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Graphene CMOS camera for visible and infrared light

Integrated circuits based on CMOS (complementary metal-oxide semiconductors) are at the heart of the technological revolution of the past 40 years, as these have enabled compact and low cost micro-electronic circuits and imaging systems. However, the diversification of this platform into applications other than microcircuits and visible light cameras has been impeded by the difficulty to combine other semiconductors than silicon with CMOS.

We show for the first time the monolithic integration of a CMOS integrated circuit with graphene as a high-resolution image sensor and operate it as a digital camera for visible and infrared light at the same time. We integrated graphene and the image sensor read-out circuitry with a pixel yield of 99.8%. Subsequently the graphene was coated with a layer of colloidal quantum dots to sensitize it to UV, visible and infrared light (300 – 2000 nm) [2, 3]. Applications for automotive, night vision, food inspection, medical imaging have been demonstrated. This demonstration of a graphene-CMOS image sensor is a major leap towards 3d integrated circuits based on 2d materials and Si-CMOS that can perform even more complex tasks than Si-CMOS alone. The natural layer-by-layer stackability of these 2d materials opens a wealth of possibilities for enhancing the functionality of future micro-electronics, sensor arrays, low-power integrated photonics and CMOS imaging systems.

References

- [1] Goossens et al., Nature Photonics (2017).
- [2] G. Konstantatos, et al., Nature Nanotechnology 7, 6, 363 (2012).
- [3] Nikitskiy et al., Nat. Communications 7 (2016).

Figures

