Reconfigurable metamaterials for spin computing.

R. Bertacco[3]

[1]Polifab – Dipartimento di Fisica, Politecnico di Milano, Italy

Next generation of computing devices requires new paradigms, both on the architecture side and on the materials side. In this talk I'll present an unconventional approach based on reconfigurable magnetic metamaterials. The way they are synthesized is not the combination of different elements (as in a multilayer or in a composite material) but the crafting, at the micro- or nano-scale, of multifunctional properties in a uniform substrate. Starting from a "clean blackboard", i.e. a pre-initialized uniform film or multilayer, the use of advanced patterning techniques allows to locally modify the functional properties of said substrate in a reversible way, to define metamaterials (like in the case of photonic crystals) with intriguing peculiarities. A true engineering of the desired functionality is possible thanks to the flexibility of patterning. I'll focus on metamaterials suitable for unconventional computing strategies, all based on the use of the electron spin.

First, I'll report on a method (thermally assisted magnetic scanning probe lithography) [1] for patterning of exchange bias systems via highly localized field cooling, to define micromagnetic configurations suitable for the implementation of (i) spin wave analog computing, (ii) reprogrammable logic gates based on spin dependent transport.

Then I'll describe a strategy for patterning spin textures in ferroelectric Rashba semiconductors, such as GeTe, exploiting the intimate link between ferroelectricity and spin texture in these materials,[2] which allows for the electric writing of ferroelectric domains associated to spin-texture domains. The ferroelectric polarization provides a natural variable of state to be used for: (i) reprogrammable logic devices, (ii) neuromorphic computing.

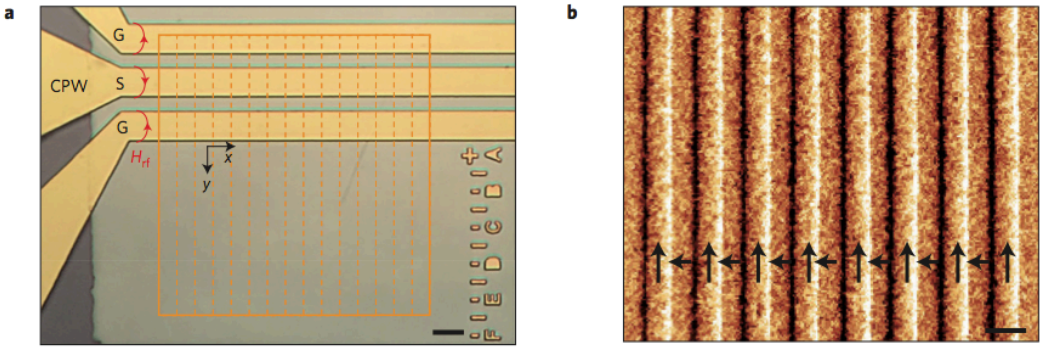

Figure 1. a, Waveguide (CPW) generating the field H_{rf} on the pad where the tam-SPL patterning was performed (orange square). Scale bar, 4 µm. **b,** MFM image of the magnonic structures, consisting of 2.5-µm-wide tracks with alternating 0° and 90° magnetization (black arrows).

[1] E. Albisetti, et al., N*anopatterning reconfigurable magnetic landscapes via thermally assisted scanning probe lithography",* Nature Nanotechnology 11, 545–551 (2016)

[2] C. Rinaldi et al., *Ferroelectric control of the spin texture in germanium telluride*. arXiv:1707.0704 (2017).