School of Physics
Trinity College Dublin

PhD Research project in **Magnetism & Spin Electronics**

Development of 2D and 3D Arrays of Magnetic Sensors based on Spin-Valves and Magnetic Tunnel Junctions

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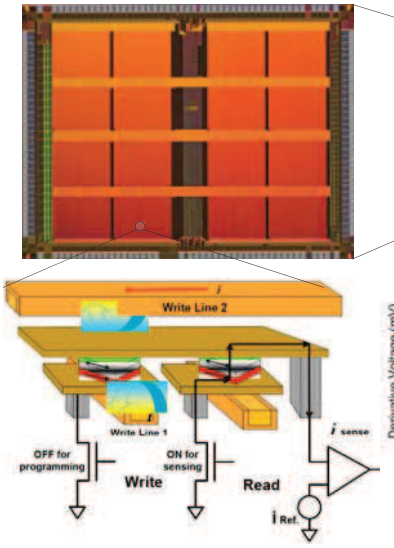
Magnetism & Spin Electronics

Scientific Background / Current Research

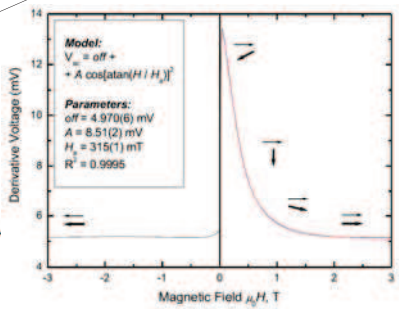
Spin-Valves (SVs) and Magnetic Tunnel Junctions (MTJs) are, in their simplest forms, sandwiches of two conducting and magnetic layers, separated by a nonmagnetic conductor or a nonmagnetic insulator, respectively. Their primary uses in spin electronics have been concentrated in the area of external magnetic field sensing. Another strand of spin electronics, however, relies on large arrays of SVs or MTJs, designed particularly to be insensitive towards the external magnetic field, as the storage elements in the so-called Magnetic Random Access Memory (MRAM). The two branches of the same field have, so far, had little interaction, but to the optimisation of the very SVs and MTJs used. The development of arrays of magnetic sensors should take the best of both worlds and provide useful measurement platforms for fields like magnetic bio-marking and imaging magnetometry.

Project

The project will involve the analytical and numerical design, simulation, construction and characterisation of prototypes of 2D magnetic sensor arrays of relatively small sizes - 8 x 8, 16 x 16. Pending potential collaboration with an MRAM manufacturer, larger arrays and 3D arrays (die-stacked) may also be investigated. Applications in the reading of magnetic bar-codes and general micron- and sub-micron scale fringing field characterisation will be tested and evaluated.



Actual 'toggle'-MRAM chip, with its magnetic shield removed; a die with the arrays of MTJ bit-cells clearly visible and a schematic structure of a bit-cell. (After Reference •)



The zero-bias, AC, low-temperature (T = 2.0 K) transfer curve of a synthetic antiferromagnet-based MTJ stack, and a fit to it.

Funding

Funding for this project has been approved and is available through the School of Physics, TCD via the PRTLI5 program, for a minimum of 4 years.

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More information / References

• *cache.freescale.com/files/32bit/doc/app_note/AN3525.pdf*

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