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Presentation title: Heterointegration Approaches for InP-HBT Technologies for 5G Applications and Beyond

SHORT ABSTRACT OF PRESENTATION

The rapid developments in the field of monolithic microwave integrated circuits (MMICs) have been driven in the recent years by the increased demand for high-speed data rates for communications and sensing applications, in the optical, as well as in the wireless domain. Although Si-based technologies offer an extremely mature platform for the realization of complex systems, they lack key performance metrics such as high efficiency and output powers due to intrinsic material limitations.

III-V based semiconductors can deliver higher output powers with higher efficiencies; however, they lack the technology readiness levels of their silicon-based counterparts.

In the light of this conundrum, heterointegration emerged as a viable solution to maintain the advantages of both technology fields.

The proposed heterointegration approach relies on realizing the main functionality of the system using a more “mature” Si-based technology (that being CMOS or even BiCMOS), whilst replacing specific building blocks with III-V technology (in this case indium phosphide heterojunction bipolar transistors (InP-HBTs) MMIC process).

The system design through heterointegration adds one degree of complexity through the compatibility of the two technologies, but offers higher degrees of freedom for realizing significantly more efficient and compact RF systems.

The heterointegration technology that will be shown in this work is based upon a low-temperature bumping process, which uses indium as a bonding metal.

In contrast to the usual bumping process found in the backend-of-line processes, this process realizes the bumps in the frontend-of-line process of the InP MMIC process.

This gives a better edge in resolution and packing density, which in turn increases the heterointegration density.

The paper details results on the RF-interconnect properties of this technology and will show preliminary results of heterointegrated power amplifiers in InP on BiCMOS carriers.

Long-term stability as well as thermal cyclic tests have also been conducted to show the stability of this technology.

KEYWORDS

Bumps, chiplet, heterointegration, InP MMIC process, InP-HBT.

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BIOGRAPHY

Hady Yacoub was born in 1987 in Giza, Egypt. He received the bachelor's degree in electrical engineering from the German University in Cairo in 2009. He received the M.Sc. degree in microelectronics and communication from the University of Ulm, Germany, in 2011. He later joined RWTH Aachen University, where he acquired his doctoral degree in 2017. He joined Ferdinand-Braun-Institut as a post-doctoral fellow in 2018.

Hady Yacoub currently leads InP devices lab since 2019. His research interests are fabrication and characterization of compound semiconductor devices for high-frequency and energy applications. He authored and co-authored more than 30 papers on various topics in III-V semiconductors.