Nucleation seeds control for the growth of sub-centimeter size crystals of single-layer graphene on polycrystalline copper foil

Malik M. Wasil [1], Sahar Jaddi[2], Bin Wang [2, 3], and Jean-Pierre Raskin [1]

[1]*Institute of Information and Communication Technologies, Electronics and Applied Mathematics, UCLouvain, 1348 Louvain-la-Neuve, Belgium*

[2]*Institute of Mechanics, Materials and Civil Engineering, UCLouvain, 1348 Louvain-la-Neuve, Belgium*

[3]*School of Physics and Electronics, Hunan University, China*

Abstract

Monocrystalline atomically thin graphene layer is of great interest in electronics, mechanics, composite materials, and nanoscale flexible devices. Yet the grain boundaries and ad-layer graphene formation make difficult the large-scale fabrication of graphene-based electro-mechanical devices. Thin copper foil is the most versatile substrate for the growth of single-layer graphene thanks to its negligible solubility of the carbon atoms. However, both surfaces of Cu foil being exposed to the precursor gas carbon back diffusion promotes precipitation of carbon and forms twisted multilayer graphene. These twisted graphene layers can reach up to hundreds of microns with a high density, and thus considerably reduce the area of single layer graphene for device integration. In this work, the carbon back diffusion mechanism is controlled by coating the back side of the Cu foil with a thin layer of foreign transition metal. This additional layer actively traps the excess of carbon atoms and therefore stops their further diffusion into the Cu foil. We demonstrated the synthesis of clean single-layer graphene having single domains size of more than 0.2 cm. These large area domains merge and assemble in the form of continuous single layer graphene. This versatile approach gives the flexibility to grow high-quality graphene sheets of area larger than 15x7 cm^2.. The quality of the synthesized graphene is verified by the RAMAN spectroscopy. This novel approach can be used to integrate wafer-scale electromechanical devices. Large area domains and highly clean monolayer graphene offer great potential for harnessing their intrinsic properties in various types of devices. The objective of this work is to ease the graphene synthesis process and scale up the production in such a way that this low-cost production can be optimized at an industrial scale.