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High-Frequency Carbon Nanotube Transistors: Fabrication, Characterization, and Compact Modeling

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Abstract: Carbon nanotube (CNT) field-effect transistors (FETs) are promising candidates for future analog high-frequency (HF) applications, such as communication systems, due to the excellent intrinsic properties of CNTs. High carrier mobility, high carrier saturation velocity, good thermal stability and especially the inherent linearity of CNTFETs make them very attractive for analog applications. Linearity, i.e. a linear dependence of the output current on the input voltage, is a unique fundamental property of devices in which the current flow is restricted to one dimension. CNTs belong to this group of so called one-dimensional materials. At the circuit level, the device linearity should lead to very high spectral efficiencies, i.e. allowing higher data rates without the need for increased bandwidths.

The talk covers different aspects in the manufacturing of high-frequency CNTFETs, electrical device characterization and compact modeling of CNTFETs. The applicability of the semi physics-based compact model CCAM for designing digital and analog HF circuits is shown. In particular, the model allows us to predict the apparent linearity seen in non-pulsed AC measurements of trap-affected CNTFETs. In contrast to the inherent linearity mentioned above, this apparent linearity is a result of trapping processes and cannot be exploited in circuits for e.g. mobile communication systems.

Bio: Martin Claus received his Dipl.-Ing. and Dr.-Ing. degree in electrical engineering in 2004 and 2011 from the Technische Universität Dresden (Germany). During his doctoral research, he investigated carbon nanotube field-effect transistors (FETs) with emphasis on modeling and simulation. His research interests include compact modeling and technology comparisons of nanoscale FETs using numerical device simulation, physical analysis, and electrical characterization. Since 2013, he has been research group leader of the Modeling Group for Emerging Electronics within the Center for Advancing Electronics Dresden (Cfaed) in Germany. Dr. Claus is responsible for the development of a multi-scale device simulation platform, experimental characterization and compact modeling for one- and two-dimensional devices. Cfaed is a Cluster of Excellence within the German Excellence Initiative. It brings together 200 researchers from eleven research institutions to address the advancement of electronic information processing systems by exploring new technologies that overcome the limits of today's predominant CMOS technology.

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