Status and progress of millimeter-wave GaN transistors for next generation high-power radar systems

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Abstract

With the development of wireless communication such as 5G or SATCOM, the need and requirements for millimeter-wave compact solid-state high power amplification has significantly increased. In this frame, high power densities have been demonstrated with GaN transistors up to the W-band, confirming the potential of this material system. However, achieving high power-added-efficiency (PAE) and output-power-density combination in the millimeter-wave range represents currently one of the key goal for the GaN technology despite some few initial results obtained so far. Indeed, higher PAE not only saves electrical power usage but also can reduce the size and cost of high power amplifiers (HPAs), due to the lower amount of heat dissipated. For instance, in space applications, the traveling wave tube amplifiers (TWTA) are still widely used, because of the high PAE while delivering high P_{OUT}. Even though attractive efficiencies on GaN devices (well-beyond 40%) have been already demonstrated up to Ka band, rather limited PAE has been reported so far in the Q band (40 GHz) and above. Furthermore, the device robustness and related reliability under high electric field ($V_{DS} \geq 20$ V) have not been yet demonstrated on ultrashort GaN power devices (sub-10 nm barrier thickness and sub-150 nm gate lengths). Actually, a number of parameters can be responsible for short GaN device degradation such as the gate leakage current, especially when using Al-rich ultrathin barriers, a poor electron confinement resulting in drain leakage current, the so-called current collapse and the self-heating due to a reduced thermal dissipation.

In this presentation, we will discuss some potential device design enabling to overcome the above-mentioned issues and properly operate in the millimeter-wave range under high drain bias > 20 V with high performance.