Graphene-CMOS integration for broadband camera

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CMOS (complementary metal-oxide semiconductors) technology has been dominating integrated circuits fabrication for the last 40 years and enabled the progress of electronics. Despite the tremendous optimization and miniaturization of the integrated circuits silicon technology has limitations in functionality, especially in the area of sensors. Here we present a monolithic hybrid graphene-quantum dot image sensor integration with a CMOS read out circuit. Our technology enables broad band (300-2000 nm) light sensitivity that compliments silicon image sensors that can only absorb light up to 1100 nm [1].

We also demonstrate the first graphene and CMOS monolithic integration. 99.8% of the graphene pixels in the image sensor were successfully integrated with the read-out circuitry. Graphene in this system is a high mobility phototransistor enabling effective charge transfer from the quantum dots [2]. We obtained images in visible and short wave infrared with illumination irradiance going down to $1 \cdot 10^{-4}$ W/cm^2 (office illumination condition) and $1 \cdot 10^{-3}$ W/cm^2 respectively [3]. As the read out circuit is not optimised (off the shelf solution) for matching ideal graphene resistance values, the photodetector performance is limited by the read out circuit. To show possible future applications in night vision we demonstrate results with single pixel detectors that can detect illumination levels as low as the airglow.

References

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Figures

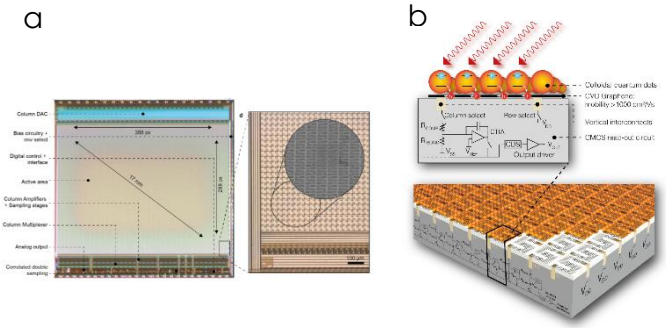

Figure 1: Back-end-of-line (BEOL) CMOS integration of CVD graphene colloidal quantum hybrid photodetector with 388 x 288-pixel image sensor read-out circuit. a) A photograph of the chip and SEM close up. b) 3D impression of the sensor.

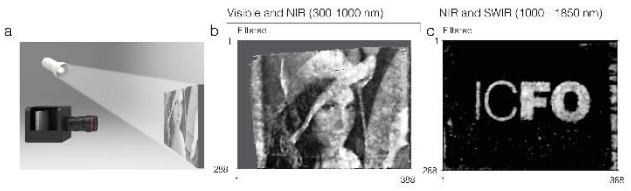

Figure 2: a) Digital camera set up representation b) Image obtained illuminating panel with visible and near infrared light as shown in a). c) Image obtained illuminating logo with near infrared and short wave infrared light.