Talk-02

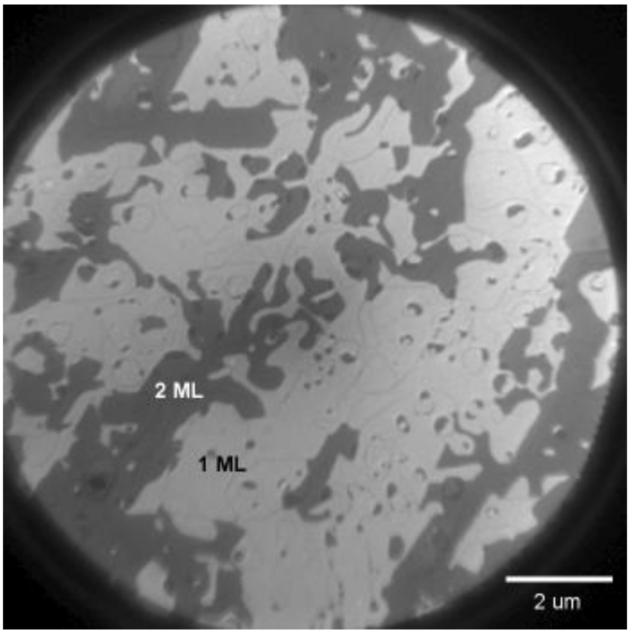
Optimizing Graphene Morphology on SiC(0001)

James B. Hannon
IBM Research Division
T.J. Watson Research Center
Yorktown Heights, NY, USA
jbhannon@us.ibm.com

Abstract

Carbon-based electronics is a major focus in the search for a viable successor to silicon-based CMOS technology. One particularly promising channel material is graphene – a single, crystalline layer of carbon with the structure of a layer of graphite. Among the many unusual properties of graphene is an extremely high electron mobility (> 200,000 cm^2/Vs [1]), offering the promise of very high-speed electronic devices.

One widespread approach to synthesizing a graphene film is to heat a silicon carbide surface above 1200 °C. At elevated temperature silicon carbide decomposes, releasing volatile silicon, and leaving behind a crystalline graphene film on the surface. One attractive feature of this approach is that, in principle, wafer-scale graphene films can be produced on a semi-insulating substrate. Given the difficulty of measuring surface morphology during decomposition at 1200 C, little is known about the details of how graphene forms on SiC(0001). In this talk, I will describe *in situ* measurements of graphene formation using Low-Energy Electron Microscopy (LEEM). When SiC(0001) is heated in ultra-high vacuum the decomposition of silicon carbide begins at about 1100 °C. At these temperatures the mobility of carbon on the surface is relatively low, and large, well-ordered domains of graphene do not easily form. Annealing to higher temperatures results in thicker films, but no improvement in morphology due to the formation of deep etch pits [2]. However, if silicon carbide is annealed in a silicon *vapor* (e.g. in a background pressure of disilane gas) the decomposition is pushed to higher temperature (> 1300 °C). At these temperatures the mobility of carbon on the surface is much higher, and large graphene domains can be formed, as shown in the image: dark areas indicated two layers of graphene and bright areas indicate one layer of graphene [3]. These results can be understood in terms of simple vapor pressure arguments.



[1] K.I. Bolotin *et al*, Solid State Comm, 146 (2008) 351.

[2] J.B. Hannon and R.M. Tromp, Phys. Rev. B 77 (2008) 241404.

[3] R.M. Tromp and J.B. Hannon, Phys. Rev. Lett., in press.