisk, Seagate, SK hynix, Smart Modular Technologies, SMIC, Sony, Spansion, Spin Ion Technologies, Spin Memory, Spin-Orbitronics Technologies, Spintec, STMicroelectronics, Stanford University, Syntiant, TDK, Texas Instruments, Tezzaron, Tohoku University, Tokyo Electron, Teledyne e2v, Toshiba, TowerSemi, TPSCo, Tsinghua Unigroup, TSMC, UMC, Violin Memory, Weebit, Western Digital, Winbond, XFab, XMC, YMTC, and more...

### **Intel Optane 128GB DIMM**

*Analysis of Intel's Persistent Memory DIMM that integrates Intel's 3D XPoint memory dies... The Optane DIMM introduced in 2019 has one of the highest levels of integration, presenting a full system on a module. Intel Optane products have pioneered 3D XPoint commercial devices, mainly targeting data center storage. – Performed by System Plus Consulting*

### **Related reports:**

- [MRAM Technology and Business 2019](#)
- [Status of the Memory Industry 2020](#)
- [DRAM Quarterly Market Monitor](#)
- [NAND Quarterly Market Monitor](#)

### **About Yole Développement**

Founded in 1998, Yole Développement (Yole) has grown to become a group of companies providing marketing, technology and strategy consulting, media and corporate finance services, reverse engineering and reverse costing services and well as IP and patent analysis. With a strong focus on emerging applications using silicon and/or micro manufacturing, the Yole group of companies has expanded to include more than 80 collaborators worldwide... [More](#)

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