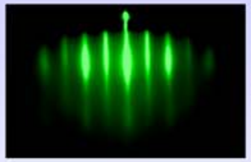
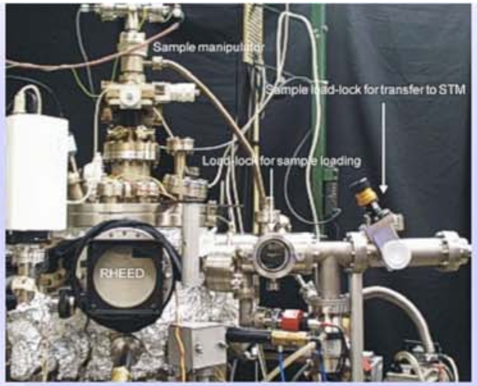
High target utilisation *sputtering* precisely controls grain size of a film.

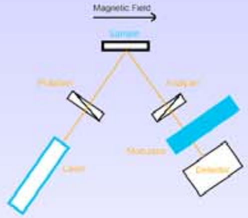
Moleculer beam epitaxy (*MBE*) is a powerful tool to grow high quality ferromagnetc/non-magnetic films in an ultrahigh vacuum. Both stuctural and magnetic properties are analysed *in situ* by using reflection high energy electron diffraction (*RHEED*), scanning tunneling microscopy (*STM*) and magneto-optical Kerr effect (*MOKE*). Strain can also be intentionally introduced during the growth.

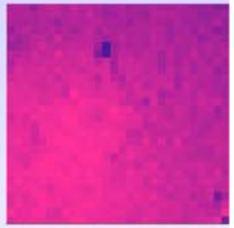


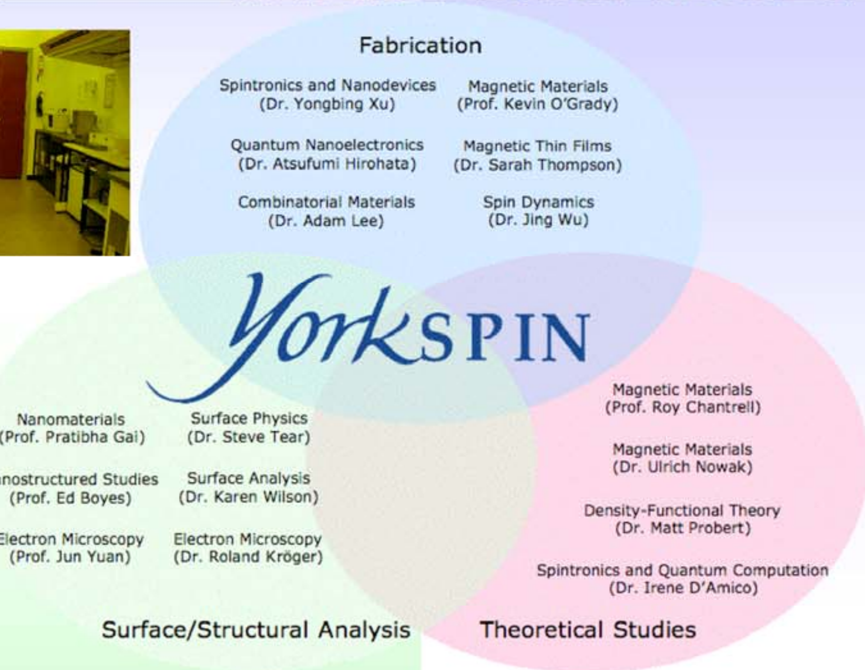


Magnetisation curves is measured by vibrating sample magnetometry (*VSM*) and alternating gradient force magnetometry (*AGFM*).

Device process laboratory is equipped with class *photolithography* for electrode patterning, plasma enhanced chemical vapor deposition (*PE-CVD*), *thermal evaporator*, *thermal oxidation furnace* and plasma reactive ion etching (*RIE*) for device fabrication. *Step profiler* and scanning electron micoscope (*SEM*) with energy dispersive X-ray analysis (*EDX*) are also installed for characterisation. *Wire bonder* and *probe station* are used for transport measurement.







Spin dynamics measurement with MOKE set-up. Spatially-resolved *magneto-refractive effect* also shows magneto-resistive (MR) signals with infra red radiation.

THE York JEOL

Electron-beam lithography and dual focused ion beam (*D-FIB*) are employed for nanofabrication.

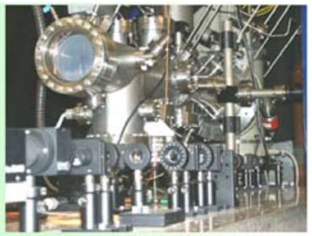
diamond

Magnetic X-ray circular dichoism (*XMCD*) to estimate atomic specific spin/orbital moments in collaboration with Daresbury Laboratory and Diamond.

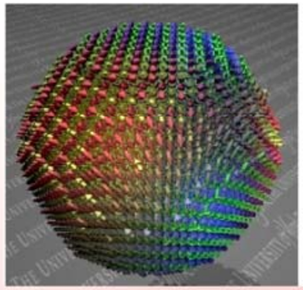
Scanning probe microscope (*SPM*) for surface/magnetic domain observation.

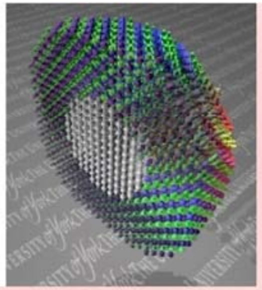
Ultrahigh resolution field-emmission transmission electron microscope (*TEM*) for *in situ* transfomation/processing studies.

UHV STM/ AFM for surface observation.

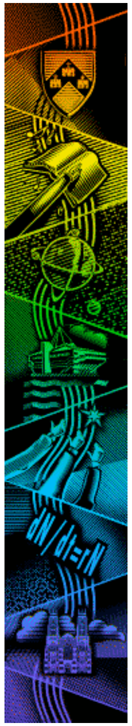


He beamline* with a phosphor screen mounted on the end for characterisation.





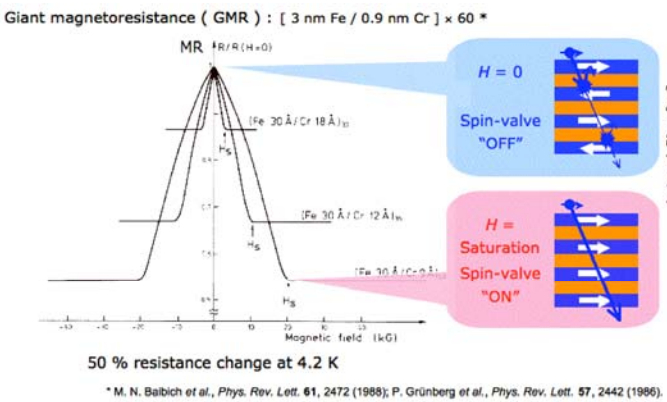
Computer simulation of magnetic moment behaviours in a nano-scale ferromagnetic materials to investigate spin dynamics and exchange bias.

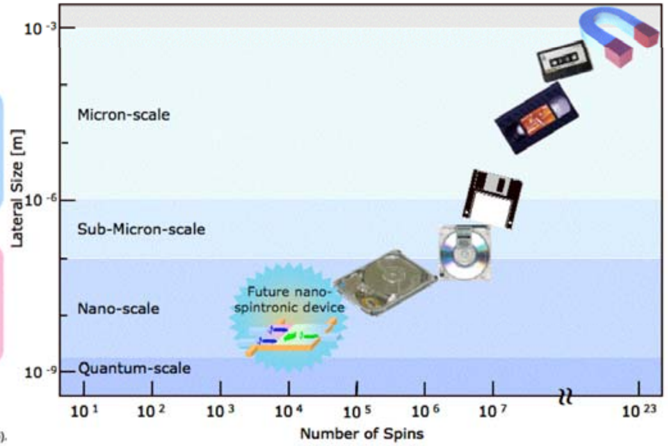


Nano-Spintronics Research in York

Contact: Atsufumi Hirohata (ah566@ohm.york.ac.uk)

Spintronics has been inspired by the discovery of giant magnetoresistance (GMR) late 1980s. The GMR is based on the difference in the resistance induced by spin scattering at ferromagnet/non-magnet/ferromagnet layer interfaces with respect to parallel and anti-parallel magnetisation configurations. This effect has been exploited in a read/write head in a hard disc drive (HDD), the most common data storage these days. Another major progress is the observation of tunneling magnetoresistance (TMR) at room temperature in 1995, derived from spin-dependent tunneling through an oxide barrier, offering a much larger MR ratio for higher areal density in a HDD.

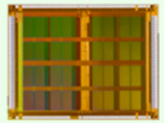




The Nobel Prize in Physics has been awarded in 2007 to *Profs. Albert Fert and Peter Grünberg* for their discovery of GMR.

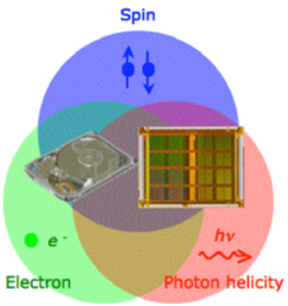
"HDDs to record 80% of man-made information." (Toshiba, Jan., 2008)
Info. created by humans: 120 Ebytes
HDD shipment: 95 Ebytes (1 E=10^{18})

Magnetic random access memory (MRAM) achieves *non-volatility, fast read/write, infinite operation, low power consumption and high density.*

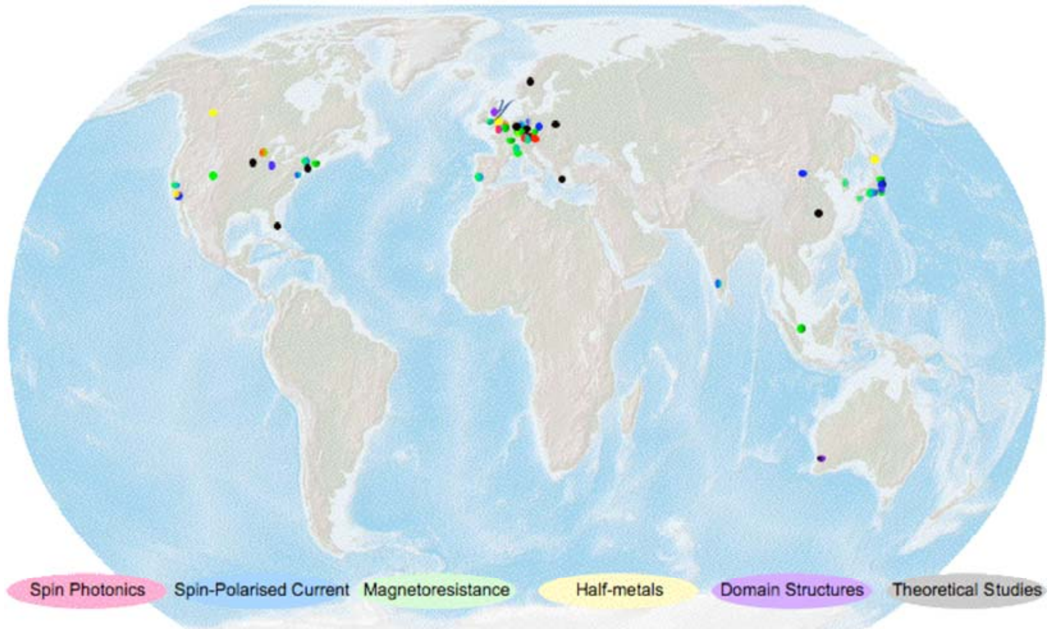


Spintronics is one of the most exciting and emerging fields in condensed-matter physics.

Due to recent advances in vacuum technology, epitaxial films can be grown to reveal crystalline-induced magnetic properties and a coherent tunneling process, etc. Further precise control on the atomic scale exploits new spintronic materials to realise unique magnetic characteristics, *e.g.*, 100% spin polarisation and large magnetic anisotropy. Nano-fabrication additionally restrict the dimensions and area to investigate spin transport properties and to improve the efficiency of a device.



The combination of physics and materials science in nano-scale affords a platform for spintronics, where spins, electrons and photons interact with each other, realising spin-polarized electron transport, very large spin polarisation and photo-induced spin dynamics, etc. The integration will promote future spintronic applications, a polarisation-tunable spin source, a spin transistor, spin diode and so on, each of which is anticipated to incorporate many accessible functionalities in conventional electronics.



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* Images are downloaded from the corresponding institutes and companies.