Graphene based flexible radio-frequency electronics: Current status and major challenges

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Radio frequency integrated circuits (RF ICs) built the core of modern information and communication systems. Graphene based devices like transistors, diodes or varactors have been recognized from the very beginning as promising candidates in future RF ICs, having the potential to significant outperform established devices based on Silicon or III/V semiconductor materials in terms of speed, functionality or mechanical flexibility.

However, so far the potential of graphene in RF electronics has mainly been demonstrated on a single device level because the realization of more complex integrated RF circuits was limited by a non-mature fabrication technology and large variations in the device performances.

In this presentation I will first present the MMIC (monolithic microwave integrated circuit) process for graphene based RF circuits developed at AMO and discuss especially the challenges and possible solutions related to device variability and yield.

Different RF ICs have been realized so far, which are designed for future WiFi communication systems in 5G and for IoT applications.

In the second part of the presentation, I will discuss approaches, challenges and possible solutions for the wafer scale integration of graphene based electronic and sensor devices [1]. The performance will be compared to chip scale production and the current limitations for yield, device to device variation and reproducibility will be discussed.

REFERENCES

[1] D. Neumaier, S. Pindl and M. Lemme Integrating Graphene into Semiconductor Fabrication Lines. Nature Materials 18, 525–529 (2019).

FIGURES

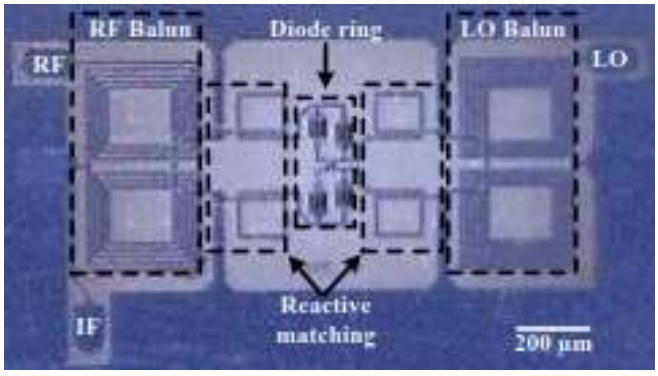

Figure 1: Optical micrograph of an integrated RF circuit (double balanced mixer operating at 6-12 GHz). The different parts of the circuit are indicated.