MicroBusiness

Reminiscing With Bob

■ Fred Schindler

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I was fortunate to join a group that was at the forefront of GaAs MMIC technology in the early 1980s, at the Raytheon Research Division. At that time, there were a number of organizations leading the development of the technology. We had a friendly competition with research and advanced technology groups and a number of companies, including Texas Instruments, Hughes Aircraft, TRW, Westinghouse, HP, and GE in the United States. NEC in Japan, Plessey in the United Kingdom, and LEP in France also had groups working on the technology. I'm sure I'm forgetting some companies that were working in this area, to say nothing of the many government labs, academic institutions, and other organizations that made important contributions.

A solid foundation had been established by the time I became involved in GaAs technology. We were able to make continual progress in both the technology and its applications. A great overview of this era can be found in an article written by Bob Pucel [1], who was also at the Raytheon Research Division.

Well into the 1990s, GaAs had earned a reputation as a perpetual technology of the future—"GaAs is the technology of the future—it always has been and always will be." For decades, we made progress, demonstrated capabilities, and showed the promise of the technology. But we were never able to replace incumbent approaches, except for some niche applications.

That, of course, has all changed. By the late 1990s, GaAs had found applications in a number of commercial and military applications. Notably, this included mobile phones—the highest volume consumer electronic product we've ever seen. Today, most of us carry a smartphone that contains a few pieces of GaAs. Billions of GaAs ICs are manufactured every year, driving multibillion-dollar businesses.

For almost as long as GaAs MMIC technology has been in development, some have expected it to be supplanted, primarily by silicon technologies. Some of that has happened. SOI has proven to offer better switch performance. SiGe can provide equal or better amplifier performance, depending on the application. But GaAs still finds a home. The cost has dropped dramatically since the 1990s, and for some applications, a GaAs implementation requires less chip area than Si, so it remains economically competitive. GaAs processes also have far fewer steps than Si, and the resulting shorter cycle times are helpful for product development cycles.

There are, of course, higher performance technologies that challenge GaAs. GaN has proven to be a better option for many high-power

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Digital Object Identifier 10.1109/MMM.2022.3226533
Date of current version: 1 February 2023

human hand [2]. In 1901, he received the very first Nobel Prize in Physics [2]. In 1896, Henri Becquerel discovered spontaneous radioactivity in uranium salts. He shared the 1903 Nobel Prize in Physics with the Curies [3]. While the discovery of X-rays was the stepping stone for medical imaging, it was the subsequent development of computer-assisted tomography (CT scans) that really expanded their role in diagnostics by creating cross-sectional images of the human body. For this, physicist Allen Cormack and engineer Godfrey Hounsfield were awarded the 1979 Nobel Prize in Physiology or Medicine [4]. In 2003, another physicist shared the Nobel Prize in Physiology or Medicine. This time, it was Peter Mansfield, whose discoveries concerning nuclear magnetic imaging led the way to modern magnetic resonance imaging (MRI) [4]. It is interesting to note that MRI does not require the use of ionizing radiation for creating detailed maps of the tissues and organs inside the body.

If this capsule history of the Nobel Prizes related to medical physics piques your curiosity about the field, you may want to dip into Van Dyk's book [1], which brings the story of medical physics to the present day with contributions from 22 leading medical physicists from around the world. Happy browsing!

References

[1] J. Van Dyk, *True Tales of Medical Physics: Insights Into a Life-Saving Specialty*. Cham, Switzerland: Springer Nature, 2022.

[2] "The very first Nobel Prizes." The Nobel Prize. Accessed: Nov. 5, 2022. [Online]. Available: https://www.nobelprize.org/prizes/themes/the-very-first-nobel-prizes/

[3] "Henri Becquerel: Facts." The Nobel Prize. Accessed: Nov. 5, 2022. [Online]. Available: https://www.nobelprize.org/prizes/physics/1903/becquerel/facts/

[4] T. Freeman. "Breaking boundaries: How physicists won the Nobel Prize for Physiology or Medicine." PhysicsWorld. Accessed: Nov. 5, 2022. [Online]. Available: https://physicsworld.com/a/breaking-boundaries-how-physicists-won-the-nobel-prize-for-physiology-or-medicine/

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Figure 1. *Pictured from left to right: Aryeh Platzker, the author, Bob Pucel, Grace Chu, Yalcin Ayasli, and Yusuke Tajima.*

applications. InP has long been a challenger for higher frequency applications but has had only limited commercial success.

I like to think that the work we did at the Raytheon Research Division had quite a bit to do with the ultimate success of GaAs. Bob's article [1] illustrates some of this. We not only had a great foundation; we had a great set of scientists, engineers, and technologists. There were other groups with a similar heritage, organization, and contribution.

Recently, a few of us gathered at the home of Bob Pucel (Figure 1). It was an opportunity to catch up and reminisce. Raytheon closed its Research Division in 1994, and those of us that were still there at that time moved to another part of the company. I left Raytheon altogether a few years later. Today, all of us have retired or moved on to other things.

When I started working on GaAs MMICs, I first worked for Yalcin Ayasli and then for Yusuke Tajima, both pictured in Figure 1. Bob Pucel was our expert resource. He not only had done much of the groundbreaking work we built on; he made sure we had the best simulation tools and was always available for technical guidance and analytical help.

We did interesting work, largely funded by U.S. military agencies, and for many years, we had seemingly endless opportunities to innovate. Grace Chu and Aryeh Platzker, also pictured in Figure 1, were among my colleagues. As with all successful teams, we all had complementary strengths. I've referenced some of my colleagues and quite a few of my bosses in previous columns, usually anonymously. I'm not sure if they've recognized themselves, and I hope they don't mind.

Reference

[1] R. A. Pucel, "Looking back at monolithic microwave integrated circuits," *IEEE Microw. Mag.*, vol. 13, no. 4, pp. 62–76, May/Jun. 2012, doi: 10.1109/MMM.2012.2189032. [Online]. Available: https://ieeexplore.ieee.org/document/6196354/