

## Graduate nanofabrication research yields commercial opportunity

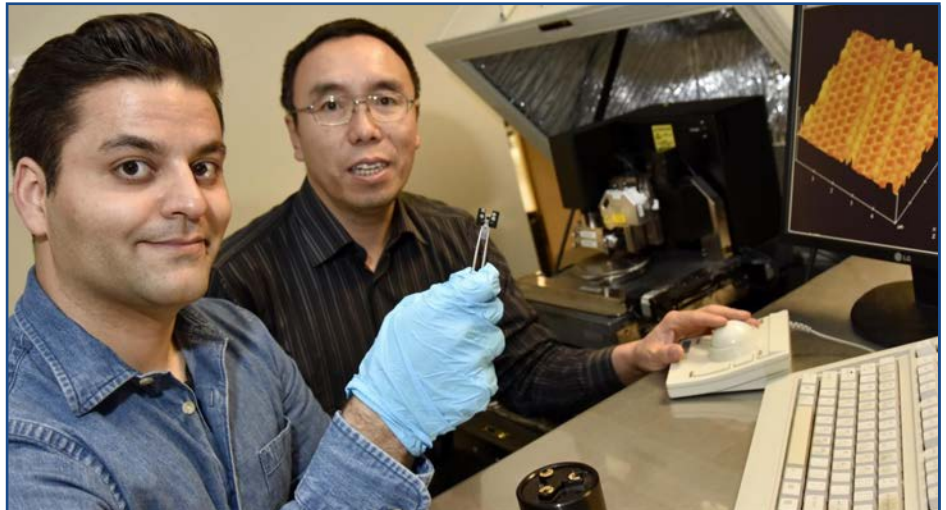
**N**ano-entrepreneur Babak Shokouhi was lured to University of Waterloo's nanotechnology engineering program, and ultimately the nanofabrication laboratory of Associate Professor Bo Cui, because of the limitless potential of the field – and because it allowed him to make things with high precision and leading-edge science.

Today, Shokouhi's desire to create is finding its fulfillment through NanoDevice Solutions, a startup company founded on his graduate student experience in building nanostructures using a variety of methods, including E-beam lithography, nanoimprint lithography and self-assembly of co-block polymers.

His undergraduate work with Dr. Cui gave him an appreciation, not just for the craftsmanship involved in nanofabrication, but for the potential commercial opportunities to be found in this rapidly emerging field. Opportunity arose when he began his Master's degree studies in Cui's lab, characterizing nanostructures using Atomic Force Microscopes (AFMs).

"I was having trouble mapping the surface topography of very deep and narrow nanostructures, and that is when I recognized the need for a specialty AFM probe to solve my problem," he says. "Addressing this issue enabled our team to make use of our nanofabrication skills, and bring the research a step closer to commercial application."

AFMs are a widely used tool in nanoscale imaging, design and characterization. Information is gathered by a probe, or AFM tip, that scans the surface of the sample and provides a detailed topographical map. In general



Characterizing nanostructures using atomic force microscopy (AFM) presented a commercial opportunity for University of Waterloo graduate student Babak Shokouhi. He and his team developed a novel process to batch-manufacture high-resolution AFM probes and today his startup, NanoDevice Solutions Inc., is the only company in the world making high aspect ratio tips in batches.

there are two types of tips: Standard resolution tips cost about \$15-\$25 each, and provide lower fidelity images than the more expensive, high resolution tips.

"The shape and sharpness of the tips dictates the image quality: the smaller the diameter, the higher quality the image. The high-resolution tips are like needles, long, and with a narrower radius that can get into the grooves of a sample," says Shokouhi. But they cost between \$100 and \$500 each, and until now, could only be manufactured one at a time.

"We thought, let's solve this problem," Shokouhi says. Batch production of these tips was a challenge because conventional manufacturing was incompatible with the pyramidal shape of the tips. Their solution is a patented manufacturing process that exploits the unique properties of plasma etching. "This process allowed us to etch batches of tips, instead of individual ones," he says. The goal is to manufacture many tips on four- and six-inch wafers, and scale to making many wafers at one time.

CMC Microsystems helped them develop the commercial potential of their idea, Shokouhi says, including access to the 3D CAD design tool Solidworks, and fabrication and travel support through CMC's MNT (micro-nanotechnology) financial assistance program. "They helped us with the initial modelling, and it worked out perfectly for us," he says.

"Startups rely heavily on other people, facilities and activities to help them. CMC played that supporting role for us. It helped us access the cleanroom facility at INRS (Institut national de la recherche scientifique), which had all the recipes and machines we needed to make a prototype just in time to talk to investors."

Those talks resulted in a deal, followed by sales of the company's first product, known as HAR Rocket Tips, to some U.S. academic institutions. A recent trip to China also proved promising for the company. "There is huge interest there from semiconductor companies that use AFM probes for the quality control of their miniature electronics," Shokouhi says. "We are the only company in the world making high aspect ratio tips in batches, with very high throughputs, at a very affordable price," he says.

Shokouhi describes himself as an ambassador for nanofabrication. "Knowing that nanotech is a relatively new field, there is a lot of opportunity for commercialization of emerging technologies." But along with a passion for the technology, he says, you also have to have a devotion to your customers – a lesson he learned from growing up in a family of entrepreneurs. "The key takeaway was, don't be one-dimensional," he says. "You have to have an open mind, you have to listen. If you can understand what the problems are, and try to solve those problems, you'll have a business." *cmc*