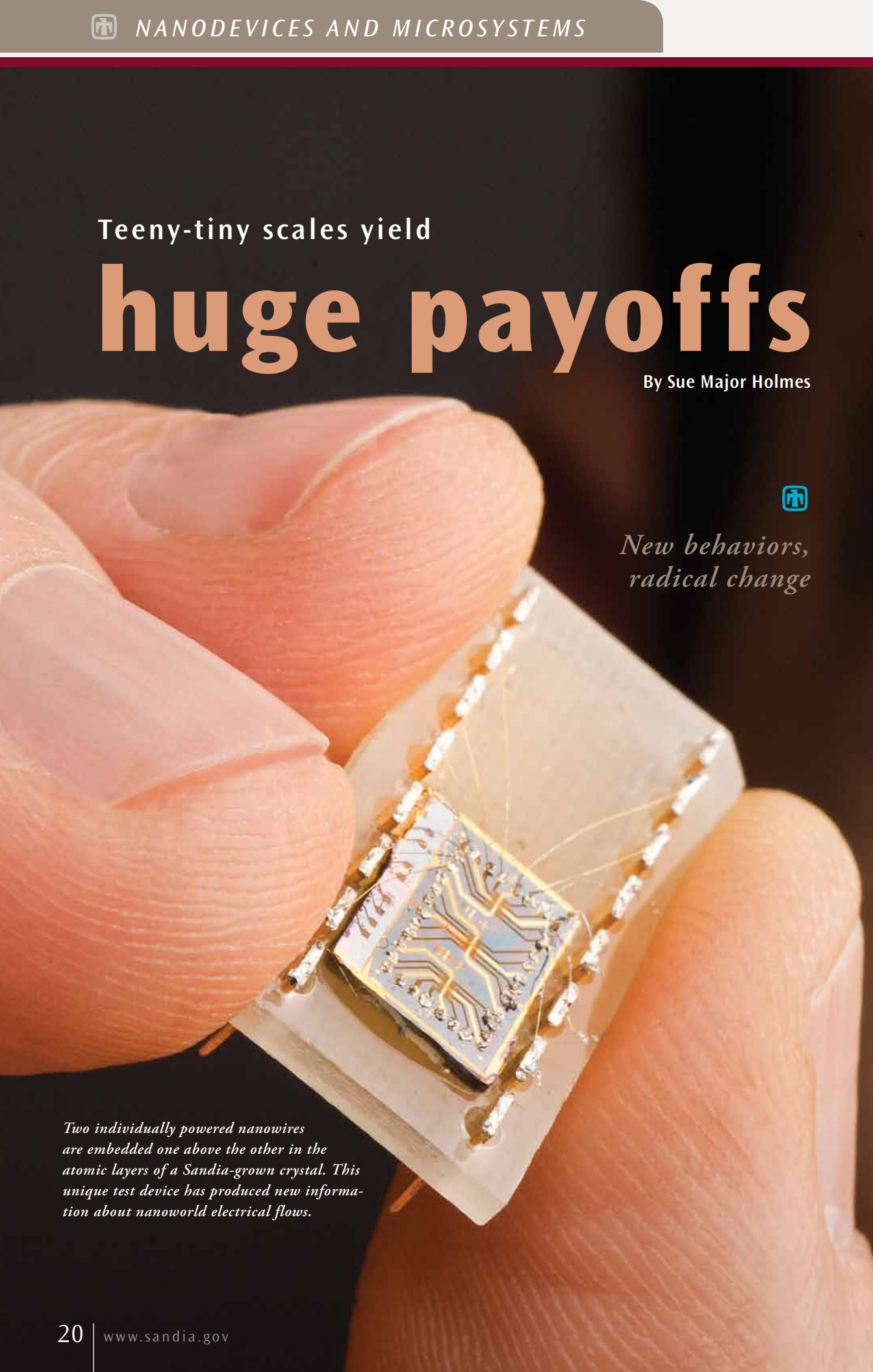
## Teeny-tiny scales yield

# huge payoffs

By Sue Major Holmes

*New behaviors, radical change*



*Two individually powered nanowires are embedded one above the other in the atomic layers of a Sandia-grown crystal. This unique test device has produced new information about nanoworld electrical flows.*

Sandia's Nanodevices and Microsystems Research Foundation works at the smallest of scales to spur imaginations on the grand scale, and does that partly through what Gil Herrera, the foundation's lead director, calls "an amalgamation of competencies."

"We foster the intermingling of people representing a number of disciplines from across the entire laboratory who understand a variety of different scientific and engineering disciplines at great depth," he says. "It really is allowing people to imagine and come up with wonderful innovations."

The foundation is responsible for fundamental microsystems research and development, engineering design, component engineering and semiconductor manufacturing. It works with other national laboratories, federal agencies and industry.

But the idea isn't simply to take things in the macroworld and shrink them. Rather, it's to understand the physics that occurs at very small scales that doesn't occur at the macroscale.

"We're trying to create new behaviors of devices and systems and create new performance that's the direct result of these very small scales," says senior manager Wahid Hermina.

Light and matter, for example, can be coupled much more strongly at tiny scales, or researchers can manipulate how acoustic waves travel through materials when they work from the fundamental properties of those materials, he says.

And there are what engineers call quantum effects that occur at nano scales. That opens the door to really radical change: Instead of trying to find a behavior or a material in nature with the necessary properties, researchers can design the needed behavior by tailoring the material or leveraging phenomena at the nanoscale.

"All of a sudden you've created something that doesn't occur naturally, engineered from the basic building blocks of understanding at these micro- and nanoscales, and that could be plentiful and available," Hermina says. "The sky's the limit. That's what we're in the business of doing here. We're trying to create devices and systems that provide new opportunities for a vast segment of the national industrial base."

Sandia pioneered work in microsystems in the 1960s with the invention of the laminar flow clean room. It went on to establish leadership in radiation-hardened integrated circuits, institute revolutionary work in superlattices that deliver the framework for custom semiconductor materials, develop groundbreaking capability in novel microsensors and microsensor systems, and create and improve a variety of chemical and biological detection systems.

Microelectronics capabilities stem from Sandia's nuclear weapons mission, which remains a primary responsibility. The research foundation focuses on broader national security challenges, Herrera says.

The people behind the research need state-of-the-art facilities for their mission, so the foundation is based in Sandia's 400,000-square-foot Microsystems and Engineering Sciences Applications complex of laboratories, clean rooms and offices. MESA brings together scientific disciplines to produce integrated microsystems, and is the only microelectronic foundry producing chips hardened to survive a nuclear battlefield or other intense radiation environments.

Researchers under the foundation also use the Center for Integrated Nanotechnology, a Department of Energy science center operated jointly by Sandia and Los Alamos national laboratories; the Ion Beam Laboratory, Sandia's unique applied physics lab with six particle accelerators; and individual laboratories throughout Sandia.

Herrera can point to recent projects arising from the foundation or in which it played a major role: microsystems-enabled photovoltaics, dubbed "solar glitter," that combine mature technology with advances in photovoltaic cell design; breakthroughs in solid state lighting; and a microsystem neuroprobe that can be inserted into the brain without causing cellular damage.

"MESA has been responsible for some really cool innovations," he says.

The foundation has been involved in 41 R&D100 awards won by Sandia. It also has participated in, although not necessarily led, most of Sandia's Grand Challenge Laboratory Directed Research & Development projects, Herrera says.

It tackles large tasks because of its multidisciplinary strength and its flexible facilities that enable people to develop their ideas, all without interfering with the mission to provide trusted and secure weapons components, he says.

"It's all based on the principle that with the best facilities, you can attract the best people and the best partners throughout Sandia, in universities, companies and other labs. It's amazing what happens when you combine incredible innovators and world-class facilities," Herrera says. ■