Advances in High-Speed Optoelectronic Mixing at 1.55 µm

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In communication systems, radiofrequency (RF) signals are carried by a high carrier frequency. Thus, before being digitalized, the signal is first down converted to baseband using an electronic or optoelectronic mixer. Graphene appears particularly promising for high frequency optoelectronic mixers due to its high mobility, broadband absorption and low carrier lifetime. Using high mobility graphene, we demonstrated high efficiency optoelectronic mixers [1] and samplers [2]. However, these performances were demonstrated on individual devices based on h-BN encapsulated graphene.

We show in this presentation improvement over state-of-the-art optoelectronic mixing at 1.55 µm on 6 inches wafers, with wafer-scale fabrication of devices with integrated optical waveguides (see fig.1). The conversion efficiency is similar to the most performant optoelectronic mixers (high mobility exfoliated graphene mixers [1]) over a 67 GHz bandwidth. First sampling results will also be presented and compared to those obtained with high mobility graphene [2].

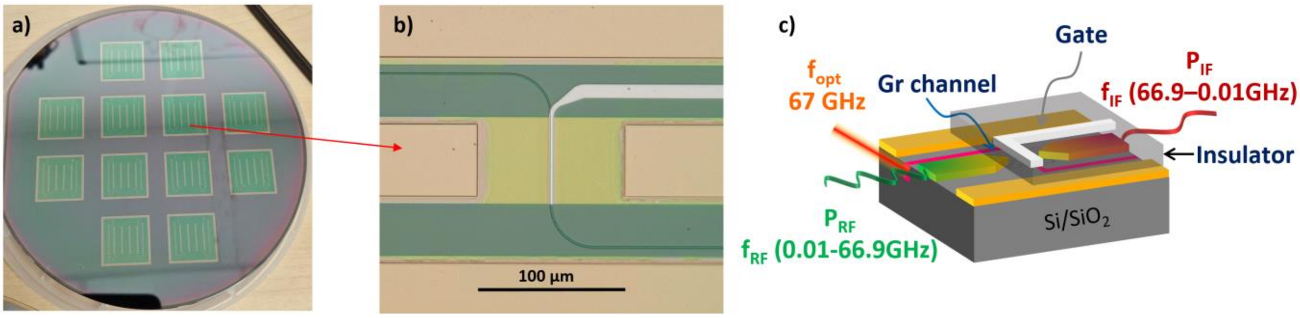

Figure 1: a) Picture of the 6 inches wafer. **b)** Picture of a mixer device. **c)** Experimental scheme: a 1.55 µm laser signal modulated at f_{opt} = 67 GHz is injected in an optical waveguide, which is embedded under the graphene channel. The graphene channel is integrated in the middle of a coplanar RF waveguide. RF probes allow both the injection of the high-frequency RF input signal (at f_{RF}), and the measurement of the down-converted output RF signal (at $f_{IF} = f_{opt} - f_{RF}$). A top-gate controls the graphene doping.

References

[1] L. Hamidouche et al., "Optoelectronic Mixing in High-Mobility Graphene", ACS Photon. 8, 369 (2021).
[2] M. Tharrault et al., High-Speed Optoelectronic Graphene Sampler at 1.55 µm Reaching Intrinsic Performances. Adv. Electron. Mater. 2023, 9, 2300260