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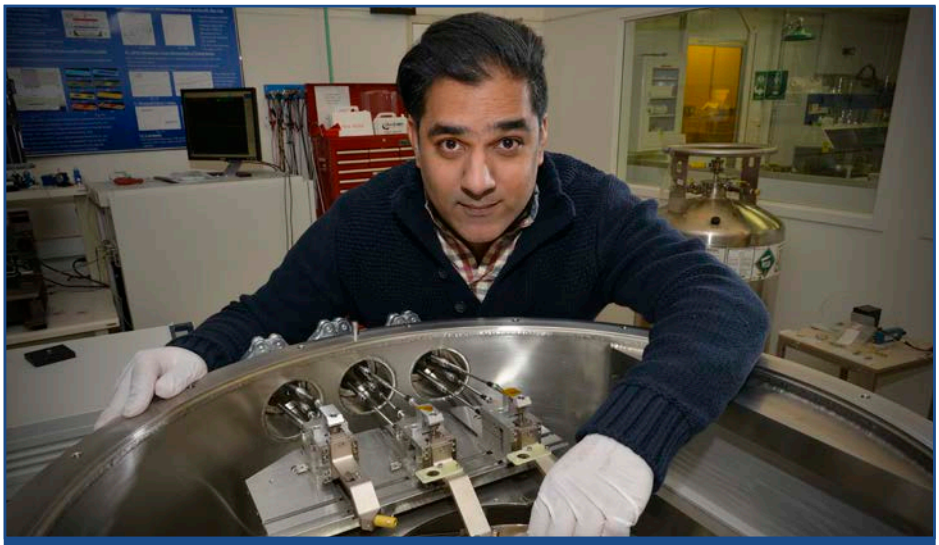
IMPACT

Pioneering MEMS technology offers nano-scale 'microscopy for the masses'

Neil Sarkar has always been fascinated with matter that lies beyond the perceptive capability of the human eye. His passion for the infinitesimal, first demonstrated in Manning Innovation Award-winning science fair projects, came to fruition last year when he was recognized for his discovery and development of the world's first single-chip atomic force microscope (AFM).



Dr. Neil Sarkar leveraged the power of MEMS to create the world's first single-chip Atomic Force Microscope. His discovery, now being commercialized by University of Waterloo startup Integrated Scanning Probe Instruments (ICSPI), has applications in semiconductor, biosciences, polymers, and nanomanufacturing sectors.

Among the highest resolution microscopes available today, AFMs are the most widely used form of scanning probe microscopes. They are used in the nanotechnology industry to capture, measure and manipulate materials at the nanoscale. Dr. Sarkar has advanced the technology to a new level by integrating all of the electrical and mechanical components that are required for an AFM to obtain an image of a sample on a single, tiny CMOS chip. His "microscopic microscopes," as he calls them, offer the performance of conventional, tabletop-sized AFMs but at a fraction of their size and cost.

His device promises precision manufacturing at the atomic level, with applications across a wide variety of product sectors, including semiconductors, biosciences, polymers, and nanomanufacturing. Last October his discovery was awarded the 2014 Douglas R. Colton Medal for Research Excellence by CMC Microsystems.

Dr. Sarkar developed his micro-electrical-mechanical systems (MEMS) technology as a University of Waterloo student working at Zyvex Labs of Texas, a pioneering nanotechnology company. "It was my first exposure to MEMS and microassembled products," he says. "It was where I learned about actuators, sensors and microfabrication processes."

He also saw how scientists would make their own specialized versions of the company's sole scanning-probe microscope for their experiments, to get round the limitations of the bulky, difficult-to-use instrument—and he recognized an opportunity. "I realized that MEMS were very well suited to replace a lot of the stuff they were doing."

Returning to Canada for his Master's research, he began to explore the idea of creating a scanning probe microscope that integrated all of the sensing functions needed for nanoscale measurement on a single CMOS-MEMS chip.

That work is now driving the growth of a new class of ultra-high-resolution microscopes and related innovations through Integrated Circuit Scanning Probe Instruments (ICSPI) Corp., a startup company he co-founded in 2007 with his University of Waterloo graduate supervisor, Raafat Mansour, Canada Research Chair in Micro and Nano Integrated RF Systems.

Dr. Sarkar credits his technology's relatively swift commercial trajectory to the National Design Network (NDN), a unique Canadian ecosystem of tools, expertise, and access to manufacturing managed by CMC Microsystems. These resources, he says, are a vital enabler for innovation in Canada, not just in helping move ideas closer to market, but in training Canadian innovators and stimulating follow-on research.

A fellow of the Waterloo Institute of Nanotechnology, Dr. Sarkar developed his micro-electrical-mechanical systems (MEMS) technology through the University of Waterloo's Centre for Integrated Radio Frequency Engineering (CIRFE), where he was able to design, prototype and test his device, and where his AFMs are now post-processed and assembled.

"It was one of the refreshing things about Canada, how easy it was to access semiconductor manufacturers such as TSMC, and other processes, and design kits," he says. "CMC has enabled very easy access to world-class fab processes for us."

But creating the CMOS chip was just the beginning. Industrial funding enabled his startup company to support associated research by graduate students and research associates in the CIRFE lab, which in turn has stimulated additional funding and research in this emerging field. "It's not often a startup is working on something academically relevant but also commercializing it at the same time," he says. "It's become an active area of research for us and for Professor Mansour's group."

True to the NDN's mission, Dr. Sarkar is now looking to share his discoveries with others in the network. "We're excited about the possibility of introducing this CMOS process to the NDN community, as well as a library of components, sensors and actuators on chips to design devices."

He also hopes to eventually see his AFMs introduced into high school and university labs, to enable students to experience phenomena at the nano scale—something that's not possible with existing optical microscopes. "Learning about this technology could really have an impact on those considering a science or engineering career," he says.

For now, his company's focus is on getting the technology into commercial users' hands. Although still at the beta design stage, ICSPI AFMs have already been sold to a commercial client, and plans are for a large group of Canadian government scientists to try them out as well. ***cmc***