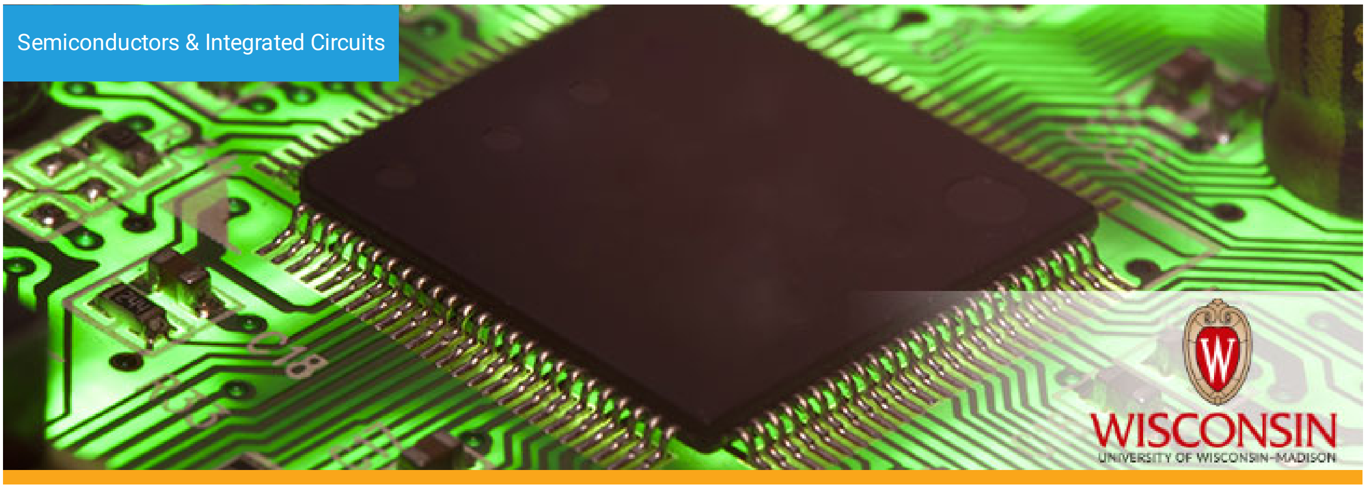

Patterned Graphene for Field Effect Transistors

View U.S. Patent No. 9,105,480 in PDF format.

WARF: P110242US01

Inventors: Michael Arnold, Padma Gopalan, Nathaniel Safron, Myungwoong Kim, Jonathan Choi

The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a method to fabricate graphene nanoribbon arrays using block copolymer lithography.

Overview

Interest in graphene has surged due to its outstanding electrical properties. Graphene is a two-dimensional, carbon-based material with high tensile strength, stiffness, optical transparency and thermal conductivity. It also is chemically stable and patternable. Interestingly, electronic capabilities are significantly faster in graphene than in silicon.

Such exceptional properties could spur the next generation of electronics. For example, graphene nanoribbon arrays (GNRs) could be used to make better field effect transistors – devices with important applications from solar cells to quantum computing.

Unfortunately, graphene's usefulness is limited because it does not have a significant 'band gap,' which is a critical property for semiconductor applications. Electron-beam lithography has been used to fabricate carbon nanotubes that can be 'unzipped' or 'unrolled' to open up the band gap. However, this approach is difficult to scale up and implement.

The Invention

UW–Madison researchers have developed a simpler method for making and patterning GNRs using block copolymer etch masks.

In the process, a graphoepitaxy channel is created over a graphene substrate. Nonpreferential layers are first deposited followed by a secondary layer of block copolymer films over the channels. Under suitable conditions, the spatial confinement of the channel causes the block copolymer to align its self-assembled domains into an array of parallel cylinders or perpendicular lamellae. When one of the polymer blocks is etched away, the periodic pattern is transferred to the underlying graphene, producing patterned GNRs.

A field effect transistor can be formed by incorporating electrodes and using the patterned array as a conducting channel region.

Applications

- Graphene nanoribbon arrays
- Field effect transistors
- Nanoelectronics
- High performance, transparent and thin-film electronics
- High electron mobility transistors
- Optoelectronics and photodetectors
- Solar cells
- Magnetic, mechanical and chemical sensing

Key Benefits

- Simultaneously achieves excellent resolution and scalability
- Enables batch processing of multiple, large-area graphene substrates
- High-fidelity patterning of exceptionally small nanoribbon features

Additional Information

For More Information About the Inventors

- Michael Arnold
- Padma Gopalan

Related Technologies

- WARF reference number P100012US02 describes a method to fabricate nanoperforated graphene.

Publications

- Safron N.S., Kim M., Gopalan P. and Arnold M.S. 2012. Barrier-Guided Growth of Micro- and Nano-Structured Graphene. Advanced Materials, DOI: 10.1002/adma.201104195
- Safron N.S., Brewer A.S. and Arnold M.S. 2011. Semiconducting Two-Dimensional Graphene Nanoconstriction Arrays Fabricated Using Nanosphere Lithography. SMALL, DOI: 10.1002/smll.201001193

Tech Fields

- Semiconductors & Integrated Circuits : Lithography

For current licensing status, please contact Jeanine Burmania at jeanine@warf.org or 608-960-9846