Electronic Supplementary Material (ESI) for Lab on a Chip

Supporting Information

Scrolling Graphene into Nanofluidic Channels

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Fabrication Procedures:

We used monolayer CVD graphene grown on copper foil which covers both side of copper foil from Graphene Laboratories Inc. Graphene on one side of the copper foil was etched away using vacuum plasma system (Model: Vita I, Femto Science) with the following parameters: Power: 50W, Time: 2.5 min., Ar: 20 SCCM, Oxygen: 20 SCCM, followed by oxygen plasma treatment for another 2.5 min. However, simple oxygen plasma cleaning units will also work. Graphene on copper foil was then floated on 0.7% (wt./vol.) ammonium persulfate (APS) solution (300 ml) in a dedicated beaker with graphene facing top to the air and exposed copper being in contact with APS. Surface tension keeps copper from sinking. A gold Quantifoil holey carbon TEM grid (Electron Microscopy Sciences, QUANTIFOIL; 200#; 7X7UM GOLD-5) was then gently placed on top of the graphene copper foil with carbon mesh side of the TEM grid facing the graphene. After complete etching of copper foil in APS (~10 hrs), graphene adheres to the TEM grid. The resulting TEM grid with graphene film was rinsed in a clean beaker with di-water (300 ml) by allowing it to float for ~2 hrs with graphene side of the grid facing water.

Separately, another graphene on copper foil (back-side graphene plasma etched) was floated in a dedicated beaker with 300 ml of 0.7% (wt./vol.) APS solution with exposed copper being in contact with the solution. A drop (~3 µl) of water was then placed on top of the floating graphene on copper foil. TEM grid with graphene layer prepared earlier is placed on top of the water drop with graphene side of the grid facing the droplet. After ~10 hours of etching, this grid was rinsed in di-water (300 ml) for two hours by allowing grid to float in a clean beaker. The sample was further heated at 60^0C for 5 minutes prior to loading the grid into the TEM holder.

In addition to the above working process, multiple attempts were made to increase the number of channels encapsulating water. We found these alternative routes to be less effective:

a) Drying the TEM grid that encapsulates water at room temperature (~22^oC) instead of 60^oC resulted in sample with more dirt contaminants over the graphene and channels on TEM grids. Presumably, slow drying attracts contaminants in the air even when grid is covered up by Petri dish.
b) We also prepared two separate grids with monolayer graphene and tried to sandwich water drop in between by clamping these grids. However, we end up with few scrolls. Water was practically absent.

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c) We also varied the concentration of APS to etch and release the last layer of graphene. Increased concentration gave mixed and inconsistent results (i.e. we would get channels or planar sandwich structures with little water at different times).

d) When a drop of water was placed on a single layer of graphene attached to a TEM grid and allowed to dry, we observed only some torn edges of graphene film to scroll.

<u>TEM images of the structures as a result of graphene tearing</u>:

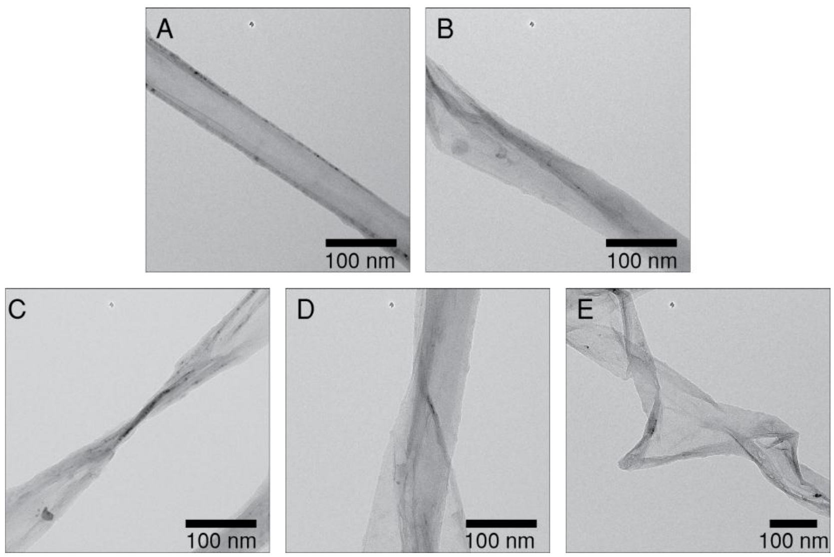

Figure S1. Graphene Structures. In addition to dominant nanochannel structures shown in (A) we also observe formation of different folding geometries shown in (B-E).