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member profile

quantum leaps

Gail J. Brown focuses on quantum dots and superlattices with her work on semiconductor heterostructures as a top researcher for the U.S. Air Force.

By Erin M. Schadt

SPIE Fellow Gail J. Brown, senior research physicist and leader for the U.S. Air Force Research Laboratory (AFRL) at Wright Patterson Air Force Base in Ohio, received the Air Force Basic Research Award this year, one of the highest research honors the Air Force bestows. She began her career at the AFRL working on traditional semiconductor materials and now focuses on leading her research team in the area of quantum wells (QWs), quantum dots (QDs), and superlattices.

A curious child, Brown says she asked so many questions her parents bought her a set of encyclopedias to try to quench her thirst for knowledge. But it just seemed to whet her appetite. She was convinced in elementary school that she wanted to be an astrophysicist and says, "It wasn't until my senior year in college that I decided to look inward at the world of atoms, versus outward at the stars, and specialize in solid state physics. I have been happy with the choice ever since."

SPIE Fellow Gail J. Brown

Brown received her bachelor's and master's degrees in physics from Wright State University in Dayton, OH, in 1977 and 1979 respectively; she completed her PhD in 1994 at the University of Dayton with the dissertation "A Study of p-Type GaAs/AlGaAs Multi-Quantum Well Materials for Normal Incidence Detection of Infrared Radiation." Her research for the dissertation led to important design criteria for long wavelength p-type QW IR photodetectors.

quantum research

Brown started her career in 1980 at Wright Patterson as a research scientist and began working with more traditional semiconductor materials such as silicon (Si) and gallium arsenide (GaAs). The research team explored the use of GaAs and aluminum gallium arsenide (AlGaAs) heterostructures as an IR detector material, since the elements used the conduction band offsets between layers to create QWs, and the intersubband transitions in the wells can be used for IR absorption of specific wavelengths.

"The drawback was, due to quantum mechanical selection rules, these materials could not absorb radiation at normal incidence," Brown explains. "So, we began to look at a way of relaxing these selection rules by using the anisotropic band structure associated with quantum wells formed by valence band offsets. This was the basis for my studies on p-type (acceptor-doped) quantum wells formed in GaAs/AlGaAs."

Currently, Brown's research group is focusing on IR photodetector applications using QDs. "There, the benefit would be that quantum dots are speculated to have a higher potential operating temperature than quantum wells," she says. "On a more fundamental level, our research interest is finding a process in which we can make ordered quantum dots where we control the spacing and position of the dots as well as their size."

In the pursuit to create an improved IR photodetector, Brown has been working on a superlattice composed of indium arsenide (InAs) and indium gallium antimonide (InGaSb) as a potential material because in type-II superlattices the conduction and valence band offsets are staggered. "The beauty of this material system is that we can design in a wide variety of energy bandgaps from a few hundred to tens of meV," says Brown. This allows the design to cover a wide range of wavelengths, making the system incredibly flexible. "By choosing the

appropriate thickness for each layer and the percentage of indium in the InGaSb layer, the band structure of the superlattice can be tailored to infrared cut-on wavelengths from 3 to 30 µm."

Brown with a sculpture in her office about which she says, "The crystal ball in the center of the eagles represents the vision of the future needed by research leaders to decide what research areas have a potential payoff 10 and 20 years down the road, and of course, to me, the eagles symbolize the U.S. Air Force."

As the research team leader of almost 30 scientists, Brown says she enjoys helping other people in the group to get the resources and support they need to accomplish the research goals. "I will consider myself a successful leader when others on my team are honored with their own awards for scientific accomplishments and when projects we study in-house are transitioned for further development in Air Force contract programs." She adds, "It's kind of interesting because I'm the only woman in the research group, so leading a group of highly talented PhD men is actually kind of nice."

commitment to community

In addition to her work at Wright Patterson AFB, Brown is an adjunct professor at Northwestern University in Evanston, IL. In this role she advises students on their theses, attends their theses defenses as a committee member, and conducts joint research with them. "It's been really great doing research with the brilliant students they have at the Center of Quantum Devices at Northwestern," says Brown. "They're very dedicated to getting results, and I think it's always stimulating to look at things from a new perspective."

Brown has been active with SPIE since 1994 when she was a conference chair for "Optical Amplifiers for High-Speed Applications." Since then she has teamed up with SPIE Fellow Manijeh Razeghi, the director of the Center for Quantum Devices at Northwestern, to co-chair the series of conferences "Photo-detectors: Materials and Devices" from 1996 through 2002 at Photonics West. For the 2003 Photonics West symposium, she and Razeghi have retooled the conference as "Quantum Sensing: Evolution and Revolution." Brown also has been a symposium chair for the symposia on "Semiconductor Lasers and Photodetectors" since 1998.

She is also a member of the Materials Research Society, the American Physical Society, the Electrochemical Society, the Scientific Research Society, and the Association of Women in Science.

For her work, Brown has received many honors and awards. During her senior year at Wright State University she was chosen as the presidential scholar. In 1995, she was the Cleary Scientific Achievement Award recipient and is a two-time finalist for the award; this is the highest scientific award in the Materials & Manufacturing Directorate of the AFRL.

"As a researcher, being chosen this year to receive the Air Force Basic Research Award is remarkable, and it's very rewarding to know that my scientific accomplishments are appreciated," Brown says. "As a professional in optoelectronics, becoming a Fellow of SPIE in 2001 was a crowning achievement. This achievement is probably the one that means the most to me personally."

member news & announcements

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