Energy Harvesting Based on Stress Induced Domain Wall Motion in Soft Magnetic Microwires

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Energy harvesting is getting significant interest due to the requirement of devices for the emerging internet-of-things (IoT) technology and their requirement of self-generation of power. As a supplement to solar energy based energy harvesting, generation of energy based on magnetic principles is useful. Domain wall propagation in ferromagnetic materials, as induced by stress and a pick-up voltage using coils has been investigated as an alternate form of energy harvesting. We have recently shown that power can be generated from mechanical vibrations in purely ferromagnetic structures. In this talk, we will highlight the details of micromagnetic simulation and experimental work.

For this work, we deposited soft magnetic FeCo films using facing targets sputtering (FTS). The fringing magnetic field from FTS was used to achieve a field-induced anisotropy. The use of suitable underlayers helped to reduce the coercivity of the films and to set the magnetization along the fringing field direction. Lithography was carried out in such a way to achieve microwires with an anisotropy in the orthogonal direction. Stress was applied and the change in the domain pattern was observed using bitter-pattern technique.

Figure 1 shows the changes in the domain pattern as a function of the applied stress. It can be noticed that the domains are densely packed when there was no stress applied. When the stress was increased slightly, the domains expanded. For higher values of stress, the domains disappeared completely. For practical applications, the stress could come from the bending of the substrates due to the picking up of ambient vibrations. For energy harvesting, the resultant change in the domain wall motion could lead to a change in flux and hence a voltage in the pick-up coil. We have made a prototype device with pickup coil and have obtained voltage pulses of the order of 1 mV in a resistive load of 50 ohms.

In summary, the use of flexible substrates with low Young's modulus and a special magnetic stack enabled us to achieve significant magnetization rotation or domain wall motion even from ambient vibrations. We have exploited the rotation of magnetization or domain wall motion to induce voltages in the pickup coils.

<u>References</u>

1. Bryan, M. T., Dean, J. & Allwood, D. A. Dynamics of stress-induced domain wall motion. Physical Review B 85, doi:10.1103/PhysRevB.85.144411 (2012).

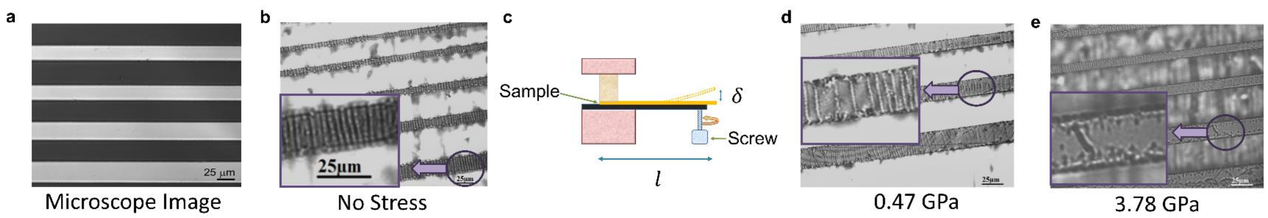

Fig 1. Domain wall images as observed by (a) optical microscope and (b,d,e) bitter-pattern technique (c) Illustration of application of stress, to induce domain wall motion.