Graphene Nanoribbons for Electronic and Sensing Applications
Ahmad N. Abbas, Electrophysics–Chongwu Zhou group

Motivation

The Nobel Prize in Physics 2010

Graphene: a 2D sheet of carbon

BUT graphene is a semimetal (with zero bandgap) and cannot be switched off in a transistor !!

Why Graphene Nanoribbons (GNRs) ?

Because electrons are confined in the width direction, a bandgap appears, changing graphene from a semimetal to a semiconductor

- Graphene nanoribbons can be used as transistor channel material because they are semiconductors.
- Edge tunable electronic and optical properties.
- Can emit light and hence have potential in optoelectronic applications.

How to make GNRs?

Top-down Fabrication

Bottom-up Synthesis

Accomplishment #1: Top-down graphene nanoribbon arrays down to 5 nm

- Challenge: One needs to fabricate sub-10 nm graphene nanoribbons to obtain bandgaps, and these sizes are beyond the resolution of most lithography techniques.
- Our Solution: Sublimation patterning of graphene nanoribbon arrays down to 5 nm using helium ion beam lithography.

Accomplishment #2: Bottom-up chemically synthesized graphene nanoribbon characterization

- Challenge: No one visualized and made transistors of such chemically synthesized graphene nanoribbons.
- Our Solution: Chemically synthesized graphene nanoribbons up to 500 nm in length are obtained from our collaborator,

Accomplishment #3: Thin-Film Transistors based on bottom–up chemically synthesized graphene nanoribbons

- Challenge: Deposition of graphene nanoribbons controllably into films for various applications.
- Our Solution: Sublimation of short graphene nanoribbons using a vacuum-sealed glass tube.