Supporting Information for

Charge-transport-driven selective oxidation of graphene

Young Keun Lee,^{a,b} Hongkyw Choi,^c Changhwan Lee,^{a,b} Hyunsoo Lee,^{a,b} Kalyan C Goddeti,^{a,b} Song Yi Moon,^{a,b} Won Hui Doh,^{a,b} Jaeyoon Baik,^d Jin-Soo Kim,^c Jin Sik Choi,^c Choon-Gi Choi,^c and Jeong Young Park*^{a,b}

^aCenter for Nanomaterials and Chemical Reactions, Institute for Basic Science(IBS), Daejeon 305-701, Korea

^bGraduate School of EEWS, Korea Advanced Institute of Science and Technology(KAIST), Daejeon 305-701, Korea

^cCreative Research Center for Graphene Electronics, ETRI (Electronics and Telecommunications Research Institute), Gajeongno, Yuseong-gu, Daejeon, 305-700, Republic of Korea

^dPohang Accelerator Laboratory, Pohang University of Science and Technology, Pohang 790-784, Korea

^{*}To whom correspondence should be addressed. E-mail: jeongypark@kaist.ac.kr



Figure S1. Photoluminescence spectra of graphene/TiO₂ as a function of UV–ozone treatment time.

After UV–ozone treatment, photoluminescence (PL) spectra of graphene on TiO_2 were measured as a function of UV–ozone exposure time. The TiO_2 was annealed at 400 °C. PL peaks at about 715 nm are visible for the UV–ozone treated graphene, while there is no peak observed for the graphene without UV–ozone treatment.



Figure S2. (a) Raman spectra of graphene on SiO₂ as a function of UV–ozone exposure time. (b) Raman spectra and the value of L_D of graphene on the TiO₂ layer as a function of UV–ozone exposure time. The TiO₂ layer was annealed at 400 °C for 3 hours. The TiO₂ exhibits the anatase phase.



Figure S3. Scanning electron microscopy image of patterned TiO_2 on SiO_2 using a metal grid.



Figure S4. Current–voltage curves measured on the graphene/TiO₂ diode dependent on UV– ozone treatment.



Figure S5. Topographic (left, yellow) and friction (right, green) images obtained on graphene/triangle-shaped TiO₂ dependent on UV-ozone exposure. (a) Triangle-shaped TiO₂ on SiO₂, (b) graphene/triangle-shaped TiO₂ on SiO₂ without UV-ozone treatment, (c) graphene/triangle-shaped TiO₂ on SiO₂ after UV-ozone treatment for 15 minutes.

The topographic and friction images were obtained using friction force microscopy (Agilent 5500) at ambient conditions. A Si tip (PPP–LFMR–50) with a typical force constant of 0.2 N/m was used. Selective interaction between the graphene and substrate by charge transfer can facilitate nanoscale patterning of the modified graphene. Figure S5 confirms the modification of graphene on the triangle-shaped nanoscale patterning of TiO₂ by measuring the change in friction. The dotted red circles represent the previous positions of the monolayer of silica spheres for patterning of the triangle-shaped TiO₂ on SiO₂ substrate using the Langmuir–Blodgett technique (Figure S6). The shape of the triangle nanostructure of the

 TiO_2 on SiO_2 was confirmed by the topographic images in Figure S5. The friction signal matches well with the topographic image; friction on the SiO_2 was higher than that on the TiO_2 . After deposition of graphene on the nanoscale triangle-shaped TiO_2 and SiO_2 substrate, the friction was reversed such that the graphene/ TiO_2 exhibited a higher friction value than that of graphene/ SiO_2 . After 15 minutes of UV–ozone treatment, the friction signal was readily distinguishable on the graphene/triangle-shaped TiO_2 from the graphene on the SiO_2 because the friction increased when the graphene was oxidized.¹ The behavior of the change in friction represents the nanoscale selectivity of the graphene modification using the nanostructure of the TiO_2 , finally suggesting the possibility for feasible applications of graphene-based nanoscale electronics.



Figure S6. Scanning electron microscopy image of the monolayer of silica nanospheres (~290 nm) on the SiO₂ substrate using the Langmuir–Blodgett technique for formation of nanoscale triangle-shaped TiO_2 on SiO₂.

Reference

1. J. H. Ko, S. Kwon, I. S. Byun, J. S. Choi, B. H. Park, Y. H. Kim and J. Y. Park, *Tribol. Lett.*, 2013, **50**, 137-144.