UNIVERSITÄT DUISBURG ESSEN

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Master´s Thesis

„Physical Analysis and Design of a highly-linear and low-noise InP DHBT in a TCAD Simulator“

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Background:

With the upcoming demand for higher data-rates (5G) the need for higher frequencies up to 130 GHz arises, which poses great challenges for the measurement instrument market. Among the III-V semiconductor technologies, InP Heterojunction Bipolar Transistor technology is known to be a very promising candidate to realize high-bandwidth, and large voltage swing mm-wave (mmW) analog circuits. Applications in measurement instruments require linear and low-noise integrated circuits. Exact physical design trade-offs to build linear and low-noise InP DHBT structures have not been treated by the scientific world so far, and are thus within the scope of this master´s thesis.

Task:

Goal of this work is the analysis of the physical trade-offs together with the design of a double-heterojunction bipolar transistor (DHBT) in InP technology, which exhibits high linearity and low-noise performance at the same time. By means of the TCAD device simulators Taurus Medici (2D) / Sentaurus (3D) the optimal material grading, doping profiles and layout geometries of a triple-mesa DHBT shall be elaborated w.r.t. the measurable quantities harmonic distortion (HD) / 3rd order intercept point (IP3) and noise figure (NF) to find the optimum device structure for realizing a highly linear but low-noise InP DHBT.

The work will take place at BHE, using state-of-the-art software and a parallel computing cluster, in close collaboration with the ASIC design department at Rhode & Schwarz, Dr. M. Coers.

The thesis encompasses the following tasks:

- Literature research w.r.t. existing InP DHBT device structures to understand general performance trade-offs
- Gain physical understanding of static & dynamic non-linearity origins in InP DHBTs, incl. their mathematical description
- Design of a highly linear & low-noise device structure - incl. super-lattice / material grading, doping profiles and optimized RF layout geometry – Synopsis TCAD

The gained results are to be summarized in form of a Master´s thesis,
including a seminar presentation.

Duisburg, 24.06.2020