Optimization of sub-100 nm InP HEMT technology

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Introduction

At high mm-wave frequencies, the InP HEMT amplifier technology provides the lowest noise and highest power. The technology is critical both for ground-based ultra-low noise receivers (IF amplifiers in radio astronomy) and in several scientific missions probing outer space. The InP HEMT technology, however, is not wide-spread and detailed data on device performance are scare, in particular for scaled HEMT devices below 100 nm. We here report results from a 50/70 nm InP HEMT technology.

Results

An InP pseudomorphic HEMT technology with 70 nm gate length has been developed. The epitaxial HEMT structure was grown using an in-house InGaAs-InAlAs-InP MBE. Dc and rf performance as a function of epitaxial parameters has been studied, in particular gate-to-channel distance. This has resulted in devices with f_{max} > 400 GHz and g_m > 1500 mS/mm, see Fig. 1 for g_m(Vg) as a function of gate-to-channel distance. The extrinsic cut-off frequency f_T was 180 GHz..

Dedicated modeling and experimental studies for the InP HEMT process have also been performed for thin-film TaN resistors, dry etching of via holes and MIM capacitance models. MMIC demonstrators have been fabricated in a microstrip process using 50 nm InP HEMTs. See Fig. 2 for a photograph of a one-stage broadband feedback amplifier exhibiting a gain of more than 8 dB from 0 to 42 GHz.

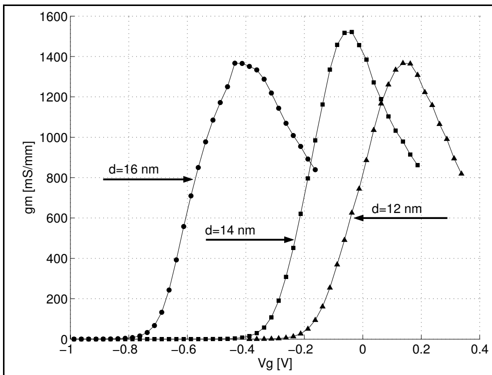

Fig. 1. Transconductance vs. gate voltage for V_{ds}=1.5 V.

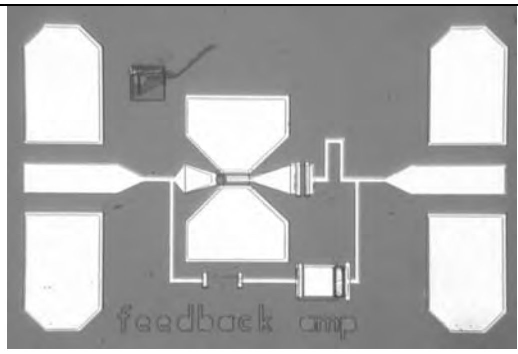

Fig. 2. A MMIC broadband amplifier based on 50 nm InP HEMT technology.