DOI 10.5162/iCCC2024/P17

Kommunikation
THz Components in InP Technology for Wireless Communications

Viktor Krozer, Hady Yacoub, Maruf Hossain, Marko Rausch, Adam Rämer, Wolfgang Heinrich, Ferdinand-Braun-Institut, Berlin, Germany, viktor.krozer@fbh-berlin.de

Abstract

Wireless communications for 6G applications and millimetre-wave radar sensing require components, which operate at frequencies beyond 100 GHz and are scalable in terms of number of channels, frequency of operation, and performance. We present recent results on component and module level for these applications using FBH InP DHBT technology. In particular the hetero-integration of InP-on-BiCMOS and InP photonic and electronic components plays an important role in implementation of 6G communications and radar systems.

1 Introduction

6G communication systems are envisaged to operate at frequencies beyond 100 GHz up to 300 GHz. At these frequencies only few semiconductor technologies exist, which are capable of delivering signal power and low-noise performance high power-added efficiency together with high data throughput and high-speed operation.

FBH has established an InP DHBT process, which fulfils these requirements and which can be in addition integrated with silicon technologies, such as InP-on-BiCMOS or InP-on-CMOS. This enables a compact highly functional modules, which allow for seamless integration of the baseband and front-end components.

2 InP device and component performance

The InP DHBT process at FBH is based on the so called triple mesa (TRM) and transferred substrate (TS) DHBT processes. The InP TS HBT process exhibits higher frequency performance at the expense of higher thermal resistance and hence higher operating temperatures. The TRM process exhibits a factor of three times lower thermal resistance with trade-off in cut-off frequency.

In addition to device fabrication, FBH operates an MMIC process using the same devices, but capable of realizing highest frequency circuits [1]. The InP DHBT MMIC process at FBH is well suited for 5G application with high efficiency high output power components [2].

3 Heterointegration of InP-on-BiCMOS

FBH InP technology is unique in that it also allows the heterointegration of silicon based processes on wafer and chiplet level. Heterointegration is fundamental to 6G communications and radar sensing in order to avoid signal transitions off-chip, which are associated with high losses at frequencies > 140 GHz. Additionally, heterointegration enables to improve the complexity of front-end components by integrating the high complexity possible with silicon based processes seamlessly with the higher performance circuits based on InP. Heterointegration can hence be considered an enabling technology, which however, requires wideband interconnects to facilitate the transition from one technology to the other.

FBH has demonstrated already for ten years a wafer level heterointegration process. Recently, we have also established a chiplet based heterointegration [3],[4]. Figure 1 depicts an InP DHBT chiplet heterointegrated onto a BiCMOS substrate chip and the frequency spectrum of the transitions available in this technology. It can be concluded that this heterointegration technology can be employed across the full 6G communications and radar spectrum.

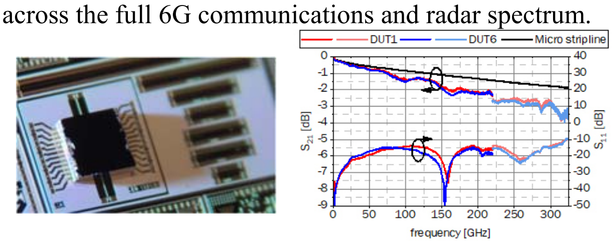

Figure 1 InP DHBT chiplet heterointegrated into a Si BiCMOS substrate (left) and back-to-back measurement of a microstrip line with two intra-chip transitions (right).

4 References

[1] M. Hossain et al., "A 0.5 THz Signal Source with -11 dBm Peak Output Power Based on InP DHBT," 14th European Microwave Integrated Circuits Conf. (EuMIC), Paris, France, 2019, pp. 302-305.

[2] M. Hossain, H. Yacoub, W. Heinrich and V. Krozer, "Front-End Active Components for future 6G Wireless Communication in InP-DHBT Technology," 24th Intern. Microwave and Radar Conf. (MIKON), Gdansk, Poland, 2022, pp. 1-4.

[3] H. Yacoub et al., "Heterointegration of mm-Wave InP-HBT Power Amplifier Chiplets on SiGe-BiCMOS Chip," 18th European Microwave Integrated Circuits Conf. (EuMIC), Berlin, Germany, 2023, pp. 169-172.

[4] M. Rausch et al., "Broadband Hetero-Integration of InP Chiplets on SiGe BiCMOS for mm-Wave MMICs up to 325GHz," IEEE/MTT-S International Microwave Symposium - IMS 2023, San Diego, USA, 2023, pp. 466-469.