Synthesis Of Graphene Nanoribbons From Monomeric Molecular Precursors Bearing Reactive Alkyne Units

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SUMMARY

Researchers in the Department of Chemistry and Biochemistry have developed a novel graphene nanoribbon synthesis, which have numerous applications in electronic devices.

BACKGROUND

Graphene nanoribbons (GNRs), narrow strips of graphene <10 nm in width, are promising new materials for the replacement of silicon in field-effect transistors (FETs), the principal devices behind nearly all modern electronics. Investigations into the uses of GNRs are currently limited by the lack of controlled and scalable synthetic methods. Current methods either employ top-down or bottom-up approaches, but neither has been able to synthesize GNRs in an inexpensive, controllable way with high yield. Top-down syntheses provide high material throughput but produces mixtures and cannot achieve widths below 10 nm. Although bottom-up approaches, either on-surface or in-solution, have excellent control over the structure, the yield is low and requires high-cost equipment and conditions or the yield is high but requires transition metal catalysts and in-solution oxidation, respectively. Large-scale synthesis of GNR with inexpensive procedures is vital to this material being used in electronic devices.

INNOVATION

Researchers led by Professor Yves Rubin at UCLA have developed a novel and simple three-step bottom-up GNR synthesis in the solid-state under mild temperatures. The resulting GNRs have a well-defined width (~1.36 nm) and bandgap (1.4 eV) in addition to being electrically conductive. This method can used to controllably synthesize a large variety of GNRs with programmable sizes and electrical properties. This new synthetic approach is well suited for electronic device fabrication processes because it only requires UV light or heating, and no external chemical reagents. Likewise, this material can be readily patterned and directly formed on any substrate. This material will have versatile applications in many electronic devices, such as FETs, solar cells, and energy-storage devices.

APPLICATIONS

- Electronic device fabrication
- Workable molecular electronics
- Field-effect transistors
- Solar cells
- Energy-storage devices

ADVANTAGES

- Tunable bandgap and electronic properties
- Easily patterned or formed on any surface (solid-state topological synthesis)
- Large-scale bottom-up synthesis
- Inexpensive
- Mild heating

STATE OF DEVELOPMENT

TheGNRs have been controllably synthesized with defined widths and features. Both the chemical and morphological properties of the GNRs have been extensively studied. Additionally, the electrical conductivity of the material has also been probed and FETs have been constructed

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INVENTORS

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OTHER INFORMATION

KEYWORDS

Graphene nanoribbons, solid-state synthesis, bottom-up, tunable bandgap, electronic device fabrication, field-effect transistors, solar cells, energy-storage devices

CATEGORIZED AS

- **Materials & Chemicals**
  - Chemicals
  - Nanomaterials
  - Other
  - Polymers
- **Nanotechnology**
  - Electronics
  - Materials

RELATED CASES

2016-946-0

and tested.

RELATED MATERIALS

- R. S. Jordan, Y. Wang, R. D. McCurdy, M. T. Yeung, K. L. Marsh, S. I. Khan, R. B. Kaner, and Y. Rubin. Synthesis of Graphene Nanoribbons via the Topochemical Polymerization and Subsequent Aromatization of a Diacetylene Precursor. Chem. 2016.
- Patent Application

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,247,905	02/15/2022	2016-946

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