Graphene for sensors and (quantum) electronics

Samuel Lara-Avila[1,2]
[1]Department of Microtechnology and Nanoscience, Chalmers University of Technology, 412 96 Gothenburg, Sweden
[2]National Physical Laboratory, Hampton Road, Teddington TW11 0LW, United Kingdom

Graphene and other two-dimensional materials are slowly reaching the market in a diversity of products including photodetectors, quantum standards, and composites.

Here I present an overview of graphene technologies based on a specific type of graphene, produced by heating silicon carbide at high temperatures, so-called epitaxial graphene on silicon carbide (or epigraphene).

The talk will focus on the production technologies for large-scale epigraphene and the use of this material for applications that we developed in the past 5 years in our group. These include using epigraphene as a superior realization of quantum standards, as well as sensors for chemical species, magnetic fields and terahertz waves. These developments have laid the foundations for large-scale production and electronic applications of graphene, and I will describe some of the already available commercial applications based on our results.

References
1. He, H. et al. Highly efficient UV detection in a metal-semiconductor-metal detector with epigraphene. Appl. Phys. Lett. 120, 191101 (2022).
2. Karimi, B. et al. Electron-phonon coupling of epigraphene at millikelvin temperatures measured by quantum transport thermometry. Appl. Phys. Lett. 118, (2021).
3. He, H. et al. The performance limits of epigraphene Hall sensors doped across the Dirac point. Appl. Phys. Lett. 116, 223504 (2020).
4. Lara-Avila, S. et al. Towards quantum-limited coherent detection of terahertz waves in charge-neutral graphene. Nature Astronomy vol. 3 983–988 (2019).
5. He, H. et al. Polymer-encapsulated molecular doped epigraphene for quantum resistance metrology. Metrologia 56, 045004 (2019).
6. He, H. et al. Uniform doping of graphene close to the Dirac point by polymer-assisted assembly of molecular dopants. Nat. Commun. 9, (2018).