Rogers' research: Practical, inexpensive and still cutting edge

Steve McGaughey, Beckman Institute Writer

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There seems to be no satisfying consumers' hunger for new and wondrous electronic devices. The quest for faster computers, smaller cell phones, slimmer monitors, and infinite playlists for digital music players illustrate the passion Americans have for their silicon-powered electronic companions.

John Rogers and his research partners think they can give consumers everything they want – without the reliance on silicon. To this end, Rogers is involved in a number of projects at the Beckman Institute that explore using some unexpected materials in unique ways.

"We're interested in low-tech materials for high-tech applications," Rogers said.

Professor Rogers and a varied group of collaborators are looking into materials such as plastics, organic tissues, and carbon nanotubes for use in digital communication devices. These materials would have many advantages over silicon, among them lower cost, lighter weight, and more flexible designs.

With those types of benefits, a lot of important people are interested in Rogers' work, from the Department of Defense to the biggest players in the technology industry. His research in areas such as microfluidic fibers and photonics have gained him considerable public notice and continued grant opportunities. Ideas like putting digital images on the inside wall of a soldier's tent, or making electronic devices cheaper and easier to produce bring notoriety. But it is the solid science behind those cutting-edge concepts that draws the funding to continue research.

"Everything we do for the most part is published and goes to the top scientific journals," Rogers said. "But again our selection of problems is determined partly by whether or not we think the material systems we're studying have the potential to be relevant somewhere down the line to technology and engineering."

His research looks to 'soft materials' such as polymers, liquid crystals and biological tissues for use in molecular electronics, nanophotonic structures, macroelectronic circuits, microfluidic devices and microelectromechanical systems.

That's why in a few years the fruits of Rogers' research may be the next line of electronic products wowing consumers. Combining his work with other researchers, Rogers has come up with novel applications such as high performance organic transistors and flexible paper-like digital displays.

"We're trying to bring electronics into objects and form factors that you haven't seen before," Rogers said. "I think flexible display is the most easy to understand, although we're also interested in smart building materials."

Rogers mentioned the concept of digital wallpaper as an example of a flexible display.

"In your house you could have ultra low cost wallpaper that is changeable," he said. "You could change the patterns that are being displayed. So it's kind of unexplored applications for electronics which are enabled by low cost printing schemes and materials that you can put on unusual surfaces that aren't ultra-flat silicon wafers or plates of glass, which is what every circuit that exists is built on."

Another area that has received a lot of interest is the concept of 'smart building' materials that contain information. Rogers has collaborated with Prof. Osman Ataman from the School of Architecture at the U of I on this research.

Rogers is involved in a variety of research projects as a full-time faculty member in the Nanoelectronics and Biophotonics group and Molecular and Electronic Nanostructures main research theme at the Beckman Institute. His work has received a tremendous amount of publicity recently, from three covers of the Applied Physics Letters journal in a little over a year to articles in Business Week 2.0 and MIT's Technology Review magazines. Last year, Technology Review listed Roger's work in microfluidic fibers as one of 10 technologies to change the world.

In late August, he was nominated for a World Technology Award, an honor that is bestowed only on outstanding innovators in the area of technology.

According to the World Technology Network Web site, Rogers and the other nominees were recognized for "doing the innovative work of the greatest likely long-term significance in your field."

Rogers is nominated in the Communications Technology. He thinks his research into microfluidics and photonics is what got him nominated. The research probes a wide variety of elements for their possible applications to an even wider variety of communication technologies.

"We're interested in things like fluids, polymers, liquid crystals and printable forms of silicon, and so on for making circuits and photonic devices that have unusual properties, compared to more established, conventional inorganic technologies," Rogers said.

Applications could be something aesthetic like a waterfall on digital wallpaper, or revolutionary such as a new way to manufacture transistor circuits. Conventional silicon circuits used in electronic devices are currently built on a wafer in a clean room facility.

"We'd like to build similar kinds of circuits not with a clean room facility but with a manufacturing system that looks more like a printing press," Rogers said. "And we'd like to build those circuits not on silicon or glass but on flexible plastic."

Such projects aren't Rogers' only area of research, but his nomination for the WTN award is for work by an individual in the category of communication technology. If he wins, Rogers will become a lifetime WTN Fellow. He is competing against 15 researchers from around the world for the award.

entrepreneurs, academicians, and others working in the technology field in 54 countries. The 2004 World Technology Summit will be held Oct. 7-8 in San Francisco, with the Awards gala ceremony set for the night of Oct. 8.

"I don't know exactly how the nominations work, but it's certainly a neat group of people to be associated with in the sense that the other nominees are quite well-known, famous guys," Rogers said of the honor.

Rogers came to the University of Illinois in January of 2003 from Bell Laboratories, following in the path of transistor co-inventor John Bardeen and Beckman Institute Director Pierre Wiltzius. Arnold Beckman himself was there for the birth of the founding research group at Bell Labs in the early 1920s.

"A big reason why Illinois was attractive to me is because of the Beckman Institute," Rogers said. "It really has a Bell Labs flavor, which is something I really like in the sense that it encourages interdisciplinary research and the way it's set up.

"The fact that its current director is a former Bell Labs director is also a great thing because I think that kind of culture is what's missing in a lot of traditional university campuses. That kind of exchange of ideas across department boundaries is where a lot of the progress in science and engineering is made and the Beckman Institute is just perfect for doing that. We've really taken a lot of advantage of that, collaborating with different people: Slava (Rotkin), Joe Lyding, Karl Hess, a variety of people."

Rogers' research combines with the work of Rotkin and Hess as they study using carbon nanotbues instead of silicon as field effect transistors.

"We are interested in nanotubes also because they have remarkable electronic properties and you can deposit them on virtually any surface because you can cast them from solutions," Rogers said. "The idea there is to try to make transistors that use hundreds or thousands of carbon nanotubes as a high-performance alternative to silicon for a semiconductor."

Microfluidics is also a big part of Rogers' work. He and a number of Beckman researchers are looking to use direct write assembly to produce a variety of devices on a very small scale.

Rogers said the basic approach in this research is doing inkjet printing at the nanometer scale. "So it requires all sorts of new knowledge about how fluids flow through very, very confining channels. How to move fluids through those channels and trying to get figure out how to get active, useful organic molecules to come through and build up devices in that way."

Rogers' research interests are as wide-ranging as his background. He received his B.A. and B.S. degrees in chemistry and physics from the University of Texas at Austin in 1989, before earning an S.M. degree in chemistry and physics and a Ph.D. in physical chemistry from MIT. He was at Bell Labs from 1997 to late 2002. Currently, Rogers is a Founder Professor Engineering at the U of I in the departments of Materials Science and Engineering and Chemistry. He doesn't know what path his research or career will take next.

Rogers said. “I just tend to be so busy with the moment that it’s hard to do that kind of long-range planning. It’s hard to do it anyway because so many unexpected things happen. But I’m having a lot of fun, right here right now. The students are great. Just collaborating with a lot of people across campus is a perfect environment for doing research in.”

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