Epitaxial graphene on SiC substrates for potential application in Security and Defense

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Graphene is one of the most promising new materials. It consists of an atomic-thick layer of carbon atoms forming a hexagonal network. It presents extraordinary properties such as high heat conduction, great elasticity, good electrical conduction, transparency at visible light wavelength, etc. [1]. This is the reason why graphene is expected to be implemented in many applications where it can provide better functionality compared to other materials. Graphene is also thought to be the starting point for new disruptive applications and has been selected for a Flagship funded project by the European Union [2].

However, experiments have demonstrated that there are many "graphenes", or "graphenes" with different qualities, showing varying physical and chemical properties. Depending on the exact application, the required quality and size of graphene is different, implying a different preparation method and different properties. In terms of electronic performance, one of the highest graphene qualities is obtained for Epitaxial Graphene (EG) [3]. Such conformal growth of graphene is observed in the sublimation process of SiC wafers. Compared to other growth methods, the advantage of this method is that graphene transfer is not required due to the semi-insulating nature of SiC. Additionally, it provides a means to develop applications at wafer level. Based on its outstanding electronic quality, promising applications based on EG have been recently demonstrated. We can highlight the following ones, which could eventually have an impact in topics related to Security and Defense:

-Development of high-frequency electronic devices: Devices based on EG have shown working frequencies beyond 100 GHz, beyond conventional Si-based and III-V based electronic devices [4-6]. This could enable faster devices in telecommunication areas.

-Development of new metrology standards based on the quantum Hall effects [7-9]. This could enable more robust and precise standards of the Ohm.

-Low-power-consumption electronic devices based on Spintronic effects [10-12]. This could facilitate the development of energy-efficient data storage, sensing and logic devices.

-High-performance sensor and biosensor platforms [13-15]. The fact that graphene is an all-surface material produces significant changes in its resistance when atoms or molecules adhere to its surface. This has been used for gas sensing using EG. Additionally, surface functionalization of EG opens the route for specific detection of targeted substances.

-Devices in the THz spectral range [16]. Devices in the THz regime such as sources, detectors, modulators, antennas and polarizers are being developed [17, 18].

In this presentation, the applications of EG will be reviewed, with special emphasis on those ones related to Security and Defense. The patterning of EG, one of the bottlenecks towards the development of devices will be discussed [19-22]. A Spanish industrial initiative towards commercialization of this technology will be presented [23].

Figures

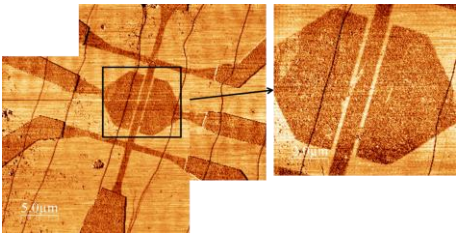

Figure 1: Patterned Epitaxial Graphene for measurements of the Quantum Hall Effect performed at CNM by N. Camara et al., Appl. Phys. Lett. 97 (2010) 93107

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