Graphene Growth Studies on Copper (111) and Silicon Carbide Substrates

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Abstract

Graphene shows great promise for use in a variety of technical applications, but the production of large area graphene is still a challenge. In this study we will show the two most promising substrates to grow high-quality graphene on, silicon carbide (SiC) and Cu(111) surface. The difference between the two substrates is that with the use of silicon carbide multiple over-layers of graphene could be grown as opposed to the single layer termination on the Cu(111) surface. With Low Energy Electron Diffraction (LEED) a Moire pattern was observed on the silicon carbide surface, which confirmed the growth of multiple layers of graphene. On Cu(111), depending on the coverage, single layer graphene is either aligned or disordered.

Introduction

Graphene is a single layer of sp²-hybridized carbon atoms bonded together in a hexagonal pattern. It is the most reactive state form of carbon, with high optical transmittance and thermal conductivity, making it useful in a variety of technological applications. The problem with graphene is that it is a method of growth viable for industry use has not yet been developed. Two competing methods of growing graphene are, growth by CVD on copper substrates or foils, and growth on silicon carbide substrates with a furnace. Both methods come with their own limitations for growing high quality graphene. Apart from cost in production, a major difference between the two growth methods, is that SiC substrates allow for the growth of multiple layers of graphene, as opposed to the monolayer of graphene grown on copper.

CVD Growth of Graphene on Cu (111)


avoid Cu sublimation at higher temperatures.
• Chamber base pressure of 1 x 10⁻¹¹ Torr.
• Series of Sputtering/Annealing to 1 x 10⁻¹¹ Torr and 700 °C respectively, in order to clean the Cu crystal.
• Chamber was filled with ethylene and argon gas up to a pressure of 50 mTorr.
• Cu crystal heated to 900 °C using an oxygen series button heater, and temperature was held for 10 minutes for graphene growth.
• Pump chamber and allow crystal to cool to room temperature.

Graphene Growth Studies on Cu (111)

The LEED measurements were performed at SUNY College of Nanoscale Science and Engineering.

Summary of Results

Graphene/Cu(111):
Rotational Disorder of Graphene Increases with CH4, Partial Pressure:
• P(CH4) ≤ 5 x 10⁻³ Torr
• Well-ordered single-domain epitaxy
• P(CH4) = 50 x 10⁻³ Torr
• Two-domain epitaxy
• Large amount of rotational disorder

Effect of Chemisorbed Oxygen on Graphene Growth:
• Single-domain epitaxy
• Large amount of rotational disorder
• Bulk oxygen affects graphene growth process

Graphene/SiC:
• Graphene Multilayer
• Moiré pattern observed in LEED

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