Future Trends for Microwave Compound Semiconductors in Military Systems

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Improvements in compound semiconductor technologies have formed the basis for rapid advances in RF electronics. Requirements for the military tend to differ from commercial applications. For example, being out of range on your cell phone is an inconvenience, but can have dire consequences for the military. Thus the military will pay a premium for the right performance. As a result military components tend to have characteristics that may push beyond standard commercial MMICs. Many military devices are semi-custom designs; most standard commercially available components are in the wrong bands or give up too much performance for typical military applications. Quantities can be small from 10's to 10's of thousands of components per year. Rarely does a need reach a commercial threshold of a million parts per year. Foundry runs are common for many military applications. Packaging costs tend to be significant, thus highly integrated MMICs are desirable minimizing critical interfaces and the number of components to be assembled. Advanced systems use a wide range of compound semiconductor technologies such as GaAs PHEMT, HBTs, InP, SiGe, MHEMT with SiC just becoming available and GaN and the antimonides becoming available within the next few years. Demand for each technology is based upon two factors. Each technology provides a significant performance advantage and fabrication of multiple technologies can be shared relatively efficiently on a single foundry line to provide sufficient throughput to maintain process yields and cover the cost of capital. Some foundries are currently running GaAs PHEMT, HBT, MHEMT and are gearing up for GaN. A final factor is the tie between devices and packaging technologies. Typical RF front ends include devices from several technologies, i.e. GaAs, Silicon, SiGe integrated into a single package. The marriage between device and package must address issues such as DC/RF interfaces and interconnections, thermal design, environmental factors applied to ever smaller form factors. Trends in packaging will place new requirements and constraints on compound semiconductors and how they are used in future military systems.