Self-Folding Graphene Using Surface Modification

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Graphene and other 2D nanomaterials have been extensively studied in their planar state, while for more advanced applications such as wearable and foldable electronics requires the integration of these materials in 3D micro- and nanopatterned geometries. Therefore, the bending, curving and folding of graphene into ordered 3D structures is an important issue, but graphene itself is chemically inert and has homogenously morphology, which cannot be readily folded. In this work, we investigate a variety of surface chemistries to induce functionalities and responsiveness to graphene through non-covalent interaction. More specifically, a thin layer of mussel-inspired polydopamine is first deposited onto graphene, which enables subsequent grafting or adsorption of responsive polymers such as PNIPAM (poly(N-isopropylacrylamide) and polyelectrolytes. The surface modified graphene is then lithographically patterned into arrays with predefined shape, using photolithography or nanoimprint lithography. Once released from the substrate, the patterned graphene can fold into 3D micro or nanostructures in response to an external trigger. By tuning the original graphene size and shape, the patterned graphene can fold into a variety of novel structures that are different from conventional carbon nanostructures, such as carbon nanotubes and fullerenes. We discuss characteristics of these structures and potential applications in electronics, optics and medicine.