Hall Of Fame

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Lester Eastman: Materials Pioneer Leaves A Legacy Of Teaching

Most people have never heard of compound semiconductors like gallium arsenide (GaAs), indium phosphide (InP), or gallium nitride (GaN). But they do rely on the smart phones these materials have enabled, as well as other vital applications like radar and satellite communications. Many of these innovations wouldn't have been possible without the work of Lester Eastman, who died on August 9, 2013, at the age of 85.

"Professor Eastman had a tremendous impact on the field of microwave electronics, particularly the area which uses compound semiconductors," said Michael Spencer, a professor of electrical and computer engineering at Cornell University and one of Eastman's former students. "First with gallium arsenide, and then later with other III-V materials such as alloys of gallium arsenide with aluminum arsenide, indium phosphide, indium gallium phosphide, and so forth."

Cornell University celebrated Lester Eastman's six decades with the school with a 2008 symposium titled "Tubes to Transistors: Megahertz to Terahertz."

A MATERIALS PIONEER

Eastman was renowned for his pioneering work in compound semiconductor materials and high-speed devices for microwave and semiconductor laser applications. He began this work in 1965 at Cornell University as an associate professor, and it continued through his retirement in 2011—and even afterward, as he mentored students and colleagues from several scientific disciplines.

"One of the most important applications of gallium-arsenide materials has been in the development of low-noise amplifiers. These compound-semiconductor-based transistors operate in such a way that you can receive very, very faint signals from distant sources," Spencer said.

"As a matter of fact, one of the early science applications of these types of transistors was in the great antennas that are listening for communication from deep space. And these gallium-arsenide-based devices had the lowest noise figure of any other kind of electronic device. So one big application was low-noise, high-gain microwave amplifiers," Spencer continued.

Eastman's later work focused on gallium-nitride high-power microwave devices, which provide power to send signals across great distances. These transistors power phased-array radar systems for military applications, for instance, with other radar applications expected to use the technology in the future.

"Professor Eastman led a research team that was the pioneer or one of the pioneers in developing gallium-nitride-based technology. When we talk about gallium-nitride technology, it really is gallium nitride plus aluminum gallium nitride. It works together, and the technology that has proved so beneficial is a heterojunction technology of gallium nitride and aluminum gallium nitride," Spencer said.

Among other innovations, this team developed polarization doping. Historically, researchers would add intentional impurities to produce electrons or holes in semiconductor materials. But chemical group III nitride materials exhibit spontaneous polarization, so doping occurs as a result of electrons shifting to compensate for the fixed charge due to the polarization. Polarization doping offers many semiconductor performance advantages that Eastman's team explored, publishing many significant papers on the topic. Many military and commercial applications have benefitted from their work.

"The most recent innovation that people have tried to exploit this material system for is power," Spencer said. "When I talk about power, I don't mean microwave power now. I mean normal, low-frequency power converters like you have in a power supply. And people have invested a lot of money in pursuing the

Photos: Cornell University Photography

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idea that a gallium-nitride system might be an interesting system for making low-frequency, high-power converters. That is under investigation. But in the meantime, all of the microwave applications are actually in production."

A BIG MAN ON CAMPUS

Perhaps Eastman's tenure at Cornell is as remarkable as his innovations. He earned his BSEE at the upstate New York campus in 1953, followed by his MS in 1955 and his doctorate in 1957, all in electrical and computer engineering. He was then named an assistant professor in 1957, an associate professor in 1960, a full professor in 1966, and the John L. Given Professor in Engineering in 1985. In 2011, he was named a Professor Emeritus. No matter the title, though, he always displayed great enthusiasm for the work.

"Most of us who had Les remember him best as a research advisor. He always had a really great grasp of the overall picture, and he could determine where the key innovations or challenges were and where to focus everybody's energy and how to make the research group work as a team. I think that's where his talent was," Spencer said.

"You could always come to his office at 8 o'clock in the morning, and he would give you a mini-lecture on the latest developments in compound semiconductors. It was almost like he was talking from a script. It was just a wonderful thing."

In 1977, Eastman was a founding member of the National Research and Resource Sub Micron Facility, now known as the Cornell Nanofabrication Facility. Also in 1977, he initiated the Joint Services Electronics Program at Cornell and directed it for 10 years. He brought this experience in founding and leading research programs to Europe, which he visited 111 times during his career. For instance, he helped Sweden establish its $90 million nanoscale facility, and he helped Germany establish one as well.

Yet Eastman always returned home to Cornell, where he coauthored more than 600 publications. He also tallied a campus record of 125 PhD students under his direct supervision, in addition to 75 post-docs. His former students include Donald MacLean Kerr Jr., former director of Los Alamos National Laboratory and now principal deputy director of National Intelligence, David Welch, cofounder of Infinera Inc., and 27 professors in the U.S. and abroad.

"I think it was just the kind of person he was. He loved his work, and he loved working with people. And he always seemed to bring out the best in people," Spencer said. "He always did best in one-on-one situations."

Eastman earned many awards and honors during his career. Cornell, for example, honored him with a symposium entitled "Tubes to Transistors: Megahertz to Terahertz" in June 2008 to celebrate his 60th year at the university. Also, the IEEE sponsors the biennial Lester Eastman Conference on High Performance Devices. The next event is scheduled for August 5-7, 2014, at Cornell University.

ENGINEER AS ENTREPRENEUR

Eastman was a U.S. Navy veteran, serving as radar specialist on the aircraft carrier U.S.S. Coral Sea from 1946 to 1948. Spencer says that this experience "absolutely informed" Eastman's research later, especially as he launched Cayuga Associates, which produced impact ionization avalanche travel time (IMPATT) and Gunn oscillators and then early gallium-arsenide FETs with micron-size structures. An earlier company he founded served the military as well.

"The first one actually made a product called Gunn diodes. And this company existed in the late '60s, early '70s, during the time of the Vietnam War," Spencer said. "And these Gunn diodes were gallium-arsenide devices that emitted high-energy microwave radiation when you applied a battery voltage to them. So these devices, which his company manufactured, were used as distress beacons for downed pilots in Vietnam."

Eastman also consulted for several companies and the MIT Lincoln Laboratories in the United States and for three companies in Europe. He served on the Department of Defense's Advisory Group on Electron Devices for six years and on the Senior Advisory Board of the Fraunhofer Institute of Applied Physics in Germany for another six years. And, never straying too far from academics, he was the external examiner of several PhDs in Europe.

"Professor Eastman, like many others, recognized that science is international. He spent his sabbatical in Sweden and developed a lot of connections there, and of his 125 students, a huge fraction of them are international students. He was especially proud of the fact that he had 125 students, and he would always talk about their accomplishments. That was the source of the greatest pride for him," Spencer said. "It was a privilege to have known and worked with him." ed