

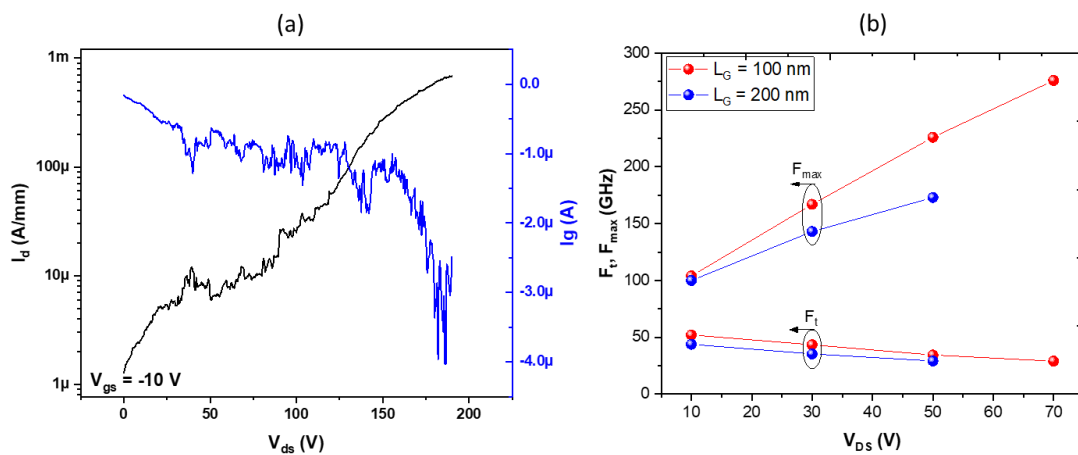
# Towards highly efficient high power X-band AlN/GaN MIS HEMTs operating above 50V

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**Abstract:** We report on AlN/GaN MISHEMT technology on SiC substrate for X-band applications. Transistors with 100 nm gate lengths deliver a high off-state breakdown voltage above 180V and 110 V in semi-on state. RF small signal measurements up to a drain bias ( $V_{DS}$ ) as high as 70V for two different gate lengths ( $L_G$ ). The maximum oscillation frequency ( $F_{max}$ ) strongly increases versus  $V_{DS}$ . As a result,  $F_t/F_{max}$  of 29/276 GHz with a power gain ( $U_{max}$ ) of 28 dB at 10 GHz and  $V_{DS} = 70V$  has been extracted. To the best of our knowledge, this is the highest small signal power gain achieved at a drain bias of 70 V. These results are attributed to the favorable AlN/GaN epi-design for high frequency operation while inserting a gate dielectric to prevent the gate leakage current and related device degradation under high electric field. Continuous wave (CW) power performances have been assessed at 10 GHz and  $V_{DS} = 50V$  in deep class AB operation. A high output power density of 29.1 dBm (8 W/mm) was measured at the peak power added efficiency (PAE) close to 50%. It can be noticed that no-degradation of the transistors occurred subsequently to many load pull sweeps up to  $V_{DS} = 50V$ , reflecting the promising device robustness under harsh conditions. These results pave the way for superior X-band performances operating beyond 50 V in a reliable way.

**Keywords:** GaN, HEMT, X-band,



**Figure 1.** Breakdown voltage transistor characteristics in off-state with  $L_G = 100$  nm (a) and  $F_t$ ,  $F_{max}$  versus  $V_{DS}$  for 100 nm and 200 nm gate lengths