TC 315 Project History

Here's a history on the TC 315 project, which was hatched in 1980.

TC 315 project. The goal of the TC 315 project was a GaAs power FET that produced 23 dBm @20 GHz with >5dB of gain. The product goal was a 2 to 20 GHz power instrumentation amplifier delivering 20 dBm across the band with good flatness and port match, unheard of performance at the time. The design engineer was Jeff Meyer on Rolf Dalichow's and Jim Rounds' Microwave Sources team.

The TC 315 was the first device that employed backside vias by thinning GaAs wafers, etching the backside, and plating vias to produce a direct connection from the device source ohmic area to the device backside. This substantially reduced source inductance in order to mitigate circuit oscillation when matching the device to highly reactive thin film matching networks, required to achieve power gain over a decade bandwidth. Another benefit was superior thermal conduction between the active layer and backside, lowering thermal rise and achieving better device reliability. Ed Wong, the principal engineer, invented an angle evaporation technique to reduce the gate length from 1 um to ~0.5 um, needed to achieve the required higher fT. Other engineers (TS Tan and Chung Li) worked on further improvements including establishing Ti-Pt-Au and the most reliable gate metallization and working with HP Labs e-beam team on their 0.25 eBeam lithography. Device characterization and test development was performed by Kevin Kerwin and technician Norm Stricklin.

GaAs exhibits negative differential mobility which gives rise to the so-called Gunn effect under certain bias conditions. While Gunn diodes employ this principle, in GaAS FETs this can result in undesirable Gunn noise. Achieving 0.5 um gate length required a wide gate trench between gate and drain ohmic contact which resulted in formation of Gunn domains and noise when the TC 315 was biased in the I/V region required to achieve optimum gain and output power. Despite multiple attempts to fix the Gunn noise problem, the project failed and was cancelled in 1983. Instead the instrumentation amplifier (HP 8349A) was eventually designed using the NEC 900 power GaAs FET which employed wrap-around metallization rather than backside vias. Nonetheless the learnings were successfully applied in TC's GaAs IC program. A follow-on TC project (the KFET) was launched around 1985 to replace the NEC FET with improved performance and 26.5 GHz bandwidth, but the customer (Microwave Sources) declined to invest in a follow-on product. No further attempts at decade bandwidth microwave power amplifiers were made. Fano's limit restricts the gain-bandwidth that can be achieved when designing with devices that have highly reactive input and output characteristics. TC's next generation of decade+ bandwidth power amplifiers designs were traveling-wave MMIC amplifiers, based upon Bill Hewlett's invention.