Transparent image sensor for eye-tracking and nanophotonic infrared photodetectors

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Integrating and manipulating the nano-optoelectronic properties of Van der Waals heterostructures can enable unprecedented platforms for photodetection, sensing and modulation. Many of the realized devices have already demonstrated competitive performances and proof-on-concept integration with Si-CMOS technologies has been demonstrated [1,2]. But many challenges remain, and there is still a clear need for competing photodetectors for the full spectral range from short-wave infrared, infrared and terahertz.

In this talk, we present
1) the first transparent camera, applied as an eye-tracking device
2) demonstrate several new photodetection concepts for infrared light.

Image sensors hold a pivotal role in society in their ability to digitize visual scenes. Currently, all commercial image sensors and therefore cameras are opaque. We present the first transparent camera based on an array of graphene photodetectors. These transparent image sensors can have a far-reaching impact on human-computer interfaces, smart displays, and eye-tracking for augmented and virtual reality. The operation of these devices presents a fundamental shift in how we think about image sensor, as these devices can be hidden in plain sight.

In the second part of the talk, we present several new photodetection concepts for infrared light [3]. The first is a novel approach for highly responsive graphene-based photodetectors with orders of magnitude lower dark current levels, exploiting a metal-insulator-graphene diode structure [4]. This detector takes advantage of the low density of states of graphene near the neutrality point, giving rise to a novel type of gain mechanism. We also present an infrared photodetector based on a plasmonic antenna coupled to hyperbolic phonon-polaritons in hexagonal-BN to highly concentrate midinfrared light into a graphene pn-junction [4]. This novel approach explicitly benefits from the extraordinary nanophotonic properties of 2D materials and yields remarkable device performance featuring room temperature high sensitivity, hence achieving a combination currently not present in the state-of-the-art graphene and commercial mid-infrared detectors.

REFERENCES

[1] Romagnoli et al., Nature Reviews Materials 3(10), 392.
[2] Akinwande et al., Nature 573(7775), 507 (2019).
[3] Castilla et al., Nature Com 11, 1 (2020).
[4] De Fazio et al., ACS Nano 14,9 (2020).

FIGURES

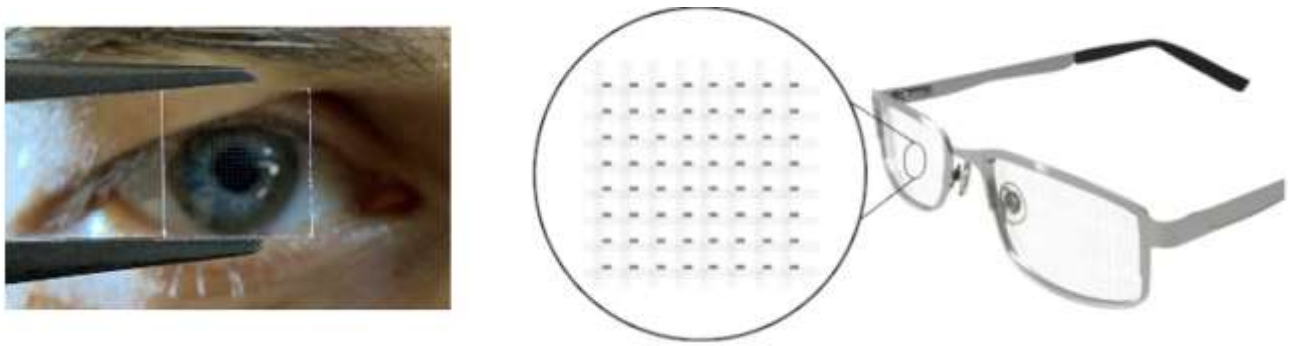

Figure 1: Left: transparent image sensor based on an array of graphene photodetectors. Right: eye-track device