Effect of Temperature on the Growth of Single Crystalline Monolayer Graphene by Chemical Vapor Deposition (CVD)

Zewdu M. Gebeyehu¹², Jo Cuppens¹, Maria J. Esplandiu¹, Sergio O. Valenzuela¹³

¹Catalan Institute of Nanoscience and Nanotechnology (ICN2), CSIC and The Barcelona Institute of Science and Technology, Campus UAB, Bellaterra, 08193 Barcelona, Spain
²Universitat Autònoma de Barcelona (UAB), Bellaterra, E-08193, Spain
³Institució Catalana de Recerca i Estudis Avançats (ICREA, 0870 Barcelona, Spain

zewdu.messele@icn.cat

Abstract

The ever increasing interest in graphene properties and its applications¹² has motivated the controlled growth of high-quality graphene³ and fabrication of graphene-based devices². The growth of graphene via CVD using metal catalysts depends on both the intrinsic properties of the metal catalysts and the growth parameters⁴. Here we demonstrate that the structure of single layer graphene flakes grown on a copper substrate by low pressure CVD depends dramatically on the furnace temperature, within a few tens of degrees Celsius. Optical microscope analysis of as-grown and transferred graphene onto SiO₂/Si shows that growth at 1000 °C results in dendritic shapes (Figure a) while growth at 1040 °C gives a compact graphene flake (Figure b). The low temperature growth was extended over a long time (1 hour) in order to check if there was a change in the structure towards a compact flake as the one in Figure b, which was obtained after just 10 minutes of growth time at 1040 °C. However, the size of the dendrites increased without merging. Although still poorly understood, the dendritic growth may be due to the poor smoothening of the copper at the lower annealing temperatures and to the low carbon attachment/detachment kinetics at the graphene growth fronts.

We have characterized the charge and spin transport properties of the graphene grown at low temperatures. We have fabricated non-local spin valve devices with 3 µm graphene channel length and found a spin life time of 0.2 ns and spin diffusion length of 2.5 µm at room temperature. The mobility of the device was of 1000 cm²/Vs, which is typical for CVD grown graphene on SiO₂/Si. Future work will focus on comparing these results with the spintronic performance of graphene grown at higher temperatures.

References


Figure: a) low temperature and b) high temperature grown graphene on SiO₂/Si substrate