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Polymer Assisted Transfer of Graphene onto Semiconductor Substrates

Graphene is being widely researched for its numerous electronic properties that make it an interesting candidate for integration into devices. Improving methods for transferring graphene and understanding the impact these transfer methods have on the properties of these devices, is necessary for the development of novel graphene-based devices.

Carbon exists in several different forms ranging from diamond to graphite depending on the arrangement of the carbon atoms. In 2004, Geim and Novoselov used simple clear tape to remove single layers from graphite crystals, for the first time isolating the two-dimensional material called graphene. Figure 1 shows an illustration of graphene's hexagonal crystal structure. Graphene is called a zero-bandgap semiconductor because at room temperature, electrons from the valence band where they orbit close to the carbon nuclei, can move into the conduction band where they move around freely within the sheet of graphene. This and other interesting properties have led to surge of research into graphene in the past decade.

The purpose of this work is to transfer graphene, using a polymer called cellulose acetate butyrate (CAB), onto two different semiconductor materials, indium arsenide (InAs), and gallium arsenide (GaAs). The graphene is prepared from graphite using the same method as the original discovery, peeling layers of graphene off of graphite crystals, using clear tape. The graphene/graphite mixture that attaches to the tape is deposited onto a wafer made of silicon (Si) with a 100 nm layer of silicon dioxide (SiO_2). A thin layer of the liquid plastic CAB is then placed on the wafer and hardens. The areas containing graphene can then be cut, and the polymer, with graphene flakes attached is transferred to the InAs and GaAs. Acetone is then used to remove the plastic from the graphene. A scanning tunneling microscope (STM) is then used to examine the samples. In STM, a metal tip that has an end only one atom across, is scanned very close to a sample held under high vacuum. Electrons in the sample can jump from the sample to the tip, and the resulting current can be used to make an image of the sample.

It is unknown exactly how the CAB will affect the semiconductors, but graphene's properties make it an interesting candidate for such an experiment. By simply adding a layer of graphene to the gate of some transistors, the rate at which the transistors can turn on and off is improved significantly. This could have huge implications in computer processor technology. In summary, graphene has a number of properties that make it interesting for integration into devices. This project seeks to identify ways to improve the transfer of graphene in order to produce graphene/semiconductor hybrid structures that could have applications, for example, in transistor and photodetector technology.

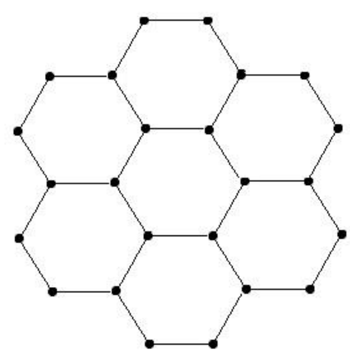

Figure 1: A representation of the hexagonal structure of graphene

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