IMPACT PROFILE

RESEARCH AT THE UNIVERSITY OF MARYLAND

REZA GHODSSI

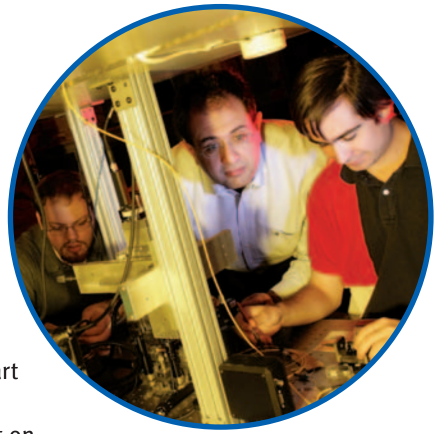
New Ideas in Optical Switches

Miniature devices called MEMS, for micro-electro-mechanical systems, are machines related to computer chips but more diverse in design and function. The devices can have intricate parts, for example a component that emits light, an arm that moves in a controlled way and yet another part serving as a signal detector.

University of Maryland researchers are working to refine these devices, creating seamless units that are more reliable than ever and so small that they are veering into nanoscale levels. Some MEMS devices, originally meant to serve as optical switches in communications networks, are also finding an unexpected role as environmental sensors.

REZA GHODSSI

Optical Switches

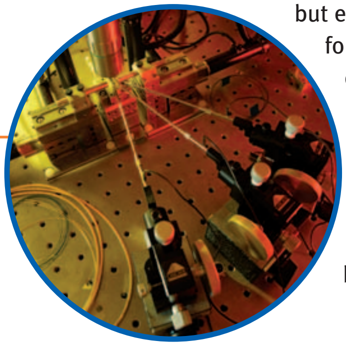


With their varied capabilities, “MEMS devices are now becoming labs and factories on a micro scale,” says Reza Ghodssi, an associate professor of computer and electrical engineering in the A. James Clark School of Engineering. These tiny labs can be used to make, analyze and test even tinier nanoscale structures and devices.

The technology for making MEMS originated with the semiconductor industry. Like computer chips, MEMS were traditionally made from silicon. In recent years, some groups have experimented with alternate materials, including those that combine two types of atoms. Ghodssi, in particular, designs MEMS made from indium phosphide, or InP, materials. The great distinguishing characteristic of material made with InP is that it can be used both to generate and to absorb light. In other words, a single device made from InP could have a source of light and a light detector, as well as the mechanical structures of a miniature machine.

Compared with trying to meld together different materials, manufacturing a device from a single substance has several advantages, including easier production and more reliable products. Even so, working with InP presents its own challenges. The material is fragile and expensive. Ghodssi has invested considerable effort to understand the substance’s electrical and chemical properties.

The original motivation for working on InP MEMS was rooted in the telecom industry, to make optical switches for communication networks. Because light travels faster than electricity, optical fibers transmit information faster than electric wires can. Switches are necessary parts of optical cables, guiding light at crucial junctures. Currently, electronic switches interrupt the flow of light, but exchanging electronic switches for light-based ones should lead to cheaper and more reliable optical networks.



Ghodssi and his co-workers have shown that a MEMS device made with InP can be used to guide light, steering the light physically by pointing it in different directions. Now, his group is working to create “integrated” machines that can generate and detect light as well as guide its flow. The devices they envision could become an important part of communications networks. Along the way, Ghodssi has hit on another, quite different application for the all-in-one devices, an application he calls biosensing or environmental sensing.

MEMS devices often contain cantilevers, which are basically swinging arms. In an InP device, a cantilever can be placed between a light source and a detector. The cantilever swings back and forth in front of the detector, and by detecting pulses of light, the device can measure how fast the arm is moving. The arm swings more rapidly when unencumbered and slows down when it becomes heavier. “If we selectively coat the cantilever with some kind of sponge-like material that absorbs toxins,” says Ghodssi, “it will become heavier as it soaks up toxins.” The resulting MEMS device could be used as a tiny sensor, for example to detect the presence of minute amounts of explosive material in airports.

Cantilevers in Ghodssi’s devices were originally several micrometers wide. Now, they can be just 0.6 micrometers, or 600 nanometers, in width. Making smaller objects is not just an impressive engineering feat. Smaller objects can detect smaller changes and make for more sensitive tools. If a single bacterium fell on one of Ghodssi’s cantilevers, he could notice the change in weight.

Ghodssi is now working to refine absorbing materials with which to coat his cantilevers and also improving the source of light in his InP devices. He expects that in a couple of years, he will have created a biosensing device that can be used outside the lab. The first such machines will absorb gases from the air. Ghodssi would also like to design devices that can detect chemicals in solution, an accomplishment that would open up a host of medical applications.

—*Karin Jegalian*

UNIVERSITY OF MARYLAND

Impact Profile is a supplement to *Impact*, a quarterly research digest from the University of Maryland. To learn more about research at Maryland, go to www.umresearch.umd.edu.

Produced by the Office of University Publications for the Vice President for Research, University of Maryland.