Institute of Materials Research and Engineering
A*STAR
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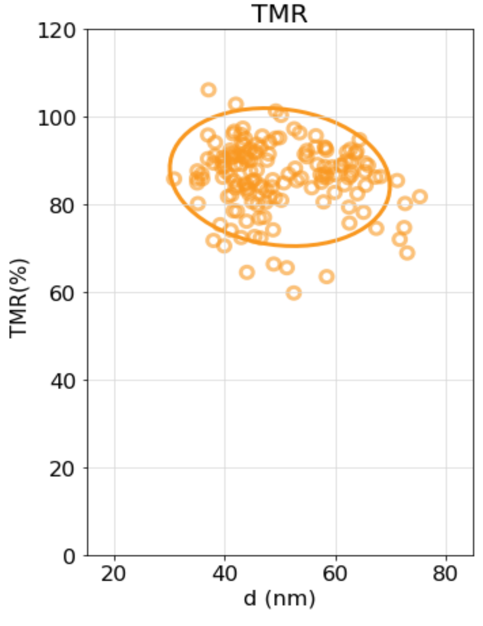
Spin Orbit Technologies

Capabilities

- 200mm fabrication line with cassette level throughput
- Sputtering equipment with multi-target module (over 20) capable of 2Å thickness uniformity, scalable to mass production
- Development of pilot-line fabrication processes with customisable specifications, ideal for CMOS-compatible emerging technologies
- Device modelling leveraging on Petascale supercomputers
- Custom-made testing equipment with pulsing capabilities <1 ns and noise levels down to ~1nV

Performance Data



TMR distributions against various device dimensions. TMR is the read signal between the 'on' and 'off' state. Clustering of TMR data indicates tight control of the fabrication process.

Potential Applications

- IMRE's low latency, low-power specifications could be used in edge computing solutions in autonomous vehicles, Internet of Things (IoT) devices and sensors.
- IMRE's high performance memory solutions could be applied in cache, buffer or computation.

Technical Results

IMRE researchers have recently achieved:

High performance memory/ sensors solution

- Tunnelling magnetoresistance (TMR) > (100±8)% on a 200mm wafer.
- Spin torque switching current < 60 mA at 20 ns pulse width
- Thermal stability > 55 k_BT at 40 nm magnetic tunnel junction (MTJ) node
- Endurance > 10^{13} cycles

Low latency, low power solution

- Demonstrated new MTJ writing mechanisms by means of
  - Spin orbit torque (SOT) as fast as 1 ns
  - Writing speed via electric field (EF) of < 1 ns and switching energy of < 10 fJ

Collaboration Opportunities

- Explore licensing and/ or joint development with semiconductor foundries, circuit designers, product developers, etc.

For more information, please contact:
industry@imre.a-star.edu.sg

IMRE website: https://www.a-star.edu.sg/imre/
A*STAR website: https://www.a-star.edu.sg/

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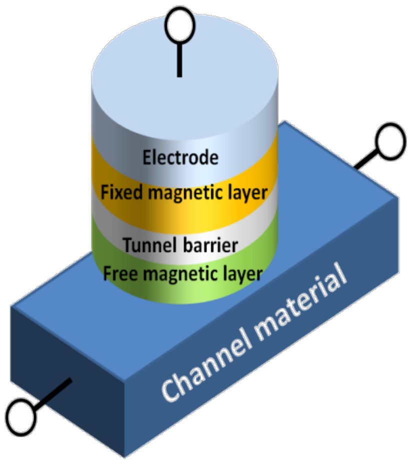
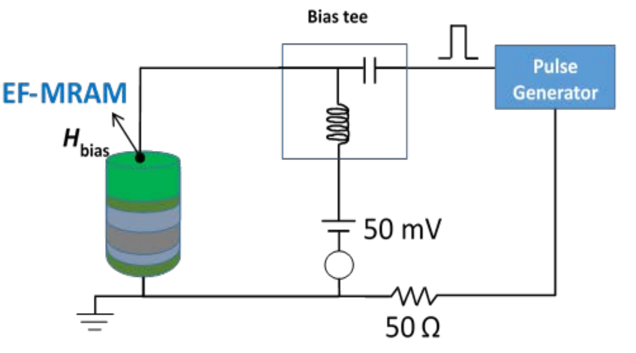
Performance Data

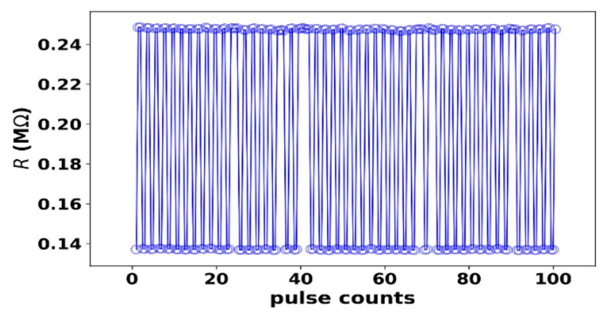
SOT-MRAM



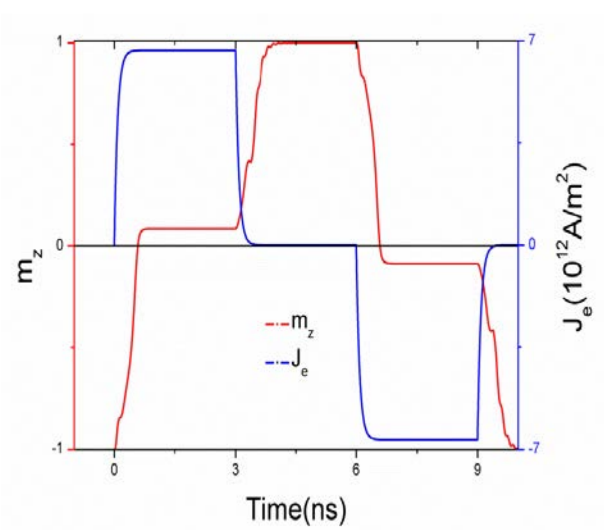
Schematic of a Spin Orbit Torque (SOT) device which can provide low latency, high endurance features required for edge computing.



Electrical characterisation set-up demonstrating MTJ switching via electric field.



MTJ switching *via* electric field for 100 identical events using writing energy <10 fJ at 0.7 ns. High speed writing mechanisms, such as the one demonstrated here, are suitable for cache-memory and low-power computing.



Temporal plot of deterministic magnetisation switching *via* spin-orbit torque at 3 ns.

References:

- J. Lourembam et. al. (2018) Phys. Rev. Appl. 10, 044057
- J. Lourembam et. al. (2018) Appl. Phys. Lett. 113, 022403
- L. Huang et. al. (2018) Appl. Phys. Lett 113, 022402
- J. Lourembam et. al. (2017) AIP Adv. 8, 055915