Graphene Nanoribbons: Molecular Fabrication on an Insulating Surface

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ABSTRACT
Graphene nanoribbons (GNRs) are quasi-one-dimensional strips of graphene with widths on the nanometer scale. Based on their size and geometry, they possess unique electro-magnetic properties and tunable band gaps which are nano-device relevant. To harness these characteristics of GNRs, it is essential to produce them with atomic precision. Recent successes with bottom-up fabrication show how precise GNRs can be synthesized on a metal surface.1,2 Our goal is to use bottom-up methods to grow GNRs on an insulating surface. Insulating surfaces will serve as a better interface for the analysis and application of GNRs. This experiment demonstrates an ab initio approach to producing GNRs on BN/Cu(111). It was conducted using a scanning tunneling microscope (STM) under ultra-high vacuum.

INTRODUCTION
Objective
- Using a scanning tunneling microscope (STM), grow graphene nanoribbons (GNRs) on insulating, boron nitride surface using bottom-up fabrication

| GNRs are Quasi One-Dimensional Strips of Graphene |
| No Band Gap |
| Tunable Band Gap |

The Idea Behind Bottom-Up Fabrication

| Precursor Molecule |
| Building Blocks |
| Produce Precise GNR |

MOTIVATION
- Synthesis has only been accomplished on metal surfaces because the surface chemistry requires the metal as a catalyst
- This is problematic to analytic techniques and hinders applicability
- Using an insulating surface = Better analysis and device relevance
- New surface chemistry = No strict requirement of catalyst

EXPERIMENT

Proposed Reaction Pathway for PG2-142 (Apollo) Molecule

| Precursor |
| Monomer |
| Polymer Chains |
| GNR |

Evaporators
- Knudson evaporators are used to deposit the Apollo molecule onto the surface

PRELIMINARY RESULTS
Images of the sample were generated using a STM under ultra-high vacuum and extremely low temperatures around 13K

| Top Left: Image of BN on Cu(111) |
| Top Right: 70% coverage of molecules after deposition |
| Bottom Left: After annealing the sample up to 93°C |
| Bottom Right: After annealing the sample up to 350°C |

Conclusion
These preliminary results show clearly that polymerization did not occur; GNRs could not be synthesized in this case.

FUTURE PLANS
- Two immediate options can be used to accomplish our goal
  1. Design and implement new precursor molecules
  2. Apply pre-polymerized molecules directly to the sample via solution droplets

REFERENCES

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