Supporting Information

In Figure S1(a), the rapid-thermal pulse steps for the deposition of the graphene were described in detail and the variations of the pressures in the growing chamber were also indicated in the each step. In the growth steps, the exposure step for 60 s in H_2 (a flow rate of 10 sccm (standard cubic centimeters per minute)) atmosphere after graphene growth was especially established to improve the quality of the graphenes. In order to investigate the necessity of the exposure step, Raman spectra of the graphene grown by the exposure for 60 s with and without H_2 were shown in Figure S1(b). The G band of ~ 1580 cm^{-1} and the G' (2D) band of ~ 2700 cm^{-1} were clearly observed and the absence of D peak (~ 1360 cm^{-1}) corresponds to very low defect density. Graphene grown by the exposure alone without H_2 showed an intensity ratio of I_G/I_{2D} = 0.47, compared with the 0.38 in the films grown by an exposure in the H_2 ambient. This result suggests that the quality of graphenes can be improved by the exposure in the H_2 ambient after growth of the graphene.

Figure S2 shows the AFM and optical images of the graphenes etched for different argon plasma powers for 30 min. Transferred graphene (see Fig. S2(a)) onto the SiO_2/Si substrate showed severe wrinkles having a root mean square (rms) roughness of about 4.4 nm. The optical image shown in an inset clearly showed an existence of the graphene. As shown in Figs. S2(b) and S2(c), wrinkles and the amount of graphenes were gradually reduced with increasing rf power. However, graphenes still remained at an rf power of 50 W, which is a limited power of the plasma equipment used in the present study. From the relationship between the rms roughness and the plasma power shown in Fig. S2(d), roughness of the graphene gradually decreased with increasing plasma power, which indicates an etching of the graphene. Figure S3 shows the AFM and optical images of the graphenes etched for different times at an argon plasma power of 50 W. As shown in Figs. S3(a), S3(b), and S3(c), wrinkles and the amount of graphenes were abruptly decreased with increasing etching time. The graphene etched for 60 min (see Fig. S3(c)) were completely removed, indicating no graphene from the optical image shown in an inset. Figure S3(d) shows the linear decrease of the rms roughness with increasing etching time, indicating an rms roughness of about 0.3 nm at an etching time of 60 min. When the SiO_2/Si substrate itself was etched for 60 min at argon plasma of 50 W, it showed an rms roughness of about 0.2 nm (not shown here). Therefore, etching results suggest that the graphenes are completely removed under the conditions of the rf plasma power, 50 W and the etching time, 60 min. From the etching results, graphene was selectively etched for the electrode applications of the transparent capacitor.

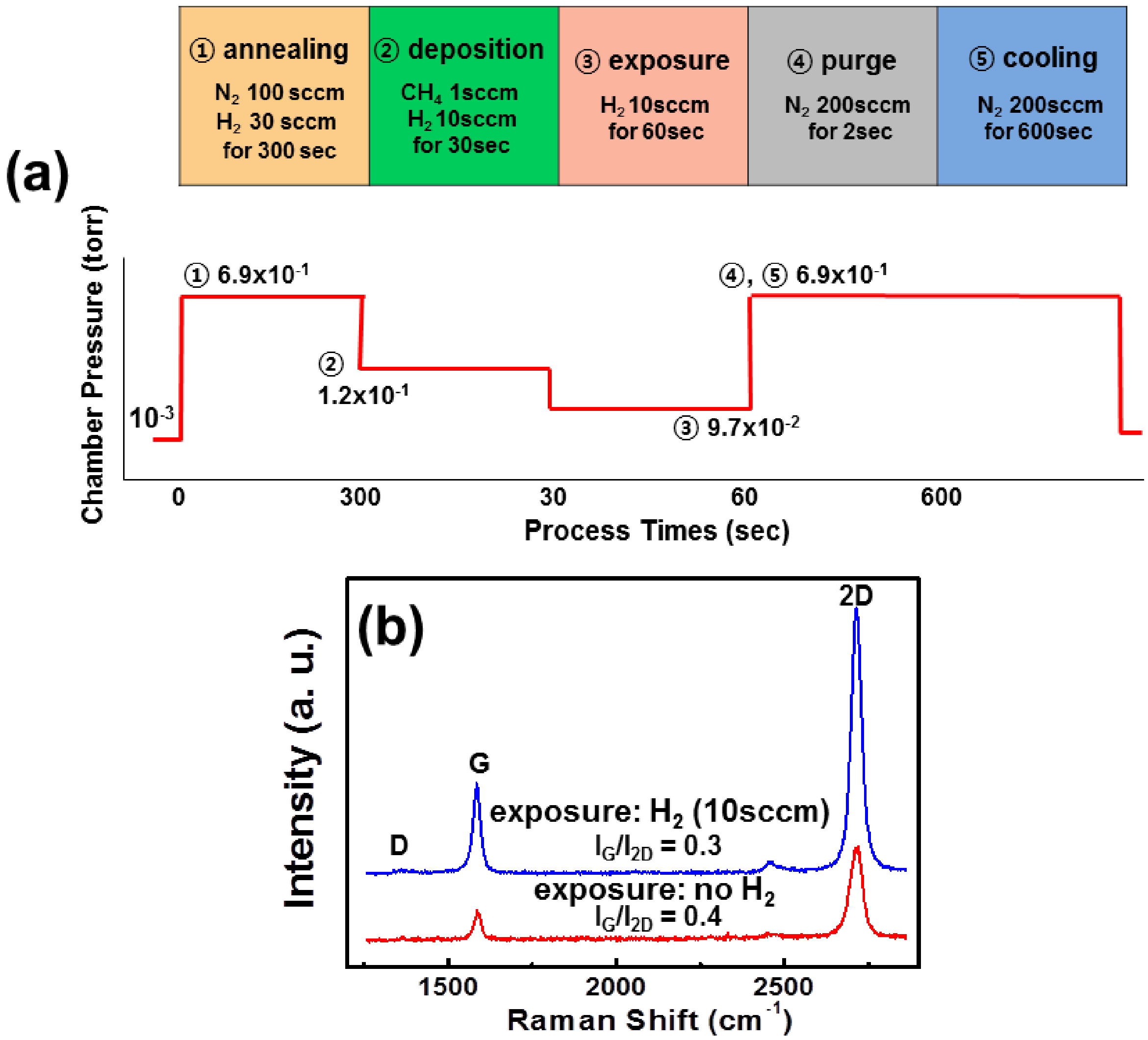

Figure S1. a) Deposition conditions and the working pressure at each step and b) Raman spectra of the graphene grown by the exposure for 60 s with and without H_2.

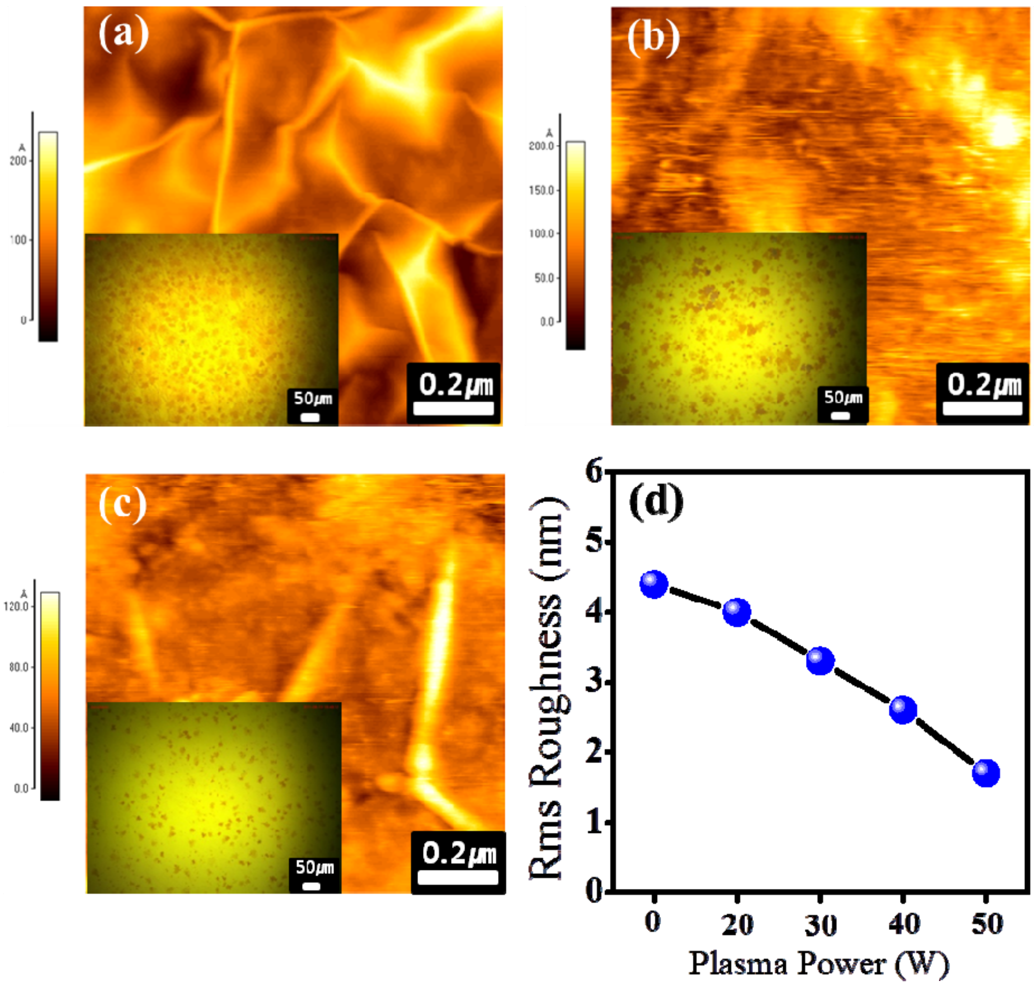

Figure S2. AFM and optical images of the graphenes etched for the argon plasma powers of (a) 0, (b) 30, (c) 50 W for 30 min. (d) Relationship between the rms roughness of the graphene and the plasma power for etching time of 30 min.

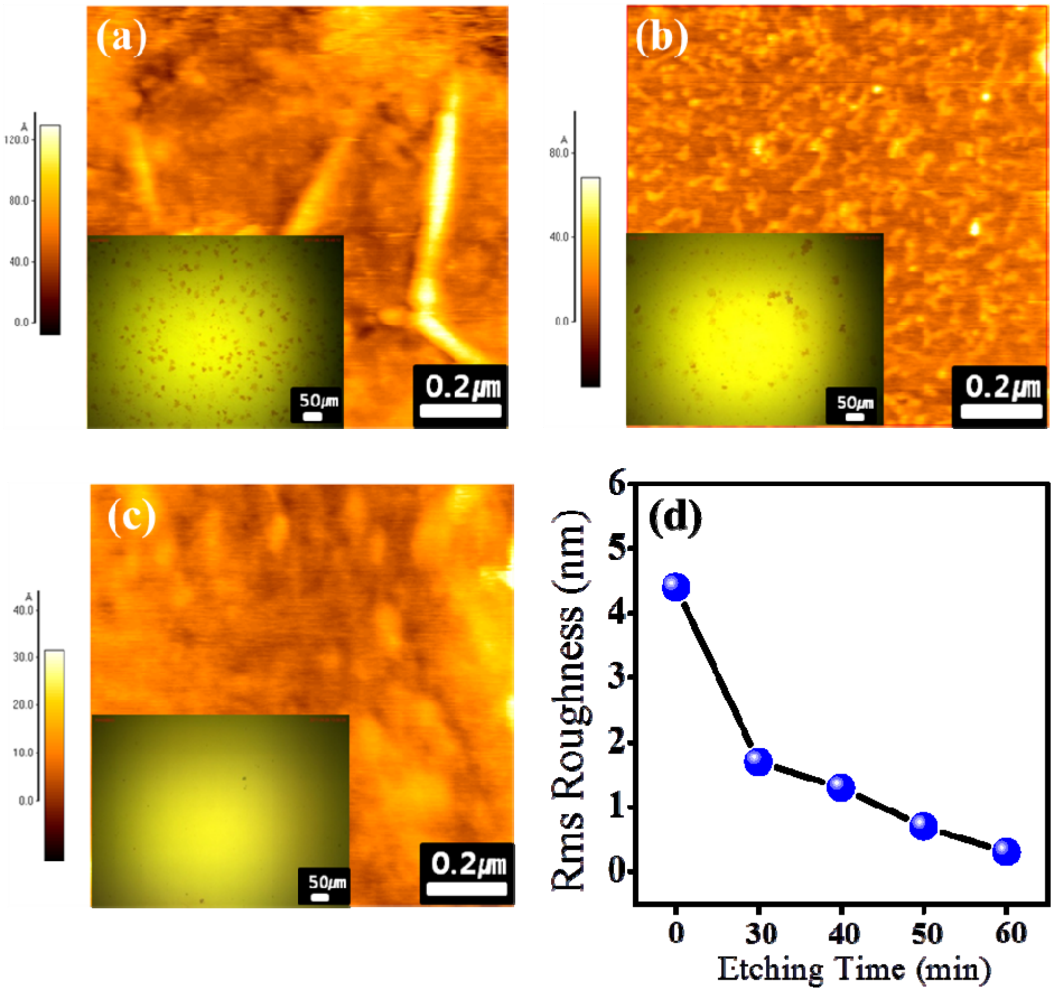

Figure S3. AFM and optical images of the graphenes etched for the etching time of (a) 30, (b) 50, (c) 60 min at an rf power of 50 W. (d) Relationship between the rms roughness of the graphene and the etching time at an rf power of 50 W.

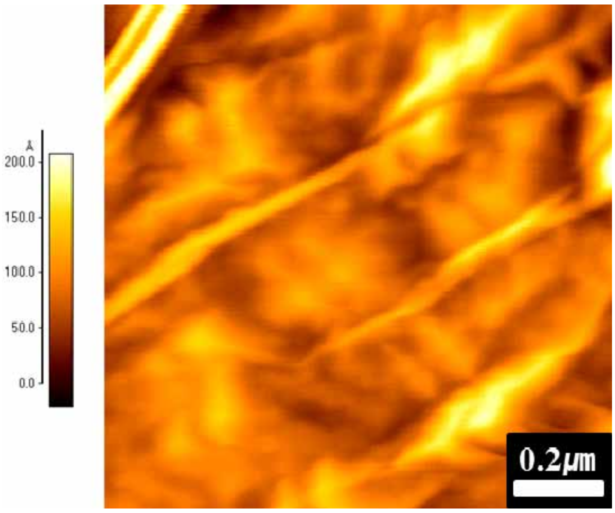

Fig.S4 Atomic force microscopic image of the graphene transferred onto the BMNO/graphene/Ti/glass