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SUPPLEMENTARY INFORMATION
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Graphene nanomesh

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Supplementary Information

1. AFM image of block copolymer pattern with 27 nm periodicity.
2. TEM image of few-layer graphene nanomesh.
3. Low magnification TEM image of GNM structure.
4. TEM image of a GNM with ~5 nm neck width.
5. Transistor characteristics of another high on-off device.
6. Assembly of block copolymer pattern directly on top of graphene.

1. AFM image of block copolymer pattern.

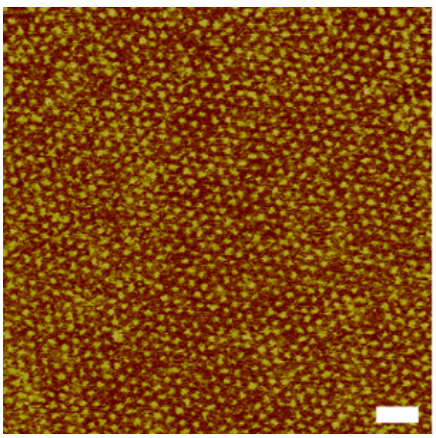

Figure S1| AFM tapping mode phase contrast image of block copolymer (with molecular weight of 47700 g mol^{-1}) pattern on top of SiO_x/graphene. The obtained periodicity is around 27 nm. The scale bar indicates 100 nm.

2. TEM image of few-layer graphene nanomesh.

We first use optical microscope, Raman spectrometry or AFM to distinguish and locate few-layer graphene on silicon oxide substrate, from which GNM is fabricated

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using the method describe in the paper. In order to obtain the TEM image of the GNM from exactly the same graphene flakes observed in optical microscope, E-beam lithography was used to produce metal marker on top of graphene before the HF lift-off process.

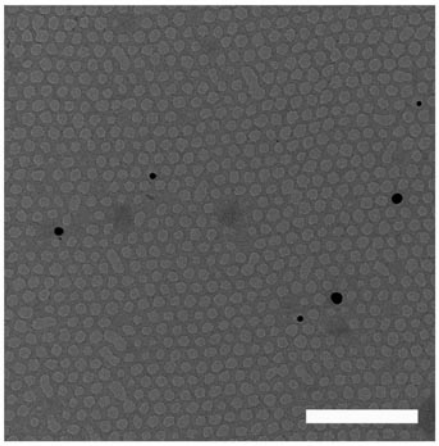

Figure S2| TEM image of few-layer graphene nanomesh. Scale bar indicates 200 nm.

3. Low magnification TEM images of nanomesh.

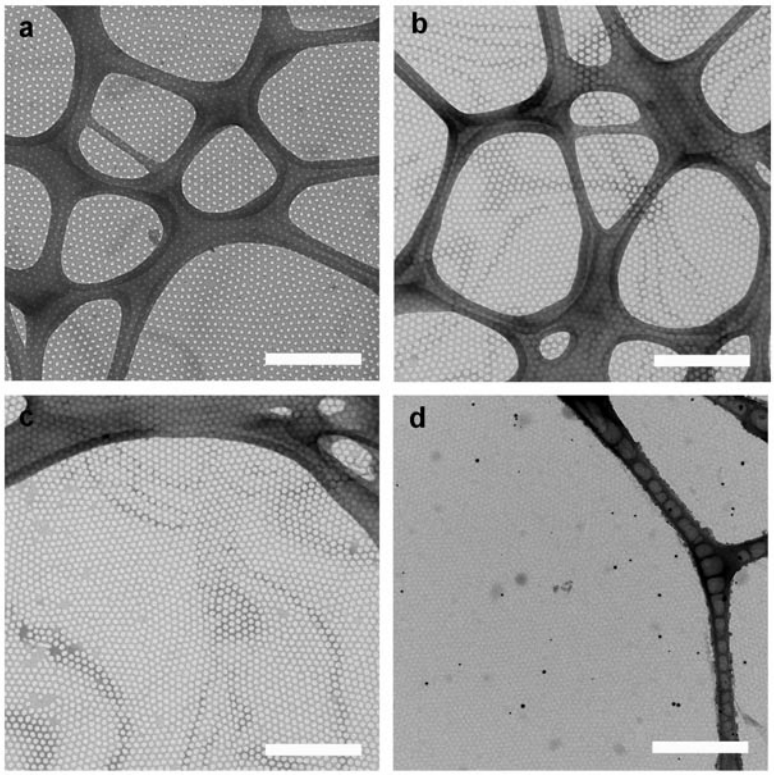

Figure S3| Low magnification TEM image of GNMs with periodicity of 39 nm and neck width of (**a**)14.6 nm, (**b**) 11.2 nm, (**c**) 7.1 nm, and (**d**) periodicity of 27nm and neck

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width 7.8 nm. All scale bars indicate 500 nm. The nanomesh structure can extend up to several microns. The only limitation is the size of graphene flakes, indicating the possibility to fabricate such nanomesh structure on wafer scale, in conjunction with the recent advances in growth of graphene over large area substrate[1,2].

4. TEM image of a GNM with ~5 nm neck width.

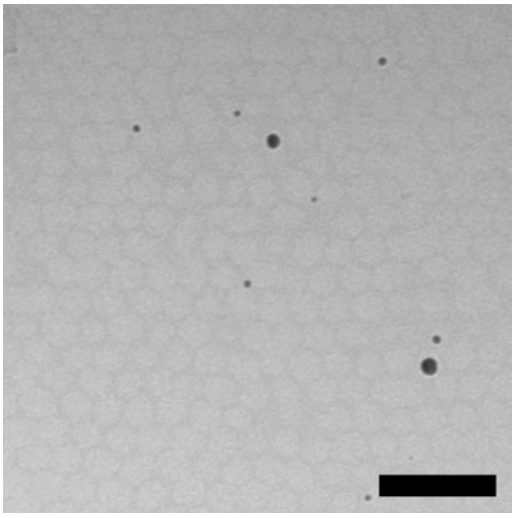

Figure S4| TEM image of graphene nanomesh with neck width of ~5 nm. Scale bar indicates 100 nm.

5. Transistor characteristics of another high on-off device.

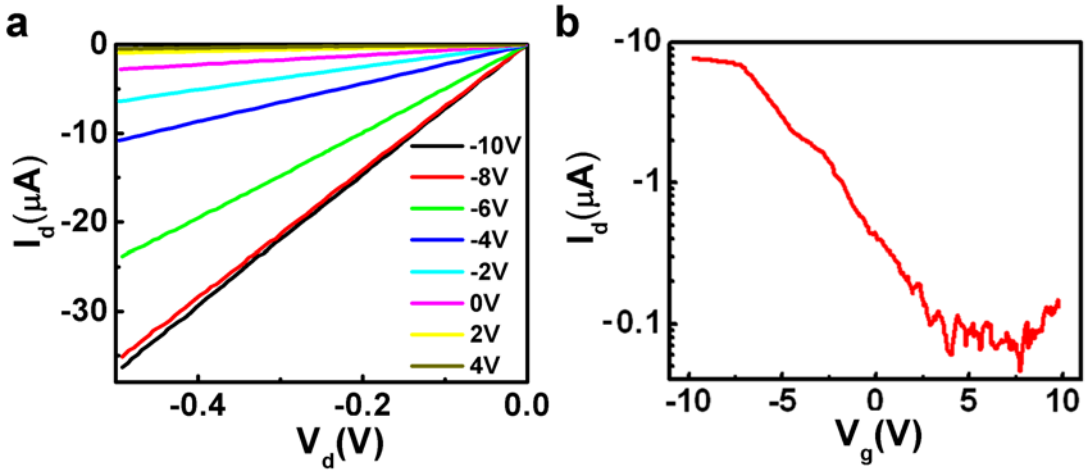

Figure S5| Device characteristics for a high on-off (~100) GNM device. (**a**) Output I_d-V_d relation at variable gate voltages for the device. The device has a channel width 3.5 μm and channel length 2 μm. (**b**) Transfer characteristics I_d-V_g at V_d=-100 mV.

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6. The role of evaporated silicon oxide layer and alternative.

The evaporated SiO_x on top of graphene served as the substrate to anchor the neutral random copolymer layer P(S-r-MMA). The interactions between the random copolymer and the PS block, and between the random copolymer and the PMMA block are balanced so that the vertical aligned domains will form. One may argue whether graphene itself can serve as the neutral layer to assemble vertical aligned domains. We performed block copolymer assembly directly on pristine graphene. However, we didn't obtain the hexagonal packed domains, instead, random placed holes and shallow trenches show up after removing PMMA domain (Fig. S6a), suggesting graphene surface can not serve as effective neutral layer in the case of P(S-b-MMA) nanopatterning.

As an alternative to use evaporated SiO_x or other oxide to anchor the neutral polymer (additional etching step is required with oxide layer), we can directly neutralize the graphene surface by using P(S-r-benzocyclobutene(BCB)-r-MMA) instead of P(S-r-MMA)[3]. Unlike P(S-r-MMA), which will diffuse away with thermal treatment, the P(S-r-BCB-r-MMA) thin film will thermally cross link by annealing at 250 °C, resulting in relatively stable neutral layer on top of graphene. Figure S6b shows ordered PS nanomesh (PMMA has been removed) on top of graphene with cross-linked neutral brush layer. From this, GNMs can be easily prepared only by controlled O_2 plasma etching. The disadvantage is that it is difficult to separate the polymer from the resulting GNM. Extensive high temperature annealing is needed to remove the polymer residues.

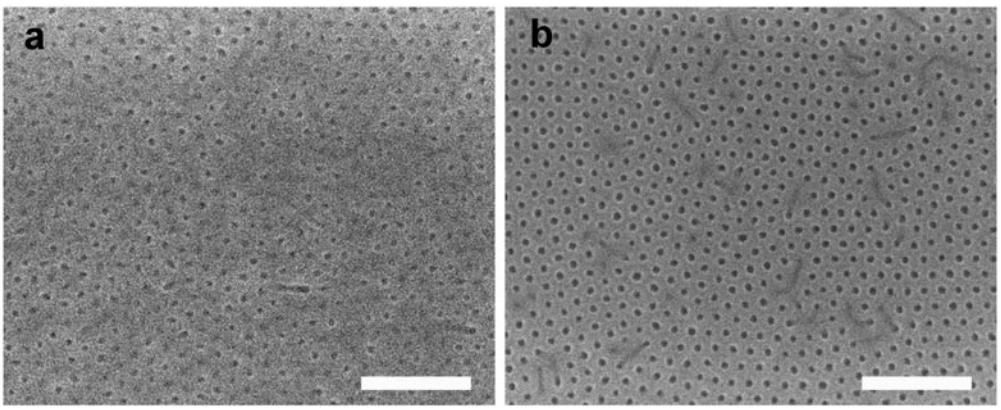

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Figure S6| SEM image of PS mesh on top of graphene after dissolving PMMA domain. (**a**) Disordered pattern with shallow holes formed directly on top of graphene when no random copolymer neutral layer is applied; (**b**) Hexagonal patterned PS mesh obtained on graphene with cross-linked random copolymer neutral layer. All scale bars indicate 200 nm.

Reference

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