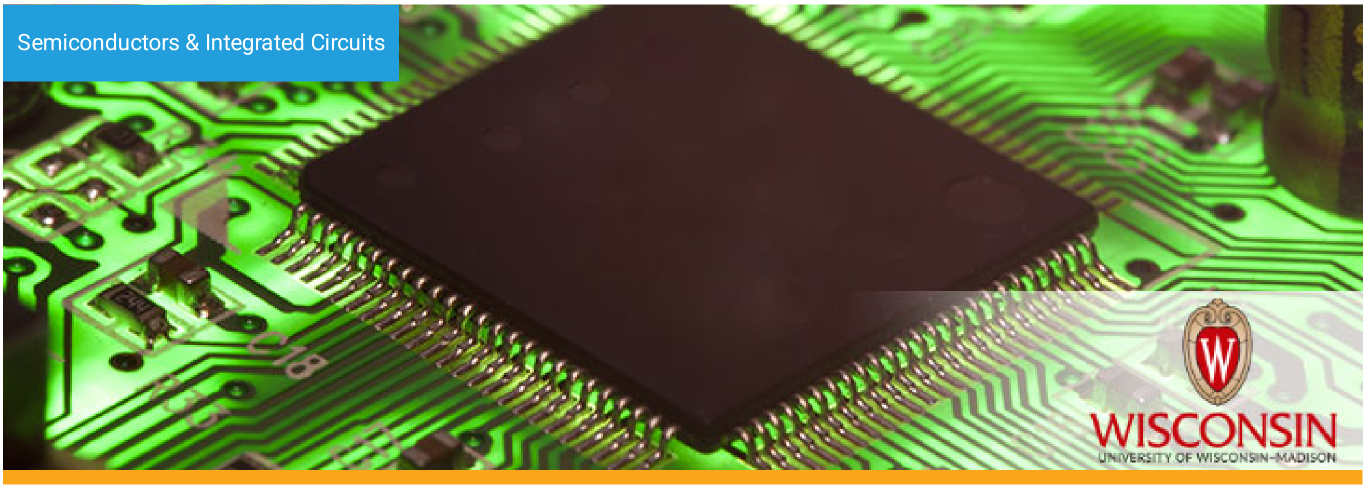

Large-Area, Nanoperforated Graphene Materials for Semiconducting Applications

View U.S. Patent No. 8,268,180 in PDF format.

WARF: P100012US02

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

The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a method to fabricate nanoperforated graphene.

Overview

Recently, interest and research in graphene has grown rapidly due to its outstanding electrical properties. Graphene, a two-dimensional carbon-based material, has high tensile strength, stiffness, optical transparency and thermal conductivity. It is also chemically stable and patternable using photolithography. In addition, the potential mobility of electronic free carriers in response to an external electric field is significantly faster in graphene than in silicon.

Graphene's exceptional properties could enable the development of next-generation, high performance electronics and improved transistor logic circuits. Unfortunately, graphene's usefulness is limited because it does not have a significant band gap, a critical property for semiconductor applications. Electron-beam lithography has been used to fabricate nanostructured graphene with semiconducting behavior. However, the critical nanoscale dimensions needed to open significant band gap are on the threshold of conventional electron-beam lithography capabilities, which are limited by electron scattering effects. Electron-beam lithography also is limited by its throughput and applicability to large-area patterning. An improved technique for forming nanoperforated graphene material that is applicable to large areas is needed.

The Invention

UW–Madison researchers have developed methods to fabricate nanoperforated graphene by etching periodic arrays of nanoscale holes into graphene sheets. The features of the periodic array of holes, including diameter, spacing and constrictions between holes, can be fabricated with dimensions smaller than 20 nm and are designed to provide an electronic band gap of at least 100 meV.

The methods comprise forming an etch mask that defines a periodic array of holes over single or multiple layers of graphene material that has been grown or deposited onto a support material. A perforated structure is formed by depositing and patterning the masking layer onto the graphene via a pattern-defining block copolymer, which may also include a wetting and a neutral layer. Once patterned, the graphene is etched to form interconnected graphene strips that behave as semiconductors with a sufficient band gap. The method provides control over the size and pattern of the holes, which allows the material to be tailored for specific material properties and applications.

Applications

- High performance electronics

- Optoelectronics and photodetectors
- Solar cells
- Magnetic, mechanical and chemical sensing
- Filtration

Key Benefits

- Enables utilization of the material properties of graphene
- Controls feature size to allow tailored material properties
- Allows features with dimensions of less than 20 nm
- Provides electronic band gap of at least 100 meV

Stage of Development

The development of this technology was supported by WARF Accelerator. WARF Accelerator selects WARF's most commercially promising technologies and provides expert assistance and funding to enable achievement of commercially significant milestones. WARF believes that these technologies are especially attractive opportunities for licensing.

Additional Information

For More Information About the Inventors

- Michael Arnold
- Padma Gopalan

Related Intellectual Property

- View Continuation Patent in PDF format.

Publications

- Kim M., Safron N., Han E., Arnold M. and Gopalan P. 2010. Fabrication and Characterization of Large-Area, Semiconducting Nanoperforated Graphene Materials. Nano. Lett. 10, 1125-1131.

Tech Fields

- Semiconductors & Integrated Circuits : Components & materials
- Semiconductors & Integrated Circuits : Design & fabrication

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