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Block Copolymer Directed Assembly for Nanomaterials and Nanodevices

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Block copolymer nanopatterning is a promising technology that can complement the inherent limitations of conventional photolithography. The spontaneous and parallel assembly of block copolymers may generate densely packed, periodic 10-nm-scale nanodomains in a scalable way. Furthermore, laterally ordered, device-oriented nanostructures are attainable by the directed self-assembly principles employing prepatterned substrates. In this presentation, the overview of my research achievements associated to block copolymer nanopatterning will be presented. My research group demonstrated the world-first successful integration of block copolymer nanopatterning with 193 nm ArF lithography. We also developed soft-graphoepitaxy, which generates highly aligned nanoscale metal and semiconductor nanostructures without any trace of structure-directing topographic pattern. Soft-graphoepitaxy could be further developed to ultralarge-area nanopatterning, where micrometer scale photoresist pattern can be completely transformed into large-area block copolymer nanopattern. My research group also developed various pattern transfer methods for block copolymer nanopatterning. Mussel-inspired block copolymer nanopatterning exploiting universal natural adhesive of mussel polydopamine enables the nanopatterning of low surface energy materials, such as gold, Teflon and graphene. Our recent transferrable and flexible nanopatterning employing chemically modified graphene films as pattern substrates makes it possible to apply block copolymer nanopatterning onto arbitrary nonplanar and flexible geometries and generates ideal three-dimensional assembly of carbon nanotubes and graphene.