

Supporting Information

All-solid-state Reduced Graphene Oxide Supercapacitor with Large Volumetric Capacitance and Ultra-long Stability Prepared by Electrophoretic Deposition Method

Mei Wang¹, Le Dai Duong¹, Nguyen Thi Mai¹, Sanghoon Kim¹, Youngjun Kim², Heewon Seo², Ye Chan Kim¹, Woojin Jang², Youngkwan Lee³, Jonghwan Suhr^{1,2}, and Jae-Do Nam^{1,2*}

¹Department of Energy Science, Sungkyunkwan University, Suwon, 440-746 (S. Korea)

²Department of Polymer Science and Engineering, Sungkyunkwan University, Suwon, 440-746 (S. Korea)

³Department of Chemical Engineering, Sungkyunkwan University, Suwon, 440-746 (S. Korea)

*Corresponding author:

Jae-Do Nam

Email: jdnam@skku.edu

Tel.: +82-31-290-7285

Fax: +82-31-292-8790

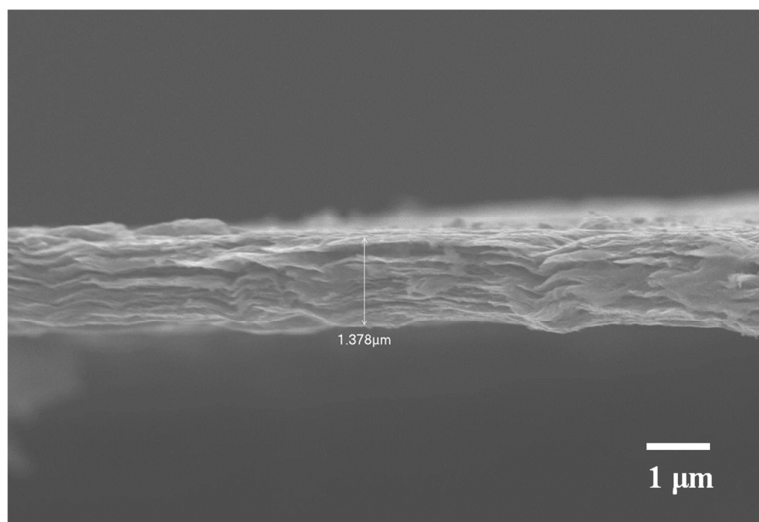


Figure S1. SEM image of cross-sectional RGO membrane, showing the layer-by-layer morphology with thickness of 1.378 μm.

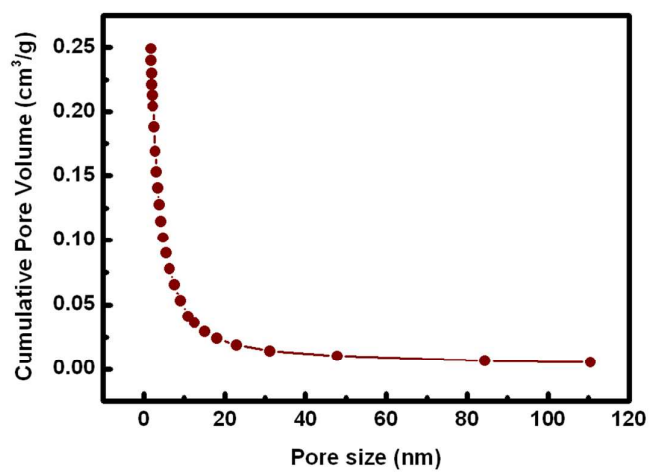


Figure S2. Cumulative pore volume as a function of pore width measured using nitrogen adsorption isotherm of RGO.

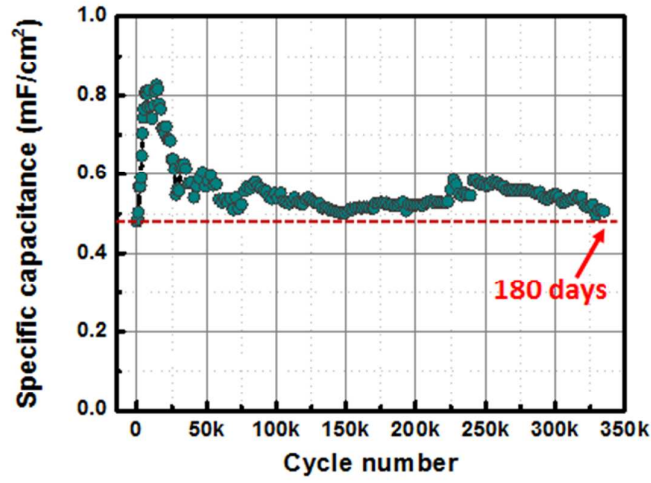


Figure S3. Cycle ability test of RGO all-solid-state supercapacitor measured by galvanostatic charge/discharge at the current of 0.2 mA, in terms of specific areal capacitance as a function of cycle number.

From the EIS measurement, the frequency responses of capacitances (C_A and C_{Vol}) are estimated using the following equation:

$$C_A = \frac{1}{2\pi f A Z''(f)}, \quad C_{Vol} = \frac{1}{2\pi f V_{ol} Z''(f)} \quad (3)$$

where f is the frequency and $Z''(f)$ is imaginary part of the impedance. The C_A and C_{Vol} are plotted as a function of frequency, as presented in Figure 4c.

The specific volumetric capacitance of the RGO supercapacitor can be described by using $C'(f)$ and $C''(f)$, which are expressed as functions of frequency²:

$$C'(f) = \frac{Z''(f)}{2\pi f A |Z(f)|^2}, \quad C''(f) = \frac{Z'(f)}{2\pi f A |Z(f)|^2} \quad (4)$$

where $C'(f)$ and $C''(f)$ are the real and imaginary parts of specific capacitance, $Z'(f)$ is the real part of the impedance, and $|Z(f)|$ is the absolute value of the impedance¹.

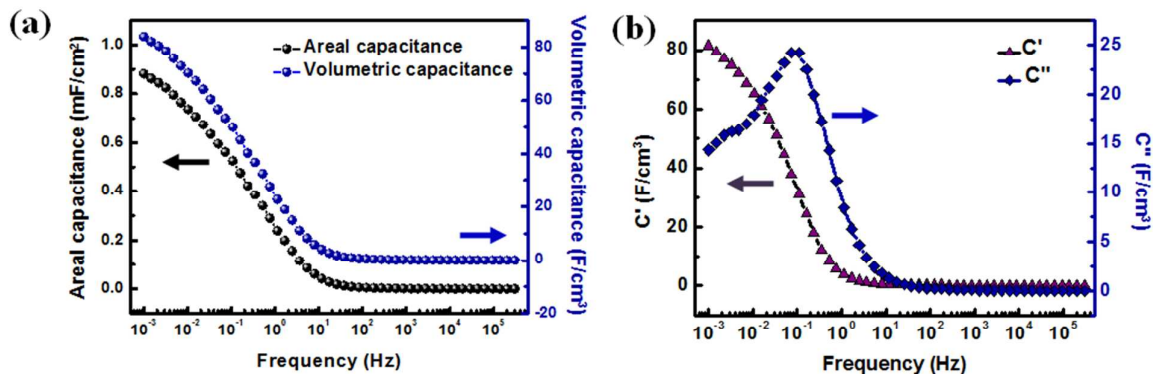


Figure S4. (a), Areal and volumetric capacitances as functions of frequency. (b), Plots of the real and imaginary parts (C' and C'') of specific volumetric capacitance versus frequency.

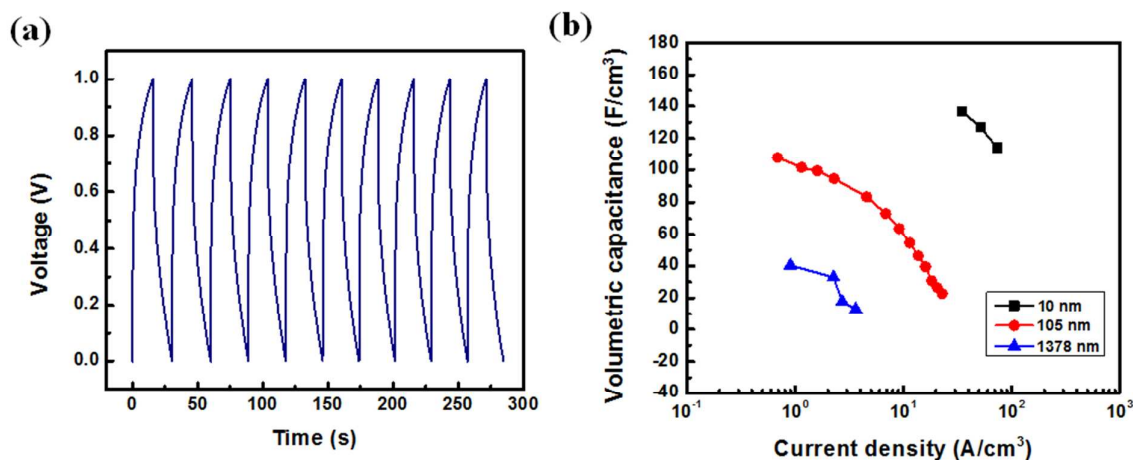


Figure S5. (a), Galvanostatic CD measurement of all-solid-state supercapacitor with RGO electrode thickness of 1.378 μm at 0.5 mA. (b), Volumetric capacitance of RGO all-solid-state supercapacitor as a function of current density. The thicknesses of the supercapacitor RGO electrodes are 10, 105, 1378 nm, respectively.

Reference

1. Lin, J.; Zhang, C.; Yan, Z.; Zhu, Y.; Peng, Z.; Hauge, R. H.; Natelson, D.; Tour, J. M. 3-Dimensional Graphene Carbon Nanotube Carpet-Based Microsupercapacitors with High Electrochemical Performance. *Nano Lett.* **2013**, 13, 72-78.