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.[1] Recent successes with bottom-up fabrication show how precise GNRs can be synthesized on a metal surface.[2,3] 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.

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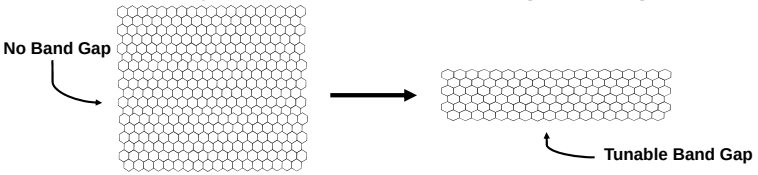
INTRODUCTION

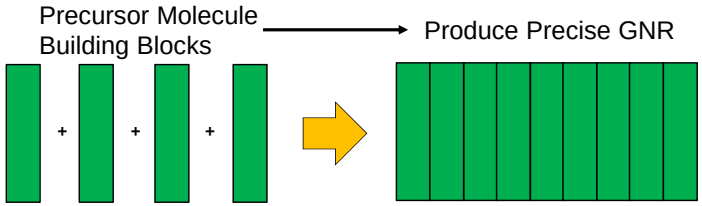
Objective

- 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

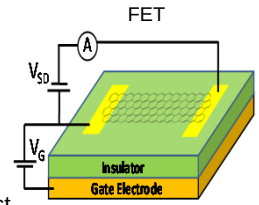


The Idea Behind Bottom-Up Fabrication



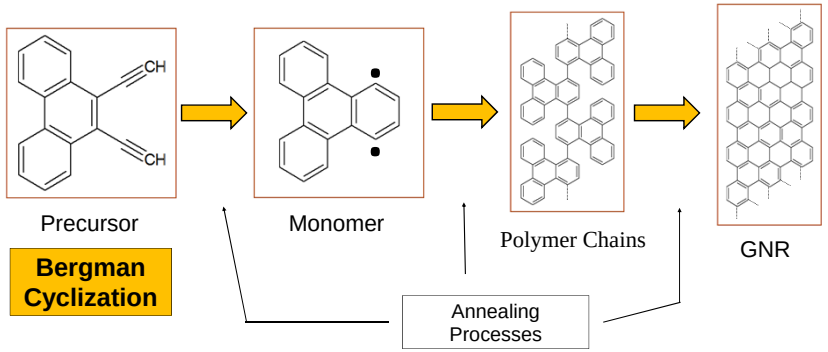
MOTIVATION

- 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

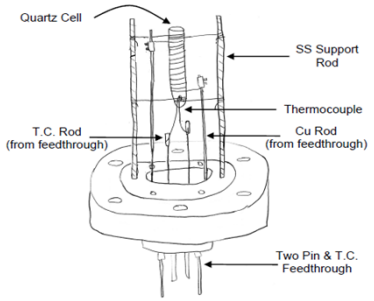


EXPERIMENT

Proposed Reaction Pathway for PG2-142 (Apollo) Molecule



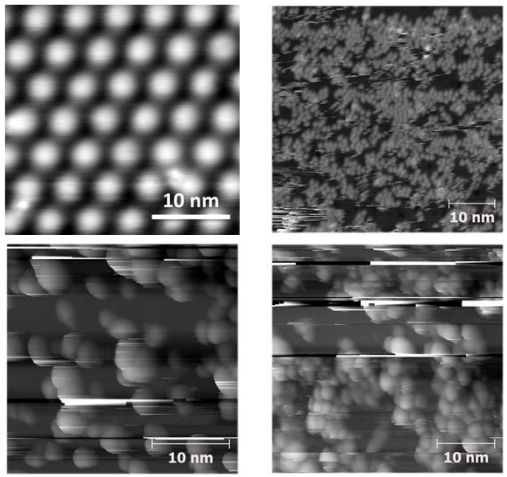
Evaporators



- 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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3. Chen, Yen-Chia, et al. "Tuning the Band Gap of Graphene Nanoribbons Synthesized from Molecular Precursors." *ACS Nano* 7.7 (2013): 6123-128.

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