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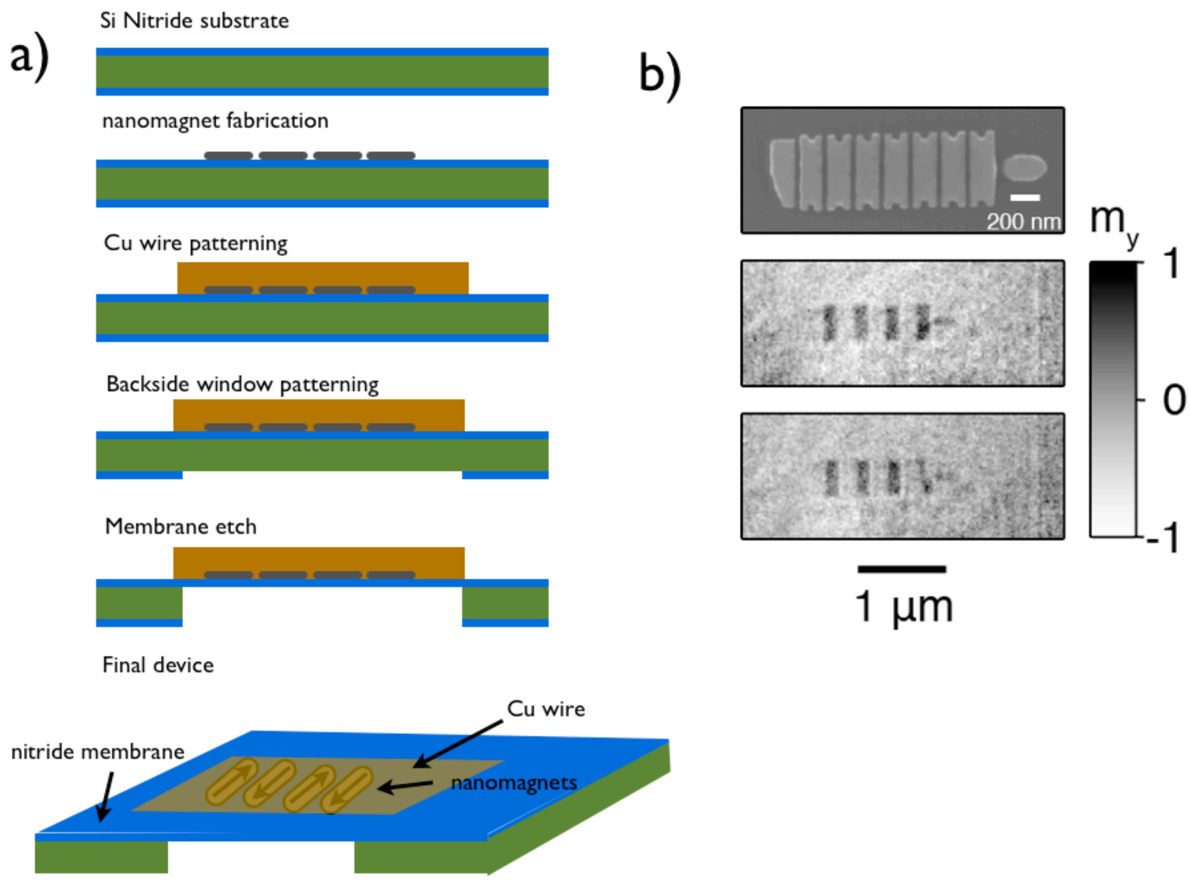
Nanomagnetic Logic is a computing architecture promising continued exponential improvements in ultra-low power operation as CMOS approaches its scaling limits. The state variable is stored in the magnetization direction of single domain nanomagnets fabricated in closely spaced chains that interact via nearest neighbor dipole-coupling. This coupling is tuned such that a signal can be passed from one nanomagnet to another in a cascade.

After a magnetic signal has been propagated, the process can be studied by imaging the magnetic state of the circuit. In the past, these nanomagnet chains have been imaged with Magnetic Force Microscopy (MFM) and Photoemission Electron Microscopy (PEEM). All imaging techniques have tradeoffs, however, and there are benefits to exploring additional methods. PEEM, for example, must be done in high vacuum, is incompatible with external magnetic fields, and is very surface sensitive. MFM has the potential to interact and perturb the magnets during the imaging process and is not suitable for performing time-resolved measurements. In this work, we explore the use of Magnetic Transmission X-ray Microscopy (MTXM) using the XM-1 microscope at the Advanced Light Source synchrotron. MTXM measurements can be performed at ambient pressures, have very high resolution, and can be used to explore dynamics using pump-probe techniques.

One challenge associated with MTXM is sample preparation. The nanomagnets must be fabricated on membranes and integrated with Copper wires to apply external magnetic fields to reset the magnets. In this work, we develop a process to fabricate this device and demonstrate MTXM measurements on the nanomagnet chains. The MTXM results show the nanomagnets in the chains couple antiferromagnetically and can be reset using electrical pulses through the Copper wires. Figure 1 a) shows a schematic of the fabrication process for the nanomagnets chains. Figure 1 b) shows the results of the MTXM measurement as well as a Scanning Electron Micrograph of a representative nanomagnet chain.

Figure 1: a) A schematic of the fabrication process for nanomagnet chains fabricated on Silicon Nitride membranes capped with Copper wires for applying magnetic fields. b) A Scanning Electron Micrograph of a representative nanomagnet chain (top) with MTXM images showing the magnetization state of the nanomagnets in the chain.



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