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Polymeric Structures as Low-Cost Biohazard Sensors

By Mark Fitzgerald

Two researchers at the University of Virginia—Matthew R. Begley, Ph.D., an associate professor of structural and solid mechanics in the civil engineering department, and James P. Landers, Ph.D., a professor of chemistry and an associate professor of clinical chemistry in the chemistry department—have been working together to develop polymeric structures that undergo a deformation in the presence of target molecules. By using polymers, the degree of mechanical deformation caused by certain absorption molecules can swiftly be detected. By contrast, with silicon, which currently forms the basis of most microscopic devices, expensive hardware is required to measure the change that occurs.

"What's unique about our approach is that we're using the properties of polymers to amplify the amount of deformation and therefore accelerate detection capabilities," explains Begley. "We've done calculations to show that you can induce buckling if you have a micro device. Absorption can create compressive stress on the structure, and you can buckle the structure out of plane. So you can envision devices that are chemically activated on and off switches: when the right chemical is present it buckles out of plane and has a very dramatic change in geometry."

According to Begley, these sensors could be used to conduct various kinds of biochemical analyses and to identify airborne pathogens in such places as hospitals, post offices, and military bases. "The miniaturization process is a major engineering challenge, especially when you start thinking about polymers, because most microfabrication was originally developed for electronic devices and usually involves ceramics and metals," he notes. "But if you can build a more sensitive device that has

larger motions, which you can pick up optically or electronically, then you can envision the detection hardware that detects the event and then miniaturize the sensor and put it on a chip. So you go from essentially doing this in a laboratory, where you need thousands of dollars' worth of equipment to detect the motion, to where you're one step away from making a plastic device that allows you to integrate all of the components down to a miniaturized state that can be mass-produced."

Funded with a grant from the National Science Foundation, the project is an excellent example of how interdisciplinary research can lead to technological innovation. "You can't build these kinds of devices without a team like this," says Begley. "Chemists don't know anything about designing structures or beam deformation, and I can't come up with the chemistry that makes the sensor actually selective for a target molecule. So this is really a nice blend of interactions and a significant convergence of interdisciplinary work, which seems to be encouraged so much in the field of research these days."

Although the technology is still in its early stages, Begley and Landers have already filed a patent disclosure for the new sensors and hope by next year to be close enough to production to apply for a full patent. "I'd never say it's a slam dunk," Begley adds. "But we definitely see it as a novel approach and we're very excited."