Nanopatterning of graphene guided by block copolymer self-assembly

Motivated by the unique and superior properties of graphene, including transistors, integrated circuits, displays, sensors, nanocomposite materials and optical applications, we have pioneered advances in the emerging field of nanopatterned graphene. This PhD project is a part of Center for Nanostructured Graphene (CNG) activities. As compared to pristine graphene, nanopatterned graphene creates a band gap suitable for transistor logic applications, enables functionalization of graphene edges, creates novel magnetic and optical properties, and could be utilized in ultrathin, high-flow filtration applications.

The main purpose of this PhD project is to explore and develop block copolymer self-assembly for generating highly ordered nanostructure graphene with as small as possible neck width and period sizes, which can be utilized in many important applications such as sensors, transistors and optoelectronic devices. Here, we use a novel block copolymer (BCP) self-assembly method for nanolithography. This procedure significantly simplifies the traditional BCP lithography process, showing a wide substrate tolerance and allowing for efficient pattern transfer. Afterward we fabricated uniform suspended nanomesh graphene with the pore size of 24 nm and neck width of 14 nm by using this BC lithography process, combing local photocatalysis. We also achieve large-area fabrication of nanoscale graphene disk and nanomesh arrays, which support plasmon resonances in the near-infrared regime. In the end of this thesis, we functionalize graphene chemically in the presence of the nanoporous mask. These bottom-up BC lithography methods allow the fabrication of arbitrary geometries, with rational control over the graphene nanostructure’s placement, orientation, size, and lateral extent, which paves ways for numerous applications.