M-P-329 BACK TO CONTENTS BACK TO AUTHOR INDEX

Influence of Geometry on Memristive Behavior of the Domain Wall Spintronic Memristors and its Applications for Measurements

H. Mahmoudi, V. Sverdlov and S. Selberherr

Institute for Microelectronics, TU Wien, Gußhausstraße 27-29, 1040 Wien, AUSTRIA
Presenting Author: mahmoudi@iue.tuwien.ac.at

A spintronic memristor is a device employing the dynamic properties of a propagating magnetic domain wall [1]. Because the dynamics of the domain wall is strongly affected by the device geometry [2], domain wall spintronic memristors (Fig.1) exhibit a geometry dependent memristive behavior. We propose applications of a spintronic memristor in power management [3] and charge sensing. Fig.2a shows a domain wall spintronic memristor (DWSM) in which the derivative of the memristance R with respect to charge q is constant. As it follows from the memristor's constitutive relation [4], such memristors are suited for power monitoring in a circuit as shown in Fig.2b. In addition, memristors with dR/dq=const are perfectly suited for capacitance sensing, when connected in series with a capacitor. The DWSM shown in Fig.3a has a constant derivative of the memductance G with respect to flux φ. It is therefore suited for power monitoring in a system as shown in Fig.3b and also for inductance sensing, when connected in parallel with an inductor. In all cases memristors reduce the problem of measurement to a simple resistance measurement.

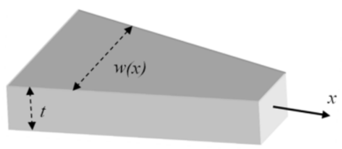

Figure 1. Domain wall spintronic memristor [1]. The constitutive relation is $\varphi = A\ q^{(1-\rho k)/(\rho+1)}$ [1] where q is the charge, φ is the flux, A is a constant coefficient, ρ determines the spatial dependence of w as: $w(x) = \tilde{w}(x/\tilde{x})^{\rho}$, with $\tilde{w}$ representing w at position $\tilde{x}$. The parameter k (=2.2 [5]) defines the domain wall mobility μ which scales with the aspect ratio $\mu \sim (w/t)^k$.

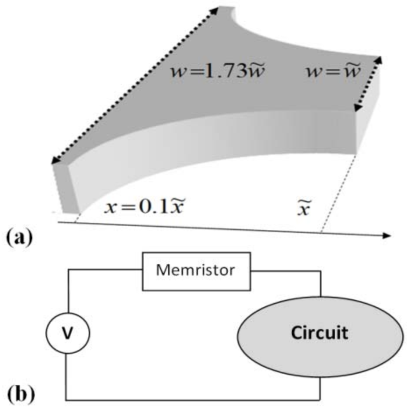

Figure 2. (a) Charge-controlled DWSM with ρ =-0.24. (b) Memristor based power monitoring. The whole system is supplied by a constant voltage V so the power is calculated as: $E = \int VIdt = V\int Idt = V\Delta q = V\Delta R(q)/2A$.

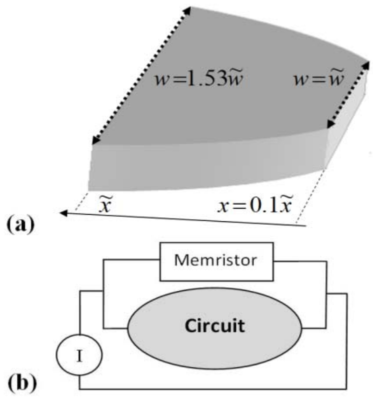

Figure 3. (a) Flux-controlled DWSM with ρ =0.19. (b) Memristor based power monitoring. The whole system is supplied by a constant current I so the power is calculated as: $E = \int VIdt = I\int Vdt = I\Delta\varphi = V\Delta G(\varphi)/2A'$.

The work is supported by the European Research Council through the grant #247056 MOSILSPIN.

References

[1] J. Wunderlich, et. al., IEEE Trans. Magnetics, **37**, 2104 – 2107 (2001).
[2] X. Wang, Y. Chen, H. Xi, H. Li and D. Dimitrov, IEEE Electron Device Letters, **30**, 294-297 (2009).
[3] X. Wang, Y. Chen, DATE, Dresden, Germany, March 2010.
[4] L. O. Chua, IEEE Trans. Circuit Theory, vol. 18, no.5, pp. 507-519, September 1971.
[5] L. Berger, Phys. Rev. B, vol. 73, no.1, pp. 014407-(1-5), January 2006.