

Patterned nanoscale magnetic field sources

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Patterned magnetic thin film technology has developed rapidly over recent years, with potential applications in sensor, memory and logic technology envisaged. In particular, extended nanowires made of simple alloys such as Ni-Fe are used in order to support magnetic domain walls. Usually, devices are operated by propagating domain walls using an applied magnetic field or electrical current through the nanowire. However, magnetic domain walls in patterned wires are also nanoscale sources of magnetic field. This field is very high at the nanowire surface (~ 1 T) but drops off rapidly over a few micrometers. We are currently investigating ways of using this stray field to trap biological cells and laser cooled atoms. In one example, we are labeling Schwann cells found in peripheral nerve tissue with superparamagnetic beads and attempting to create a magnetic template for positioning the cells relative to each other. The proximity of the cells is understood to be important for triggering cell division and the development of nerve tissue. If successful, this offers a novel route to nerve tissue engineering for surgical use. For atom trapping, we require an ensemble of laser-cooled atoms such as ^{87}Rb to be addressed into a low-field-seeking state. We can then bias the stray field from domain walls to create a zero-dimensional atom trap with very strong confinement characteristics. The promise of this system is to allow a series of mobile atom traps to enable qubit interactions in a scalable magnetic architecture.

Dan Allwood is currently an EPSRC Advanced Research Fellow at the University of Sheffield, UK. Before moving to Sheffield in 2005, he worked as a post-doc (with Russell Cowburn) developing magnetic domain wall logic.