

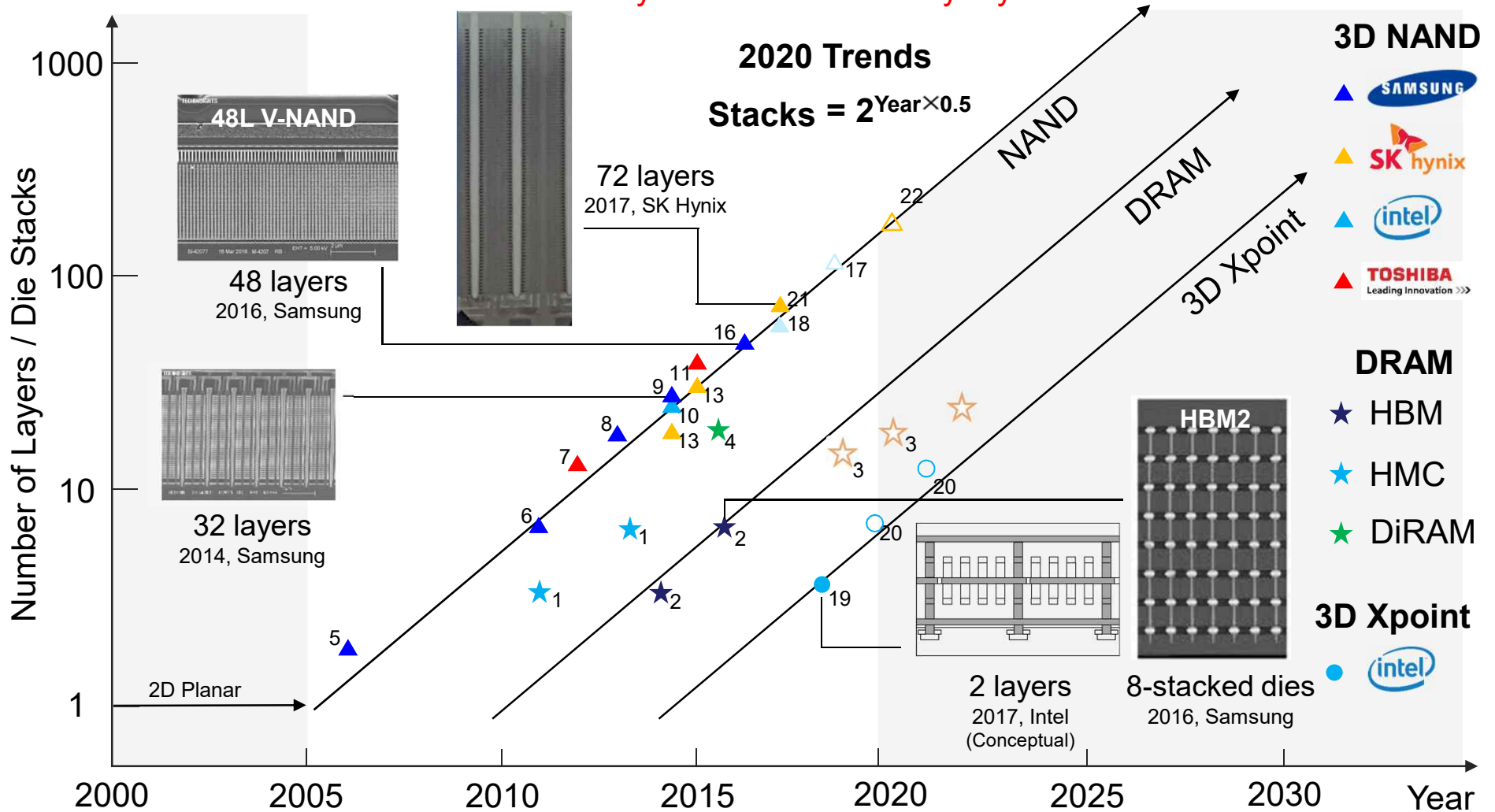
Kim's Law: Vertical Stack-up Trends

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Kim's Law : Vertical Stack-up Trends

Kim's Law : Memory stack doubles every 2 years

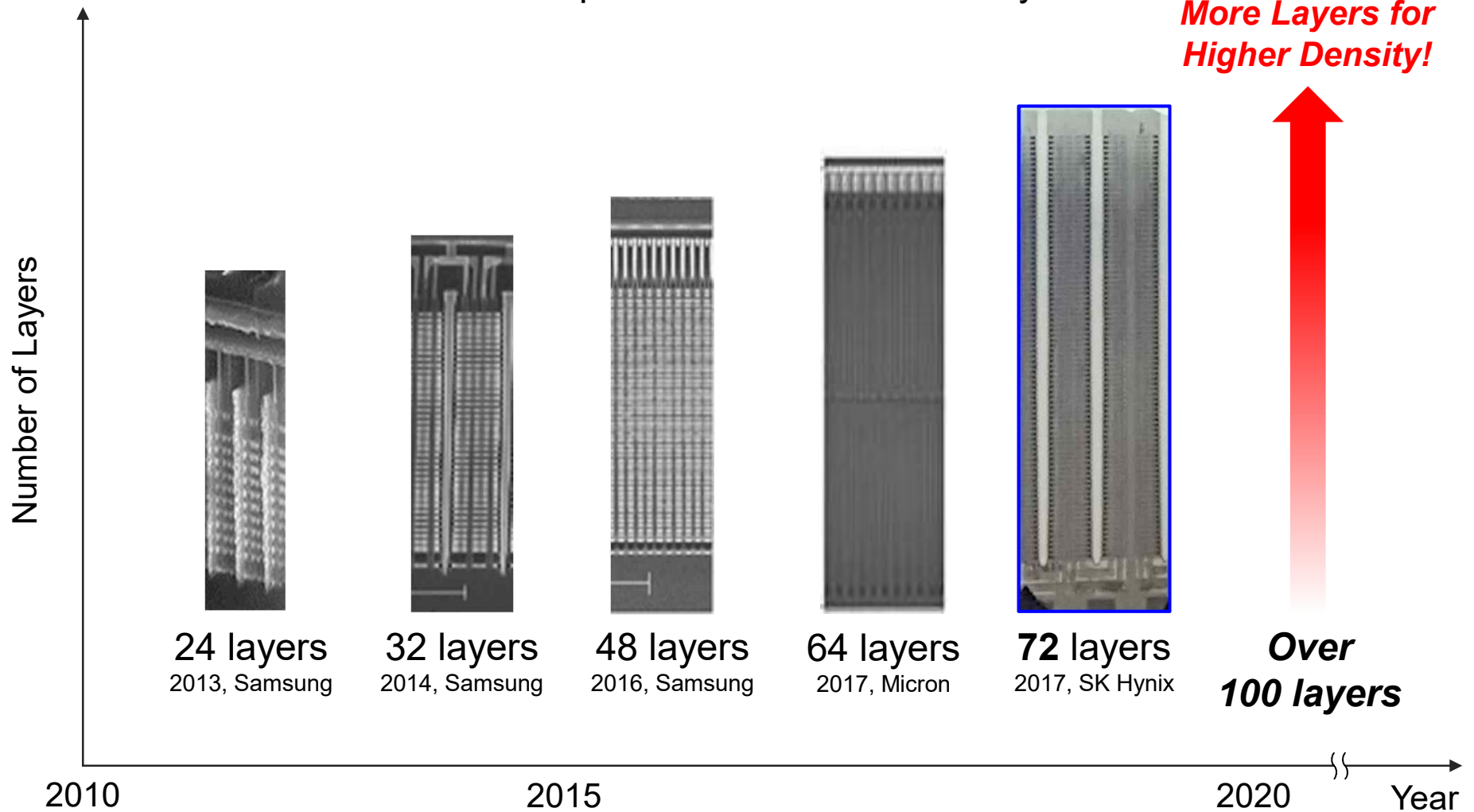


N : reference No.

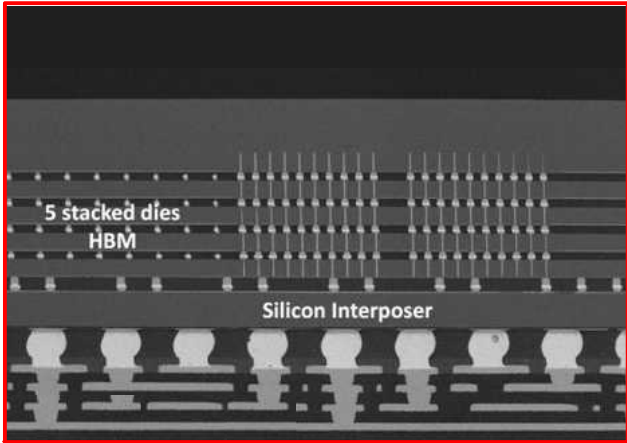
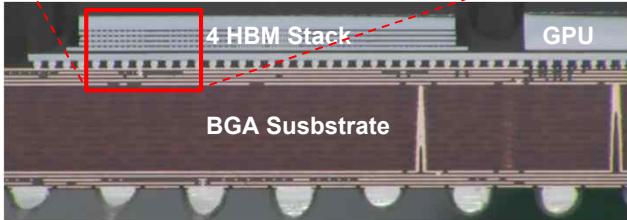
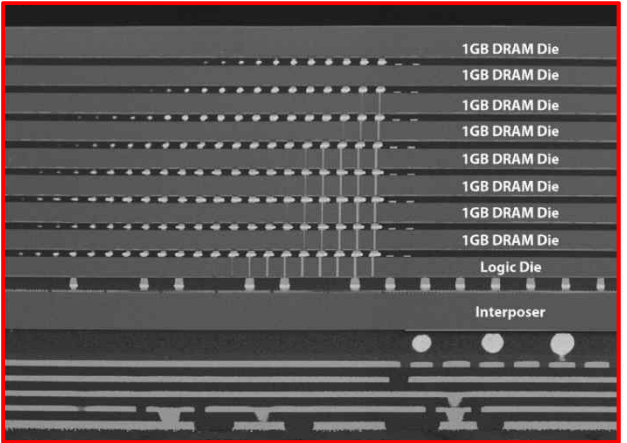
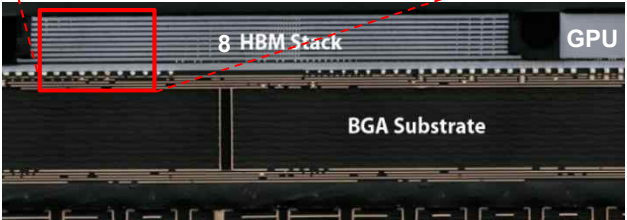
★ : Predictions

Vertical Stack-up History of NAND Flash Memory

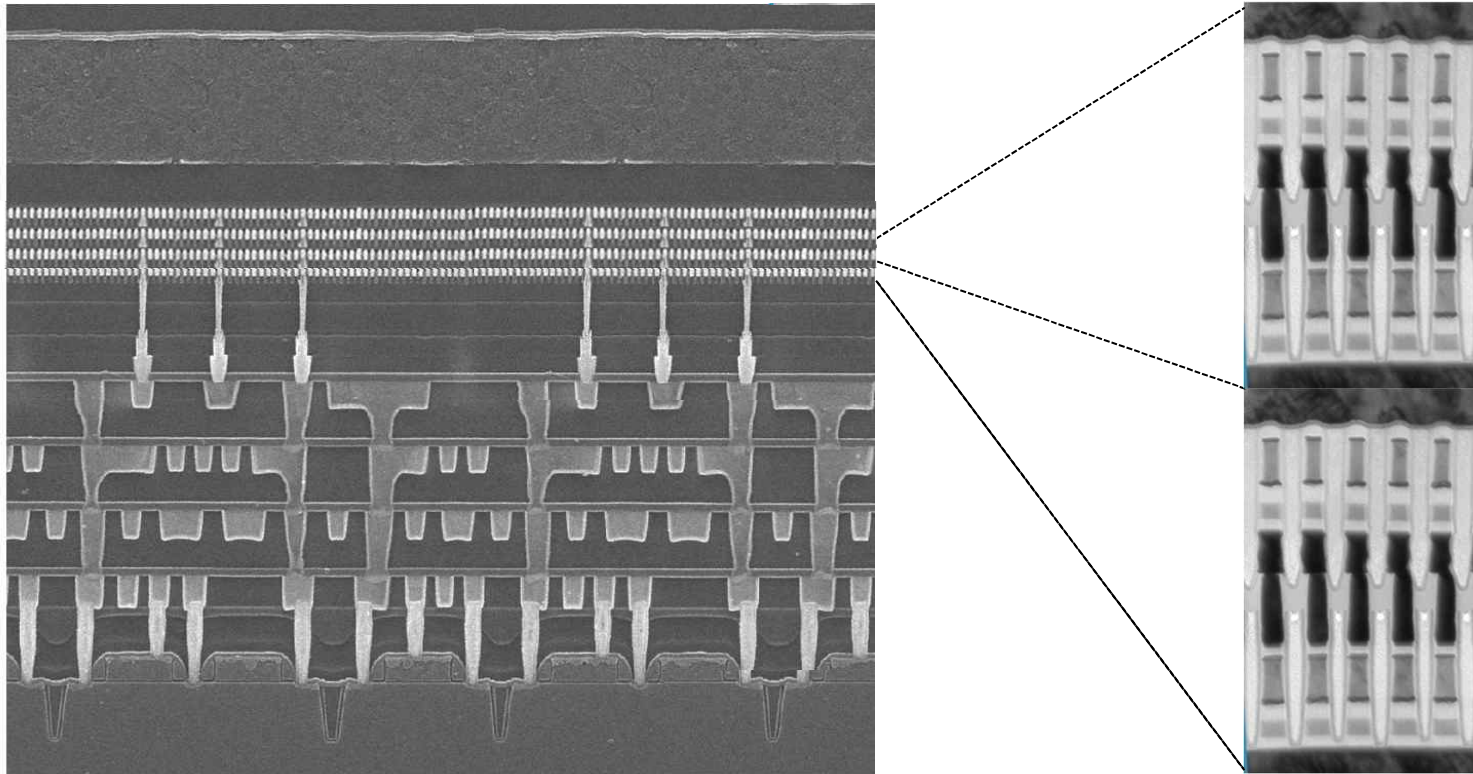
Vertical Stack-up Trends of NAND Memory Cell



Development History of High Bandwidth Memory (HBM)

	HBM 1 st Gen. (2013, SK Hynix)	HBM 2 nd Gen. (2017, Samsung)
Die shot (X-sectional)	 	 
Density	8 Gb	64 Gb
I/O	1024	
Speed	128 Gbps	256 Gbps
Chip Stack	4 Core + 1 Base (5 stack)	8 Core + 1 Base (9 stack)

Vertical Stacking of 3D Xpoint Memory



< Cross-sectional view of 3D Xpoint Memory >

- The memory structure in 3D Xpoint memory is fabricated with BEOL process.
- Stacking the memory layer in 3D Xpoint memory is easily achieved.

Thank you!



Reference (1/4)

#	Material	Reference
1	4/8 layer HMC	HMC Specification 2.0
2	4/8 layer HBM	http://www.memcon.com/pdfs/proceedings2014/NET104.pdf
3	Over 8 layer HBM	https://arstechnica.com/gadgets/2016/08/hbm3-details-price-bandwidth/
4	16 layer DiRAM	http://www.memcon.com/pdfs/proceedings2013/track3/True_3D_Memory_Architecture_Yields_Amazing_Performance.pdf
5	2 layer NAND SAMSUNG	http://www.impact.org.tw/2011/Files/NewsFile/201111110190.pdf
6	8 layer NAND SAMSUNG	http://cacm.acm.org/magazines/2014/1/170856-tsv-stress-aware-full-chip-mechanical-reliability-analysis-and-optimization-for-3d-ic/fulltext
7	16 layer NAND TOSHIBA	http://electronics360.globalspec.com/article/5177/toshiba-takes-3d-nand-to-48-layers
8	24 layer NAND SAMSUNG	Ki-Tae Park et al. "Three-Dimensional 128Gb MLC Vertical NAND Flash-Memory with 24-WL Stacked Layers and 50MB/s High-Speed Programming Solid-State Circuits Conference Digest of Technical Papers (ISSCC) 2014 pp334-335

Reference (2/4)

#	Material	Reference
9	32 layer NAND SAMSUNG	http://www.pcper.com/news/General-Tech/Samsungs-32-layer-VNAND-dissected-TechInsights-analysed-3DInCities
10	32 layer NAND Micron	http://www.extremetech.com/computing/194911-intel-announces-32-layer-3d-nand-chips-plans-for-larger-than-10tb-ssds
11	48 layer NAND TOSHIBA	http://www.anandtech.com/show/9113/toshiba-announces-48layer-128gbt-3d-nand
12	SAMSUNG 3D V- NAND Roadmap	http://www.anandtech.com/show/7237/samsungs-vnand-hitting-the-reset-button-on-nand-scaling http://techon.nikkeibp.co.jp/english/NEWS_EN/20150226/406264/?P=2
13	SK Hynix 3D NAND Roadmap	http://www.businesskorea.co.kr/article/10282/nand-sandwiches-sk-hynix-mass-produce-36-layer-3d-nand-flash-chips-later-year
14	Micron's Memory Roadmap	http://www.reram-forum.com/2015/04/01/microns-resistive-memory-roadmap/
15	NAND Flash Trend	http://seminar.trendforce.com/Compuforum/2014storage/US/download/01_Sean-Yang(TrendForce)_NAND-Flash-Market-Outlook.pdf

Reference (3/4)

#	Material	Reference
16	48 layer NAND SAMSUNG	http://www.zdnet.co.kr/news/news_view.asp?artice_id=20160728102559&type=det&re=
17	64, 96, 128 layer NAND Micron	https://www.theregister.co.uk/2017/02/03/micron_working_on_nextgeneration_xpoint/
18	64 layer NAND SAMSUNG	https://www.overclock3d.net/news/storage/samsung_announces_their_4th_generation_64-layer_v-nand/1
19	2 layer 3D Xpoint Memory Intel	http://www.intel.com/content/www/us/en/architecture-and-technology/3d-xpoint-unveiled-video.html
20	Over 2 layer 3D Xpoint Mem. Intel	http://www.theregister.co.uk/2016/02/22/microns_journey_into_the_depths_of_nonvolatility/
21	72 layer 3D- NAND SK Hynix	http://www.etnews.com/20170703000262?mc=ev_003_00002
22	Over 100 layer 3D-NAND SK Hynix	http://news.newsway.co.kr/view.php?tp=1&ud=2017041115231148181&md=20170411153800_AO

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#	Material	Reference
23	HBM3	http://electroiq.com/insights-from-leading-edge/2016/02/
24	Over 100 layer samsung	http://www.startlr.com/new-article-review-of-the-samsung-850-evo-second-version-a-48-layer-tlc-3d-v-nand-in/
25	72 layer NAND Die shot SK Hynix	2017/03/30, KAIST Seminar by S. Lee