Rapid CVD growth of millimetre-sized single-crystal graphene using a cold-wall reactor

Vaidotas Miseikis[1], Domenica Convertino[1,2], Neeraj Mishra[1], Mauro Gemmi[1], Vincenzo Piazza[1] and Camilla Coletti[1,2]

[1] Center for Nanotechnology Innovation @NEST, Istituto Italiano di Tecnologia, Piazza San Silvestro 12, 56127 Pisa, Italy

[2] Graphene Labs, Istituto Italiano di Tecnologia, Via Morego 30, 16163 Genova, Italy

Abstract

This work presents a simple pathway to obtain large single-crystal graphene on copper (Cu) foils with high growth rates using a commercially available cold-wall chemical vapour deposition (CVD) reactor. We identify a series of steps of substrate preparation and growth which allow a highly repeatable and fast growth of large single-crystals of graphene, making the technique suitable for device applications. We demonstrate the importance of each of these steps, namely: i) using passivated Cu foils, ii) pre-annealing in an inert argon atmosphere and iii) enclosing the sample during the growth. Optimisation of these steps allows us to achieve a low graphene nucleation density and high growth rates of 14.7 and 17.5 μm per minute on flat and folded foils, respectively. Thus, single crystals with lateral size of nearly one millimetre can be obtained on flat foil in just one hour and 3.5 mm crystals can be grown inside copper "pockets" in 3 hours. The samples are characterised by optical microscopy, scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS), Raman spectroscopy as well as selected area electron diffraction (SAED) and low-energy electron diffraction (LEED), which confirm the high quality and homogeneity of the graphene. The development of a process for the quick production of large grain graphene in a commonly used commercial CVD reactor is a significant step towards an increased accessibility to millimetre-sized graphene crystals.

Figures