Embedded ReRAM is making good progress

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Application: from Chip to Consumer Electronics

- Eco-management
- Smart meters
- Security
- Portable electronics

0.18 µm 1-Mbit ReRAM

Long drive
System cost reduction
High-speed rewriting
Radiation Hardness

D. Chen, IEEE TRANSACTIONS ON NUCLEAR SCIENCE, 61, 3088, 2014

No upset from the ReRAM array
Process:
from 0.18 μm to 40 nm

Successfully scaling down to 40 nm
Filament: from Qualitative to Quantitative

Qualitative

Quantitative

Percolation Estimation Model

$$\varphi \approx 30 \text{ nm} \quad \leftrightarrow \quad \varphi = 2d \frac{n_x n_y}{\pi} = 27.2 \text{ nm}$$

EELS Results

S. Muraoka, 2013

H. Chang, 2011
Filament: from Everywhere to Centralizing

Side oxidation and other technologies centralize the filament
Summary

- ReRAM is already in our daily life.
- ReRAM is successfully scaling down to 40 nm.
- Filament dimensions can be estimated for each bit in memory array.
- Filament position is controllable.