



Western Digital®

Western Digital Research Center

Ricardo Ruiz

Industry Leading Product Portfolio Breadth

Client Devices



- Notebook / desktop HDD
- Consumer electronics HDD
- Client SSD
- Embedded, components

Client Solutions



- Branded HDD
- Branded flash
- Removable products

Datacenter Devices



- Enterprise HDD
- Enterprise SSD

Datacenter Solutions



- Datacenter systems and platforms
- Related software and solutions

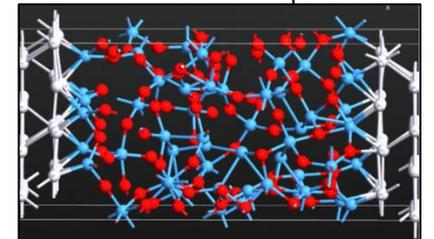
Western Digital Research Center

Long history of world class research in data storage technologies

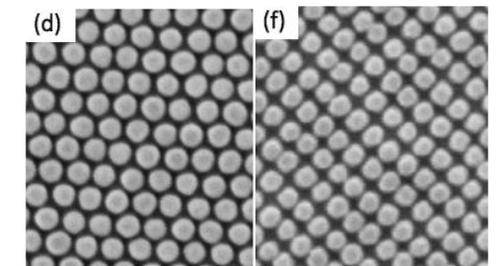
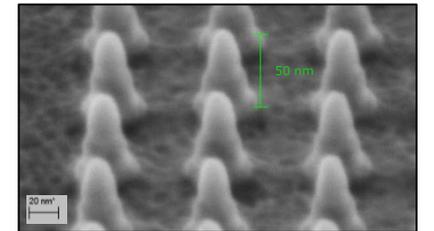
- Pioneer in data storage materials, devices, and systems
 - Heritage dates back to the IBM San Jose Research laboratory, founded in 1956
 - Hard-disk-drive division and related research activities were acquired by Hitachi in 2006 and integrated with Western Digital in 2015
 - Active work at the Western Digital Research Center includes emerging non-volatile memory devices, data storage architecture, and magnetic recording concepts
- State of the art facilities
 - Dedicated NVM clean room with PVD/ALD deposition, photo/e-beam lithography, and wafer processing capability.
 - Access to world class materials characterization lab for TEM/SEM, FIB, AFM, etc.
 - Resources for prototyping, device test, and modeling/simulations.
- Recent breakthroughs and demonstrations
 - Density multiplication in block co-polymer self assembly, *Science* **321**, 936 (2008)
 - Heat-assisted magnetic recording on 1 Tb/in² bit pattern media, *Nature Photonics* **4**, 484 (2010)
 - 3 million IOPS, 1.5 μ s latency phase change memory based PCIe SSD, *Flash Memory Summit* (2014)
- Current department accolades
 - 2015-2016: 65 publications, 40 patents filed
 - 3 APS Fellows, 1 IEEE Fellow, 1 AVS Fellow



NVM Material Deposition Tool



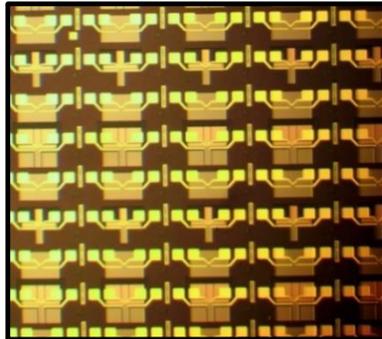
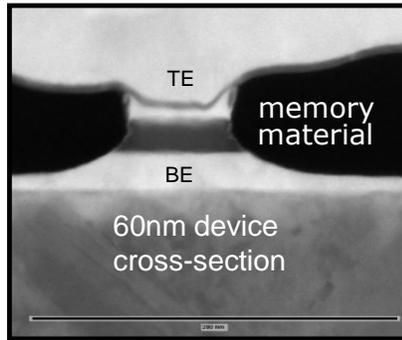
Modeling ionic and electronic transport in ReRAM devices



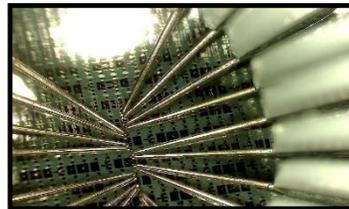
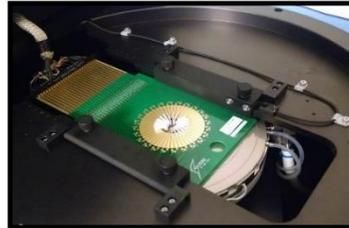
1.0 and 1.6 Td/in² magnetic bit patterned media from block copolymer self-assembly

Fast Learning Cycles For Materials Characterization

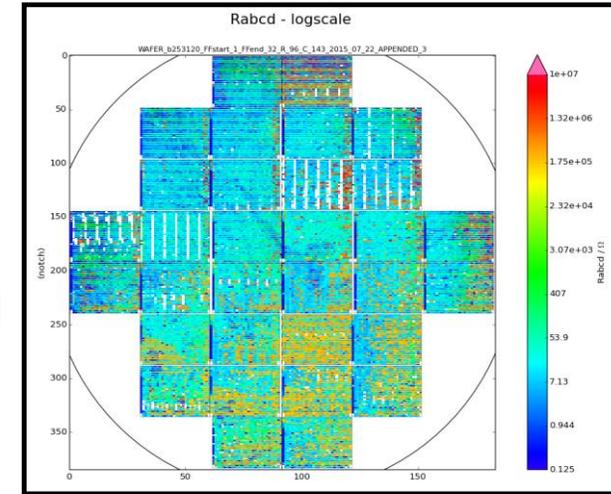
Fast-Track Wafer Process
For Materials Development



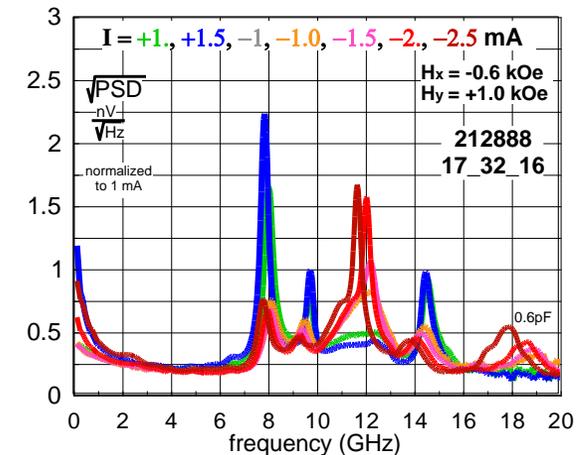
Automated Probe Station
& Test Algorithms



Wafer Data & Yield Analysis



Use of FMR to Compare RL to FL Stability



Contact information

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Insights

Machine Learning

Context
Aware

Automation

Anytime

Real-Time
Results

Anywhere

Protection

Analytics



Delivering the possibilities of data