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ReRAM: The Automotive NVM Solution

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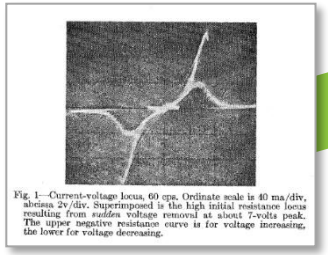
FMS the Future of Memory and Storage

Outline

- Embedded ReRAM market
- Weebit Nano – 4 pillars of ReRAM success
- Automotive qualification status
- GF22 qualification results
- Summary

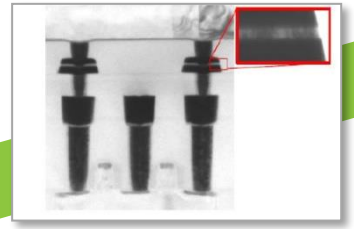
ReRAM History

1960



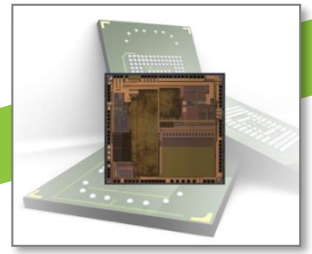
Resistive switching phenomena in oxides discovered!

2000s



Samsung
RRAM integrated in 0.18µm…
40 years later

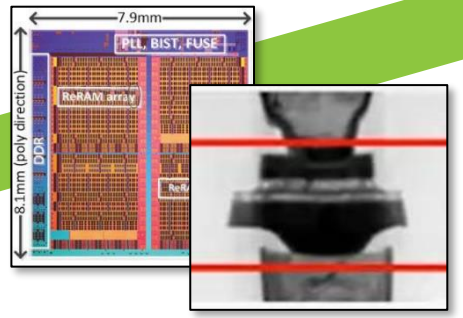
2010s



Panasonic
1st commercially available implementation of RRAM

Healthcare, security equipment or sensor processing applications

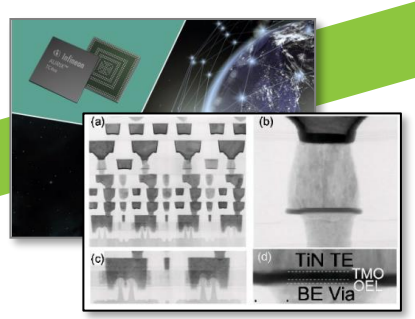
2019-2020



22nm FinFET
Intel, TSMC
10^4 cycles, 85°C 10ys retention

14nm & beyond
IMECAS

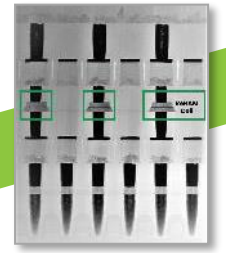
2021-2022



Automotive µC 28nm
Infineon & TSMC

Trusted supplier ReRAM qualified
Weebit & SkyWater

2023-2024



TSMC NVM Roadmap: RRAM
Down to 6nm

Nuvoton ReRAM MCUs
Up to 512KB

Power Management NVM
Weebit & DBH

ReRAM products available for embedded applications…
50 years after the switching effect was discovered

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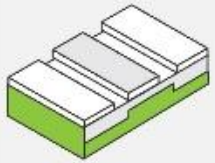
Embedded NVM Comparison

	eFlash	FeRAM	STT-MRAM	PCM	ReRAM (RRAM)
High-temp reliability	🟢	🔴	🟢	🟢	🟢
Radiation immunity	🔴	🟢	🟢	🟢	🟢
EMI immunity	🟢	🟢	🔴	🟢	🟢
Low power consumption	🔴	🟢	🟢	🔴	🟢
Fast programming	🔴	🟢	🟢	🟢	🟢
High endurance	🔴	🟢	🟢	🟢	🟡
Production cost	🟡	🔴	🔴	🟡	🟢
Contaminating materials	🟢	🟡	🔴	🟡	🟢
Small module size	🟡	🔴	🟢	🟢	🟢
Mature technology	🟢	🟡	🟡	🟡	🟡

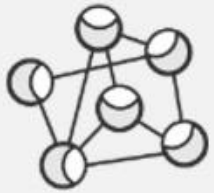
ReRAM best positioned to lead the next NVM wave

The Pillars of ReRAM Success

Device



Process



Analog Design

Digital Design & Algorithms

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State of Weebit ReRAM Today

Qualified modules at 85°C and 125°C

- Temperatures specified for industrial and automotive grade 1 ICs
- Qualified for endurance and 10yr retention per JEDEC industry standards

AEC-Q100 qualification (150°C and 100K cycles) in progress

- Good results achieved, collecting statistical data for full qualification

Technology demonstrated on multiple process nodes

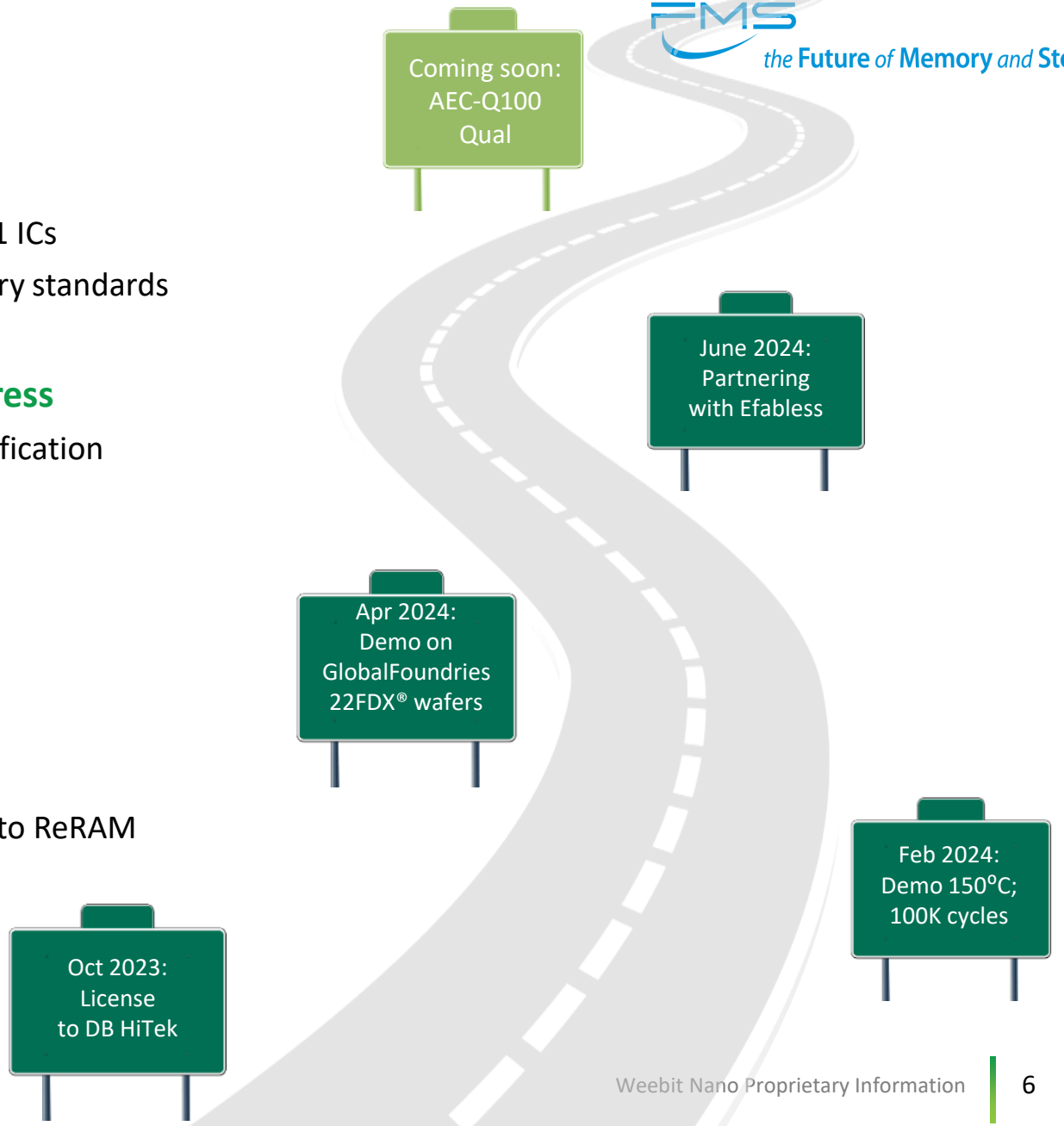
- From 130nm to 22nm, Al / Cu, 200mm / 300mm
- Successfully simulated on FinFET nodes

SkyWater: ReRAM module now available for production

- Partnering with Efabless to give chipIgnite customers access to ReRAM

DB HiTek: Technology transfer underway

GF22 FDSOI: 1st silicon is under characterization



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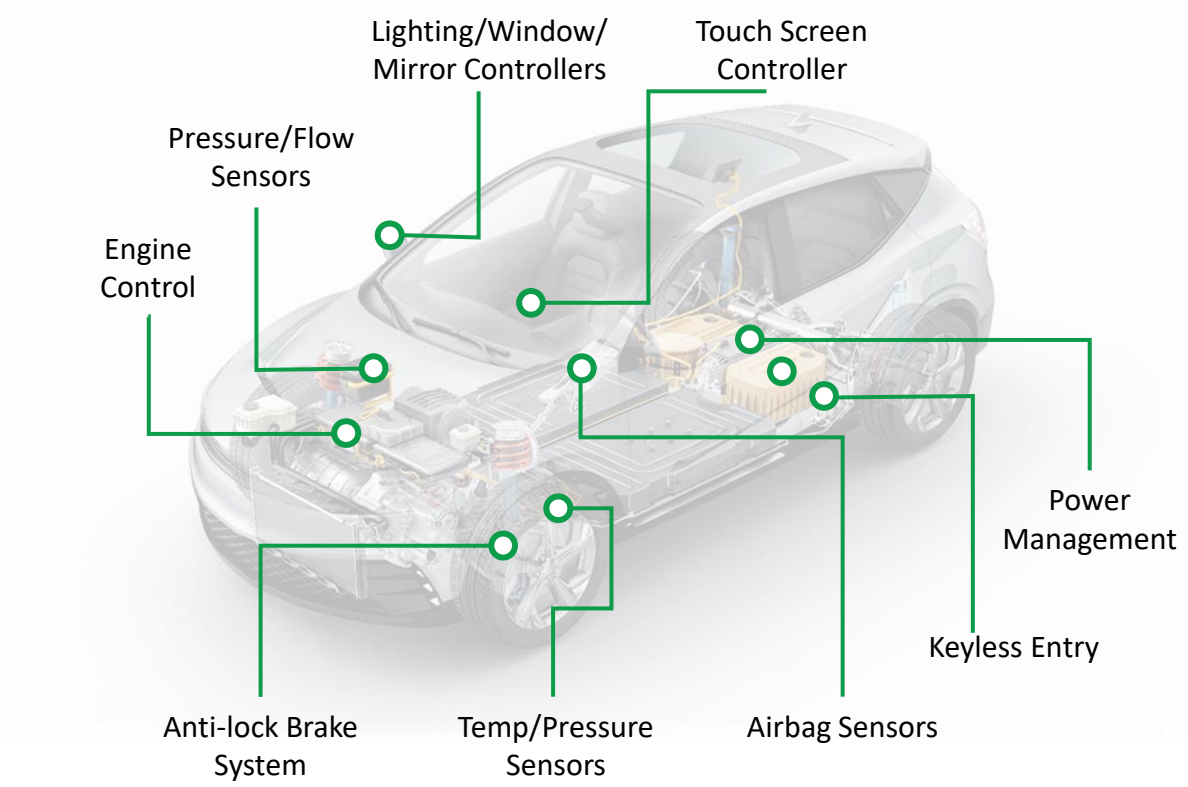
Automotive in Need of New NVM Technologies

- **Growing needs for emerging NVM**
  - Needed for code storage, trimming, data logging
- **Automotive ICs have unique requirements**
  - Design for safety, security and longevity
  - Reliable against extreme temperatures, EMI, vibration, humidity, etc.
  - Support fast boot, instant response, frequent OTA updates
  - Advanced process nodes are adopted quickly
- **Weebit ReRAM**
  - High-temp reliability, immunity to EMI, endurance, fast switching speed, longevity, secure
  - Can effectively scale to the most advanced process nodes

Some Places Where NVM is Found in a Car



Performance under Extended Automotive Conditions

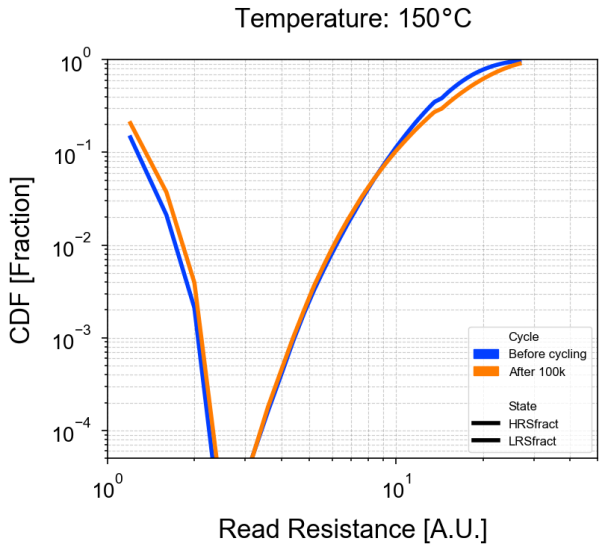
150°C Operation

- For automotive qualification, need to demonstrate operation at Tmax = 150°C
- Automative grading for temp according to the specific application
- Grade 0 (-40°C to +150°C) is the most stringent and usually needed for under-the-hood applications

Grade	Ambient operating temperature range
0	- 40°C to +150°C
1	- 40°C to +125°C
2	- 40°C to +105°C
3	- 40°C to +85°C

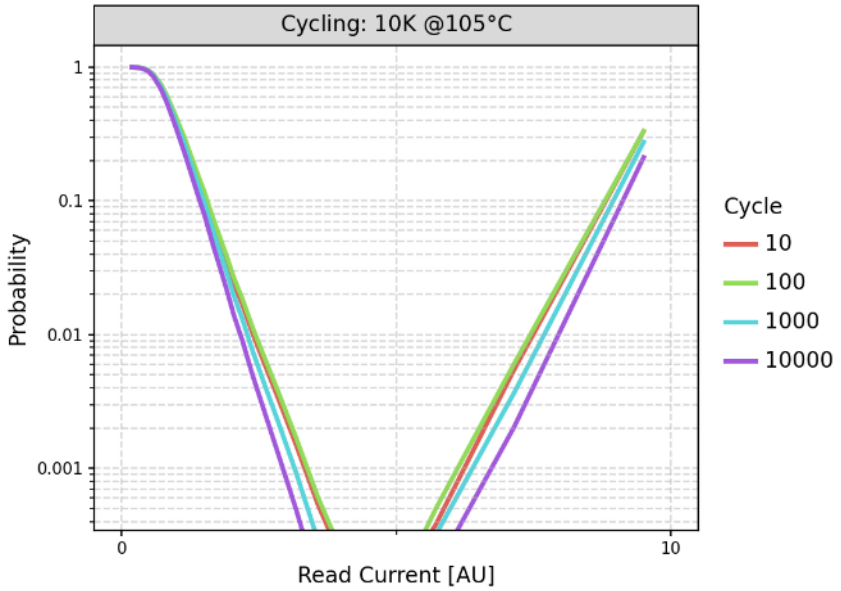
100K Endurance

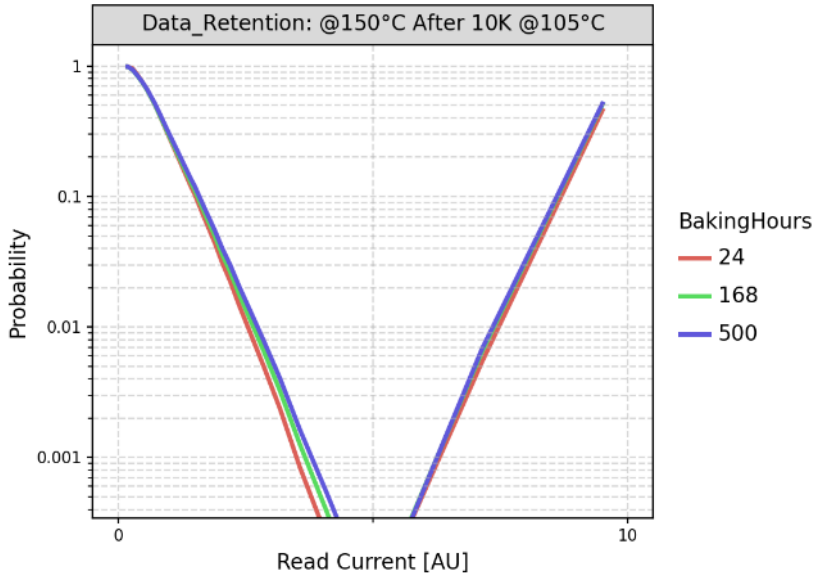
- Automotive requires up to 100K endurance cycles
- Our performance demonstrates good BER throughout the entire 100K cycles
- No significant degradation is seen



GF22 results

- GF22nm characterization and qualification activities are ongoing
- Pre-qualification results show:
  - Weebit's ReRAM stack is stable at 105°C cycling endurance up to 10K cycling
  - Very good data retention pre- and post-cycling is maintained for a long time at high temperatures





Conclusions

- Weebit ReRAM ported successfully to commercial foundries
  - e.g., SkyWater and DB HiTek
- Weebit is targeting the automotive market and is in the process of automotive qualification with very good results
- Weebit presenting pre-qualification results of ReRAM technology in 22FDX® FD-SOI

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