Nanoscale Liquid Jets Shape New Line of Business

Just as a pistol shrimp stuns its prey by quickly closing its oversized claw to shoot out a shock-inducing, high-velocity jet of water, NanoMatrix, Inc., is sending shockwaves throughout the nanotechnology world with a revolutionary, small-scale fabrication process that uses powerful liquid jets to cut and shape objects.

Emanuel Barros, a former project engineer at NASA's Ames Research Center, set out to form the Santa Cruz, California-based NanoMatrix firm and materialize the micro/nano cutting process partially inspired by the water-spewing crustacean. Early on in his 6-year NASA career, Barros led the development of re-flown flight hardware for an award-winning Spacelab project called "NeuroLab." This project, the sixteenth and final Spacelab mission, focused on a series of experiments to determine the effects of microgravity on the development of the mammalian nervous system.

In 1999, Barros transitioned into a project supporting the development of International Space Station research hardware, and was considered a nanotechnology expert among many of his peers in the Life Sciences Division at Ames. Fully satisfied with his accomplishments at NASA, Barros departed Ames in 2002 to succeed in nanoscale manufacturing as the chief technical officer and acting chief executive officer of NanoMatrix.

In addition to cutting and shaping, NanoMatrix's proprietary machining services and equipment are capable of performing sub-micron etching, drilling, and welding, all with nanometer precision. "At the scale that we are working, the jets use individual molecules to produce a machining effect," Barros explains. The processes pioneered by NanoMatrix are environmentally friendly, unlike semiconductor chip photolithography, which makes use of toxic chemicals. NanoMatrix employs mechanical methods, so no harsh chemicals are required. The processes are also extremely tolerant of contaminants, so they can be used in environments with less stringent cleanliness controls.

The company's work represents an alternative method for developing and building small-scale electronic, mechanical, and medical devices, among other applications. Until this technology became available, most small-scale fabrication processes were developed using large-scale circuit tools like semiconductor-manufacturing equipment. While these larger-scale tools continue to evolve and enhance the size and yield of two-dimensional circuits, they do not always meet the needs of developers working in other application areas. Leading-edge semiconductor technologies use a limited set of materials and are expensive, according to NanoMatrix. While they produce superb economies of scale, these processes require very large run sizes to be cost effective, the company adds. For this reason, microelectrical mechanical systems (MEMS) or nanoelectrical mechanical systems (NEMS) are traditionally produced using older semiconductor technology. Conversely, NanoMatrix's processes offer flexible run sizes, as large volumes are not required to be cost effective.

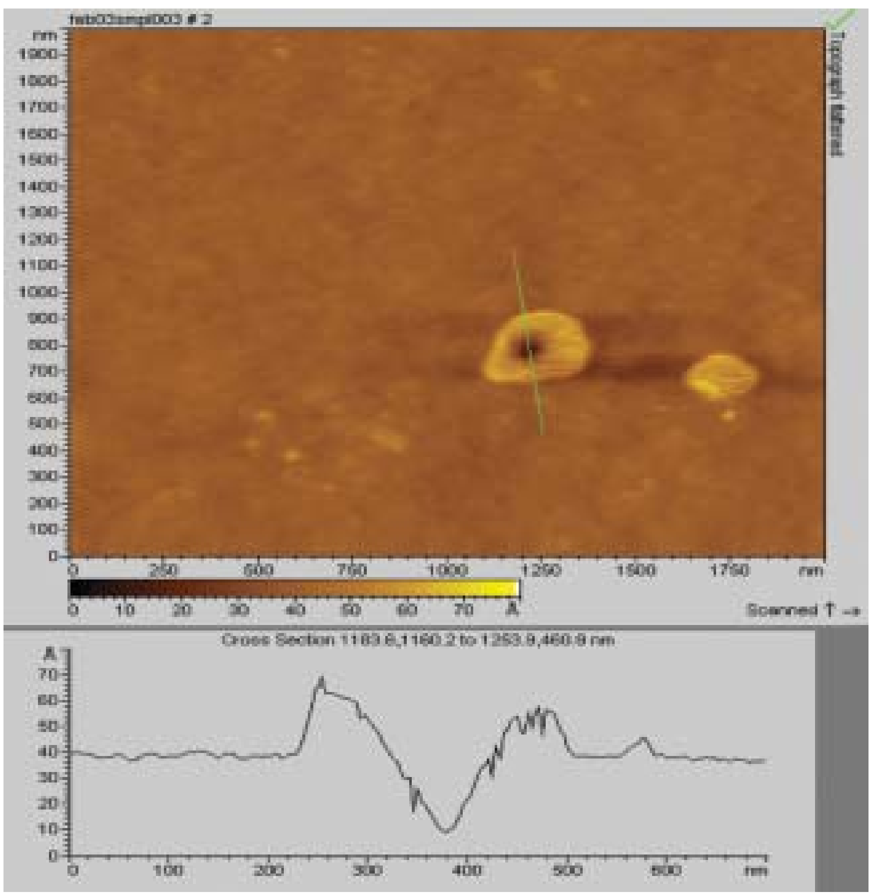
With NanoMatrix's liquid jet machining, significant opportunities abound in prototyping and creating smaller MEMS/NEMS devices. Furthermore, the process widens the potential for use of new materials that cannot be shaped or etched using semiconductor photolithography or e-beam procedures. To date, the company's biggest application involves film adhesion. NanoMatrix developed a process for a client that allows its next generation of films to adhere to a glass surface, such as a window or a lens, without affecting the clarity or the amount of light that shines through. The process increases the surface area; other procedures that attempt to broaden surface range will cause the glass to become opaque, and therefore useless, according to Barros.

This laboratory apparatus was used to develop a process in which NanoMatrix's high-velocity liquid jets helped adhere a family of next-generation coatings to materials that would otherwise not adhere very well.

NanoMatrix is also developing an inexpensive process to prevent glare on windows and lenses. This too, could be practical for computer, cell phone, and personal digital assistant screens, which are often subjected to strong sunlight that can obstruct displayed images and strain users' eyesight.

Farther down the road than the film adhesion process for NanoMatrix—but not too far, says Barros—is the likelihood of a first generation of nanotechnology-type mechanical machines that can be manufactured using a general-purpose rapid prototyping and/or production tool. These tiny machines would incorporate designs that could be developed by NanoMatrix or any third party using the company's tools. Such devices could be used as "sensing dust" for collecting sensory data of all kinds, then transmitting the information to a central computer for processing, which in turn, could benefit future space exploration, crime scene investigations, and field operations for military personnel.

NanoMatrix is currently focusing its efforts on joint development projects with customers and business partners. "We have found that there are a number of companies that cannot effectively build their next-generation products using the limited tool kit that is currently available," Barros notes. The projects include a variety of MEMS, microfluidics, and optics companies that are developing solutions to problems associated with fabricating devices with feature sizes often smaller than the wavelength of visible light. In addition, NanoMatrix is constructing a general-purpose workstation for customers wishing to work independently on development and prototyping projects.



An "Atomic Force Microscope" micrograph shows a nanometer-drilled hole that increases surface area for film adhesion. The line graph represents a profile of the hole, along the bisecting green line.