

# Integrated Circuits for RF Communication with Graphene based Devices.

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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 significantly outperform established devices based on Silicon or III/V semiconductor materials in terms of speed, functionality or 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 talk I will present the MMIC (monolithic microwave integrated circuit) process for graphene based RF circuits developed at AMO (figure 1) [1,2] and discuss especially the challenges and possible solutions related to device variability and yield.

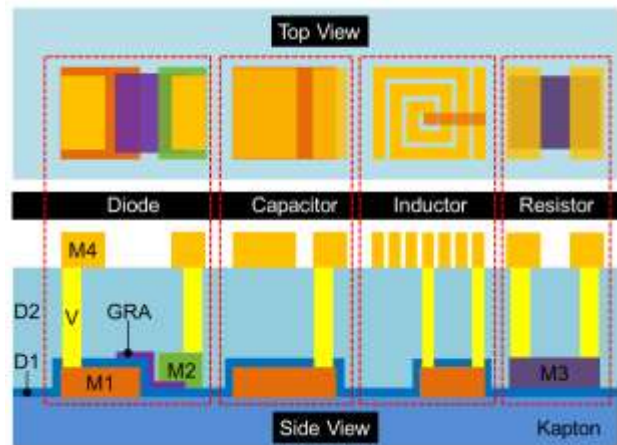
Different RF ICs have been realized so far, which are designed for future WiFi communication systems in 5G and for IoT applications [3].

As one example, a double balanced mixer designed for operation from 6-12 GHz has been realized using a graphene based diode ring and metal based passive components (figure 2). This integrated circuit was fabricated on a glass substrate and provides a down-conversion loss of only 10dB, which is identical to GaAs based mixers, but achieved with a much more flexible and cheaper production technology.

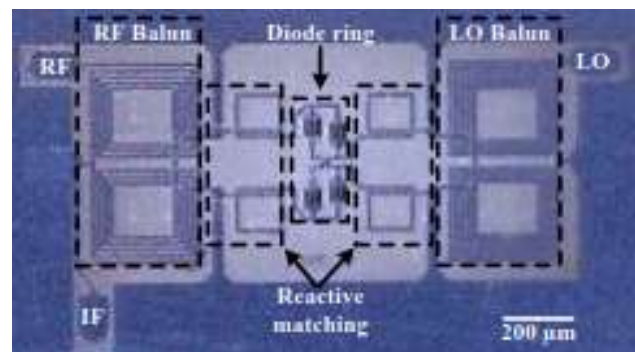
## References

- [1] A Askar et al. Microwave Conference (GeMiC), 2015 German 299 - 302 (2015).
- [2] M Shaygan et al, Nanoscale, 9 (2017), 11944.
- [3] MS Elsayed et al. Nanoscale, 10 (2018), 93.

## Figures



**Figure 1:** Schematic cross-section and top-view of the layers used in the fabrication of integrated RF circuits. Graphene is on dielectric layer D2.



**Figure 2:** Optical micrograph of an integrated RF circuit (double balanced mixer operating at 6-12 GHz). The different parts of the circuit are indicated.