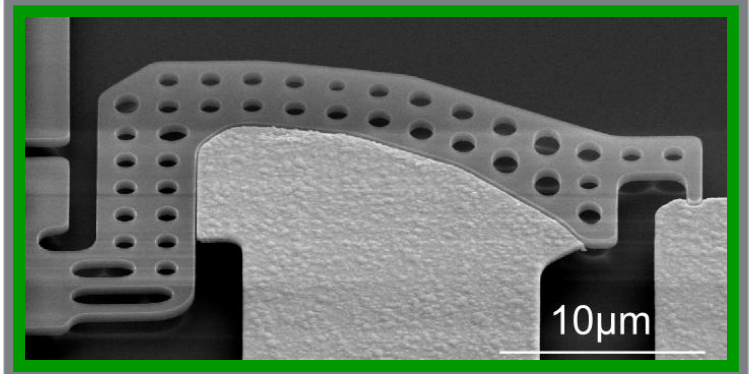
NEMIAC Newsletter

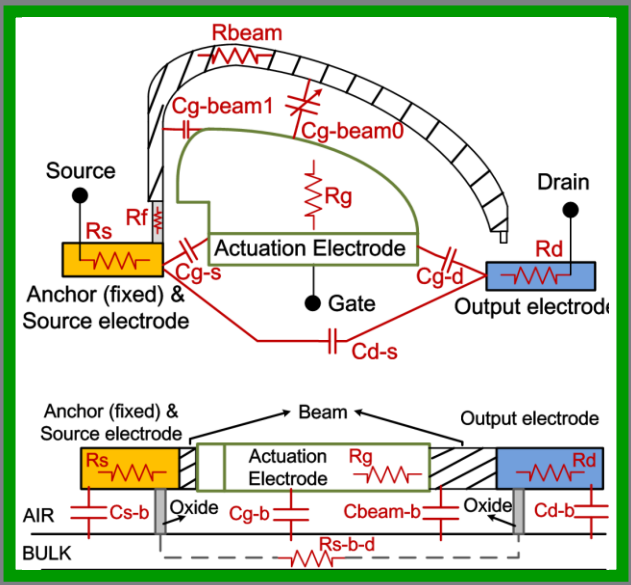
June 2013 | Industry News | Issue 1



NEM Switch for Low-Power Applications

An in-plane curved cantilever nanoelectomechanical (NEM) switch has been designed and successfully fabricated by IBM within the consortium. The abrupt switching characteristic of such a NEM switch device is attractive for the design of energy-efficient circuits. The switch has been optimized for high mechanical robustness and low switching energy. The scaling potential has been evaluated showing that sub-100 aJ switching energy is achievable.

REF: D. Grogg et al. Invited talk at IEEE Sensors 2012



Modeling of NEM switch based digital logic

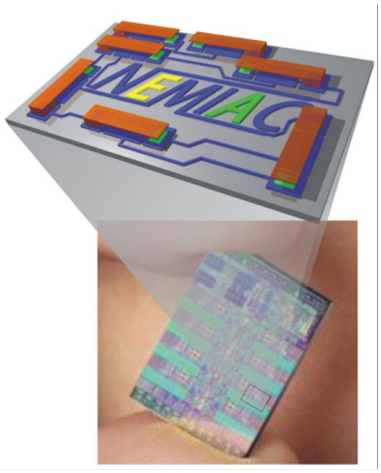
A verilog-A model has been developed to enable fast circuit-level simulation. The model includes a lumped element electromechanical model that is calibrated using 3D finite-element simulations (ANSYS) and a contact model that approximates the adhesion force and resistance of the nano-scale contact. The energy of a micrometer-range curved NEM switch is analyzed showing that the gap distance and the contact area are the key parameters affecting the total energy.

Using 3-terminal relay as a primitive, digital logic can be realised by adopting a complementary style approach. NEM relays are ambipolar and the actuation depends on the voltage difference between the gate and beam. A design library of combinational and sequential gates is being constructed using circuit architectures that are tailored to the NEM relay characteristics.

Dissemination and Promotion to industry: *EE Times Europe*

The consortium has been able to secure an article in the News & Technologies section of a popular magazine with a wide readership, *EE Times Europe*.

NEMIAC project (Nano-Electro-Mechanical Integration And Computation) awarded €2.44M by the European commission investigates NEM relay based computing for ultra-low power logic applications. The goal within NEMIAC is to build the world's first ever miniaturised electro-mechanical relay based processor.



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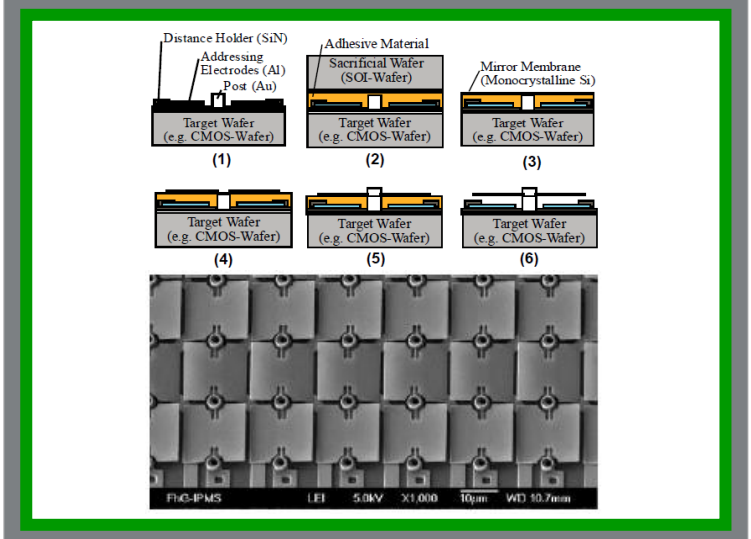
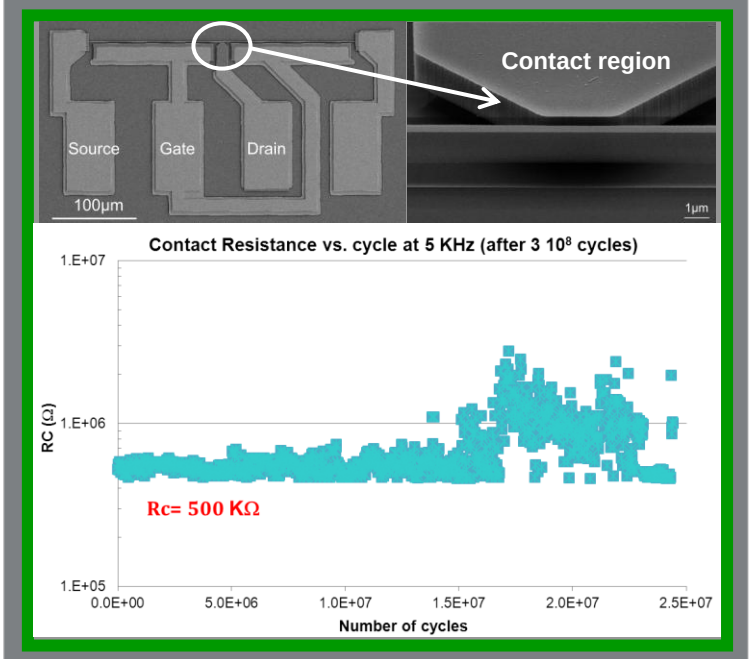


NEM switch integration

A generic, very large scale heterogeneous integration platform for the NEM switch integration on top of metal interconnect layers is being implemented by KTH and IBM. This integration platform uses thin-film layer transfer based on adhesive wafer bonding to implement the NEM switch beams from high-quality mono-crystalline silicon. The integration platform is compatible with integrated circuit technology, and thus will in the future allow hybrid logic circuits consisting of both CMOS and NEM switch technologies.

REF: F. Zimmer, et al., IEEE Journal of Microelectromechanical Systems, Vol.20, 2011.



MEM relay reliability & lifetime

Traditional failure mechanisms of ohmic switches with low power DC contact are mainly due to issues related to the metal contact region (damage, pitting and hardening). Finding a suitable material for a long life-time switch with a small hysteresis and which enables low power is a critical task for the project. Ideal contact material properties includes low adhesion (<1 N/m), strong hardness (to avoid erosion or welding), small contamination (to avoid oxide or conductive oxide films) and good electrical conductivity. The contact resistance is monitored to analyze the degradation of the contact and estimate the lifetime of the MEM relay. Lifetime over 4 10^8 cycles has been achieved for MEM relay double clamped silicon beam test structure in ambient air humid condition. A long-term reliability set-up with a fast acquisition card has been conceived to reduce parasitic in order to increase the cycling frequency up to hundreds of kHz range and thus enable 10^{10} cycles in a reasonable period of time.

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