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Laser-assisted growth of high-quality graphene and graphene-based structures

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After one decade of intense fundamental graphene research it is generally accepted that graphene's superior physical properties are currently well understood. Major experimental challenges are now related to the large-scale production of high-quality graphene, which is the prerequisite to evolve fundamental graphene science into technological applications. One of the most promising methods for large area, high quality graphene production is the thermal decomposition of SiC, which leads to the growth of epitaxial graphene (EG). The predominant approach used to obtain EG on SiC is thermal annealing of SiC wafers (at T>1500 K) either in high vacuum or under controlled Ar atmosphere.

The full potential of laser-assisted methods in graphene productions has not yet been unlocked, despite that these methods offer a number of advantages as they are fast, low-cost, environmentally friendly and adaptable to current technological platforms. Few investigations have appeared so far aimed at producing graphene using laser beams. Lasers have been employed towards two main directions, i.e. graphene growth/production and processing of graphene oxide towards obtaining reduced graphene oxide. Laser wavelengths ranging from ultraviolet to infrared have been used both in the cw and pulsed modes. In their vast majority, studies of laser-assisted methods result in graphene of dubious quality. We will review the current status of the role of lasers in graphene production and processing and discuss recent advances in our laboratory concerning the laser-assisted growth of graphene and graphene-based structures. In particular, we will present activities related to: (i) the growth of epitaxial graphene on SiC(0001) using a continuous wave infrared CO_2 laser (10.6 μm); (ii) preparation of graphene-coated SiC particles and 3D graphene froths through the complete Si depletion of SiC particles; and (iii) the growth of graphene films by decomposing various organic substances using pulsed lasers

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