Production of 3D-shaped graphene via transfer printing

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Abstract

Graphene has attracted much research interest due to its exceptional mechanical and electronic properties. Graphene is generally considered to be completely flat; however, wrinkles and folds do naturally form in the material. Bends in graphene have been shown to alter its electronic and chemical properties, yet the controlled production of folds and wrinkles in graphene remains relatively unexplored. Intentional formation of folds in chemical vapour deposited graphene by pre-patterning of the copper growth substrate has been previously reported,[1] along with formation of ripples by thermal annealing in suspended graphene[2] and ripple formation due to buckling in graphene ribbons when placed on a strained elastomeric substrate that is subsequently released.[3]

We have developed a novel method to produce three-dimensional folded graphene structures from chemical vapour deposited graphene using a patterned elastomeric stamp and a polymer scaffold.[4] The structures have been characterised using atomic force and scanning electron microscopy, Raman spectroscopy and cyclic voltammetry. Raman spectroscopy reveals doping of the graphene from the polymer substrate, while cyclic voltammetry indicates an increased surface area due to the folding of graphene. This production method provides an alternative means of creating intentional bends in graphene in a controlled manner.

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Figures

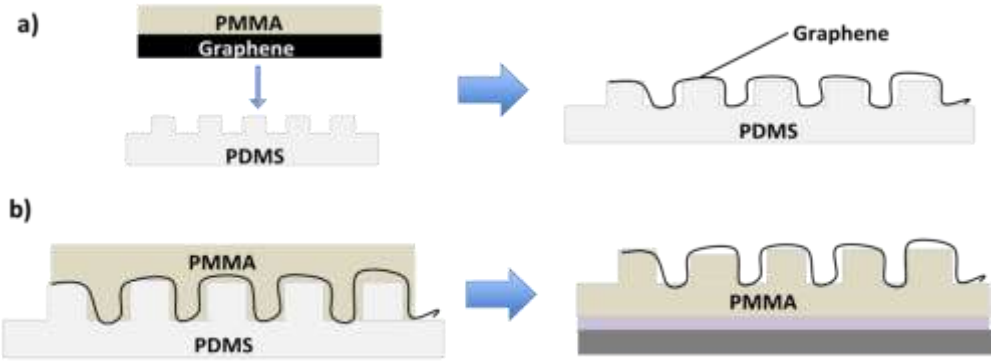

Figure 1 Transfer and printing of graphene. (a) The PMMA/graphene film is lowered onto the PDMS stamp and the PMMA is dissolved. Upon drying, graphene conforms to the shape of the stamp. (b) PMMA is spuncast over the graphene and the PMMA graphene is stamped onto a SiO_2/Si substrate.