Nanoswitches for Energy Savings Applications

University of Wisconsin-Eau Claire
Emely Hamann, Bret Meier, Jason Leicht, Caramon Ives
Dr. Doug Dunham and Dr. Marc McEllistrem

The Issue

Transistor technology has allowed electronics to get smaller and smaller. Transistors have their on and off states that correspond to high and low electric currents. So even when an electronic device is "off " it is using electricity and the transistor is wasting energy

The Possible Solution

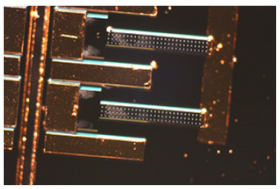
Mechanical switches (like light switches in your home) won't allow current to flow when they are in the off position. When they are off no energy is wasted. In order for switches to be used in the microelectronics industry the switches will need to be extremely small: on the order of micrometers or nanometers.

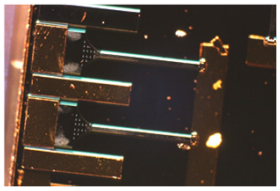
The Difficulty

Fabrication of switches this small is a challenge. In addition, at this smaller size the properties of the materials can change. It is important to be able to characterize the properties of these switches both after their made and after cycling them millions of times, to verify the suitability of these devices in consumer electronics.

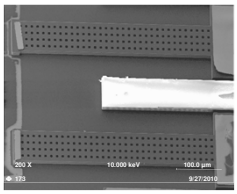
Characterization of Fabricated Switches

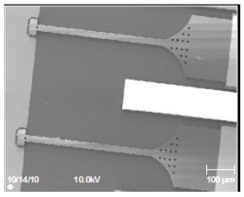
The switches to the right were viewed through an optical microscope. The silicon switches are covered in gold to improve conductive properties of the switches.



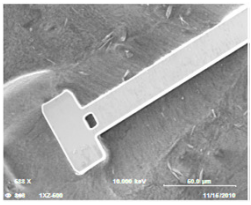


The images to the right were taken with an SEM (Scanning Electron Microscope). The SEM allows us to view the switches at a much higher magnification.

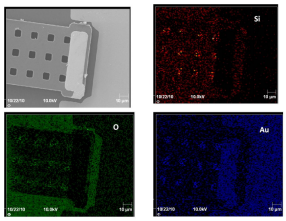




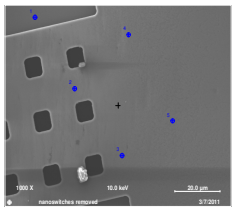
We broke the cantilevers off in order to view and characterize the underside of the switches. The switches shown have a width of about one-fourth the thickness of a human hair.

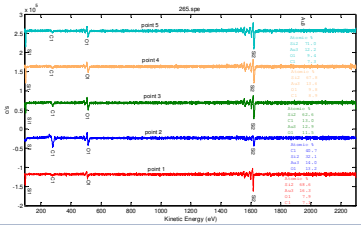


To the right is an example of Auger mapping. It shows where specific elements are located on the nanoscale



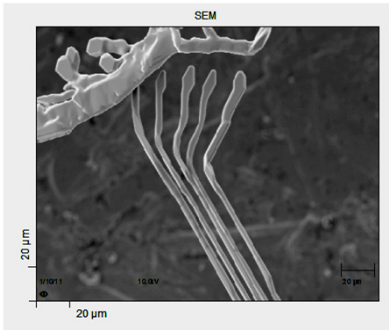
Belowis a point survey, used to identify the elements present and their concentrations.





Development of SiC Nanoswitches

The switches being currently developed are made mostly of Silicon (Si). If they switches were made out of Silicon Carbide (SiC) it would improve their durability and strength as well as their ability to function at higher temperatures. The SiC cantilevers on the right are about one-tenth the thickness of a human hair.



Acknowledgements:
UWEC NanoSTEM DIN Funding, Resonant Microsystems
Purdue University's Adaptive Radio and Electronics Systems Research Group,
Ronald E. McNair Program, Dr. Jill Ferguson