High performance graphene flexible and transparent sensor platform with application in health sensing

Stijn Goossens, Eric Puma, Juan-Jose Piqueras, Marc Montagut, Tania Lasanta, Gabriele Navickaite, Turgut Durduran, Gerasimos Konstantatos, Frank Koppens

ICFO – The Institute of Photonic Sciences, Av. Carl Friedrich Gauss, 3, 08860 Castelldefels (Barcelona), Spain
stijn.goossens@icfo.es

Abstract

There is a large demand for sensors that can be easily integrated with many different objects. The rising trend of the internet-of-things illustrates the need for electronic sensing by any object surrounding us. Especially in health care the promises of using ubiquitous sensors are very high. Remote health monitoring will minimize hospital visits for patients and give doctors early warnings in case of developing illnesses.
Sensors for ubiquitous sensing should be cheap, invisible and easy to integrate with many different surfaces such as bendable plastic, fabric and glass. Transparent, wide wavelength range and flexible are key properties for a sensor used in remote monitoring. Here we present a novel sensor platform with these properties.

The technology is based on graphene and colloidal quantum dots which gives the sensor not only a high signal to noise ratio, but also provides inherent flexibility and transparency [1]. By using PEN as a substrate for the graphene and quantum dots we made the entire system flexible and transparent (see figure 1a). Our hybrid photodetectors cover a much wider wavelength range than conventional silicon detectors: 400 – 2000 nm. They have a very low noise equivalent irradiance of $<10^{-6}$ W/m^2 and time response is below 5 ms. The detector is stable in ambient conditions and even after 2000 bending cycles it does not lose performance.

As a proof of applicability we made a flexible and transparent heart rate sensor (see figure 1b). The heart rate sensor measures reflected light from the skin that is modulated by the blood pulse. The sensor works in many different real world lighting conditions. This application demonstrates not only the robustness of the technology, but also the high dynamic range.
Future developments of the sensor platform will exploit the broad wavelength range. Both ends of the spectrum will enable new health monitoring devices that can be integrated on a simple invisible patch on the skin.

References

[1] G. Konstantatos, M. Badioli, L. Gaudreau, J. Osmond, M. Bernechea, F. P. Garcia de Arquer, F. Gatti and F. H. L. Koppens, Nature Nanotechnol., **7** (June 2012). Hybrid graphene-quantum dot detectors with ultrahigh gain.

Figures

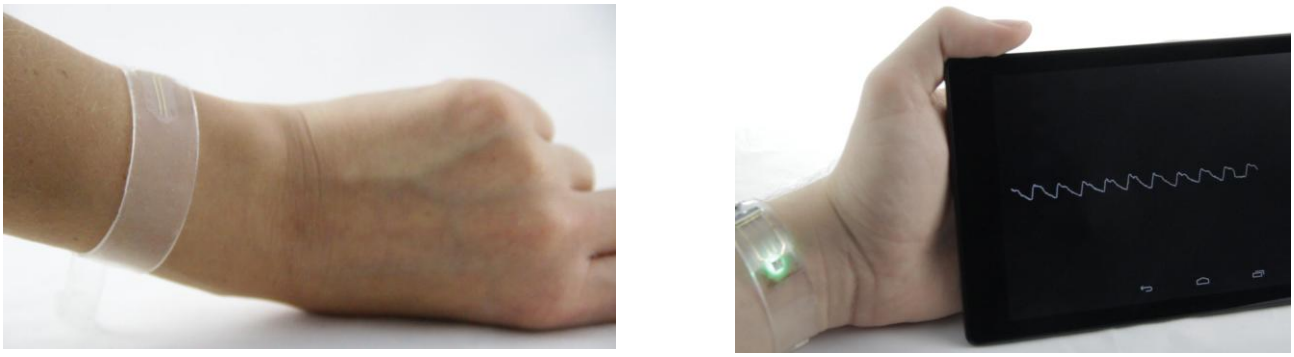

Figure 1 (a) Wrist band with graphene sensor. (B) A working prototype system in the form of a wristband, including a tablet to display the pulse in real time.