Supporting Information

Advanced Hybrid Supercapacitor Based on Mesoporous Niobium Pentoxide/Carbon as High-Performance Anode

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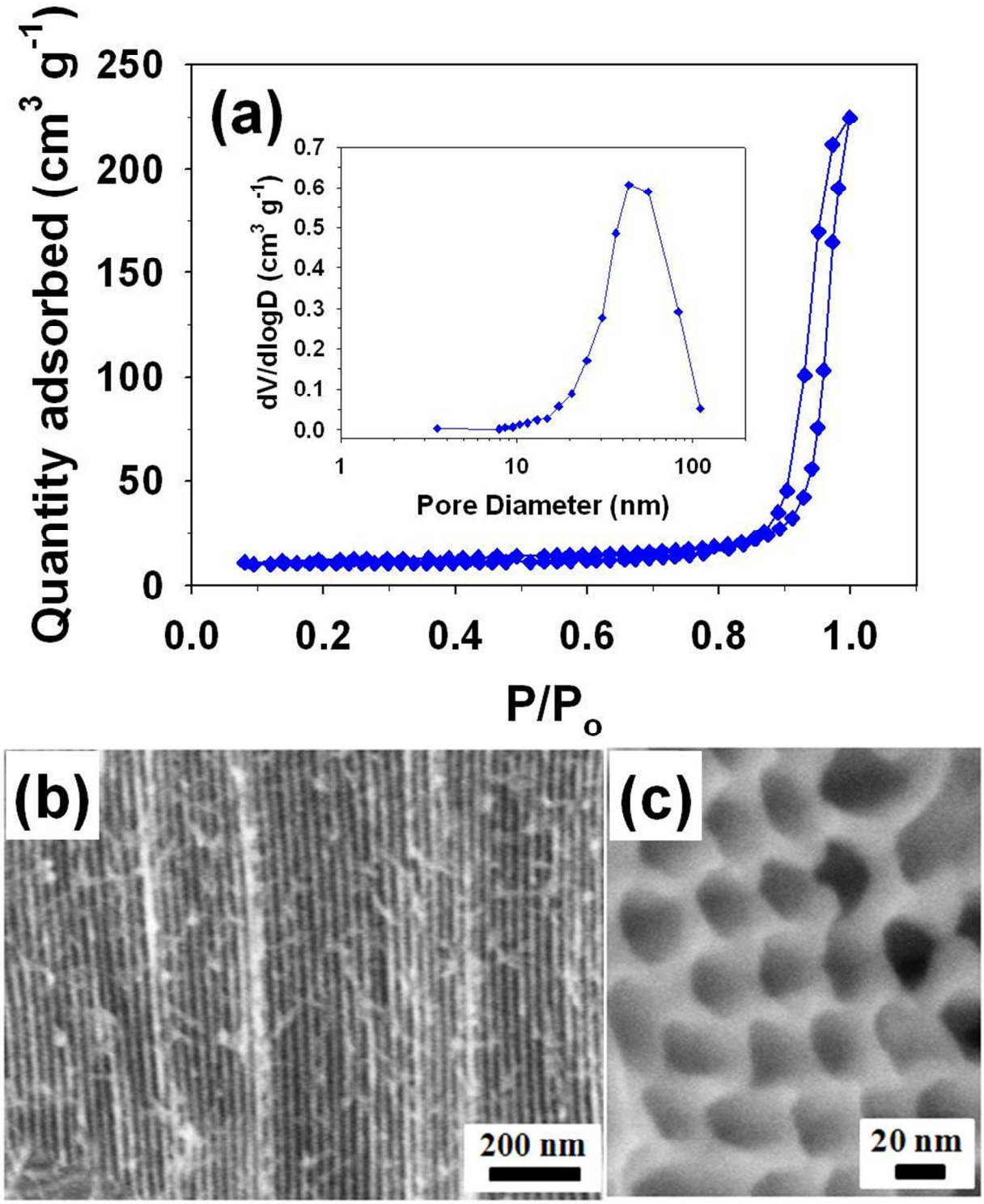

Figure S1. (a) N_2 adsorption-desorption isotherm for m-Nb_2O_5 and the corresponding pore size distribution. SEM images of (b) as-synthesized Nb_2O_5 and (c) m-Nb_2O_5.

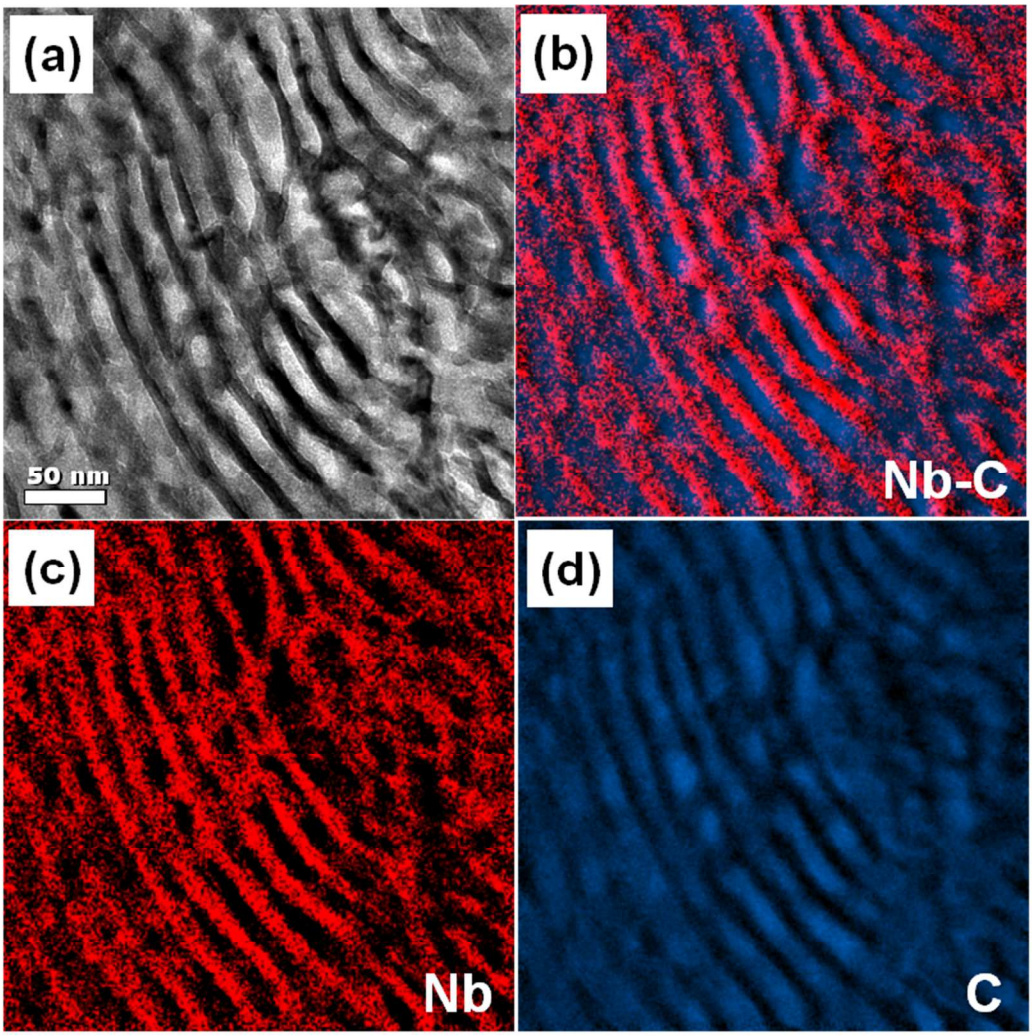

Figure S2. Electron microscopy images. (a) microtomed TEM image of m-Nb_2O_5-C (b, c, d) EELS mapping images of the (b) Nb-C, (c) Nb, and (d) C.

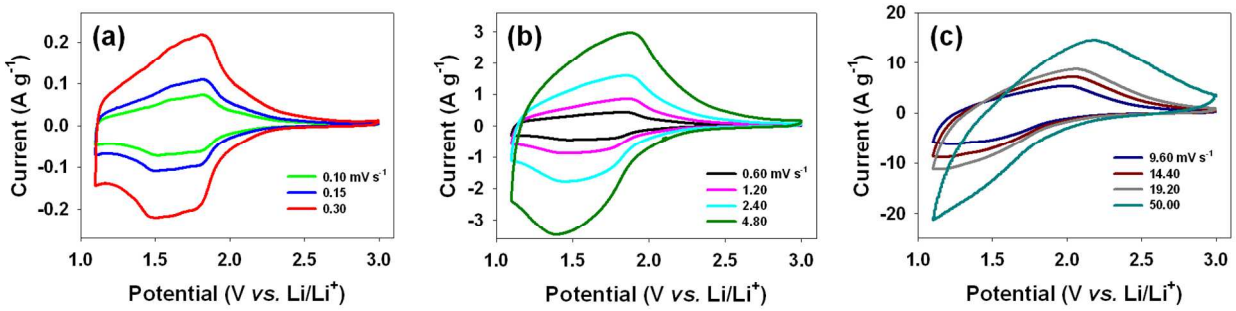

Figure S3. CV analysis of m-Nb_2O_5-C at different sweep rates (a) from 0.10 to 0.30 mV s^{-1}, (b) from 0.60 to 4.80 mV s^{-1}, and (c) from 9.60 to 50.00 mV s^{-1}. The distorted CV profiles at high scan rates are inevitable due to a variety of resistances resulting from coin-type cells.

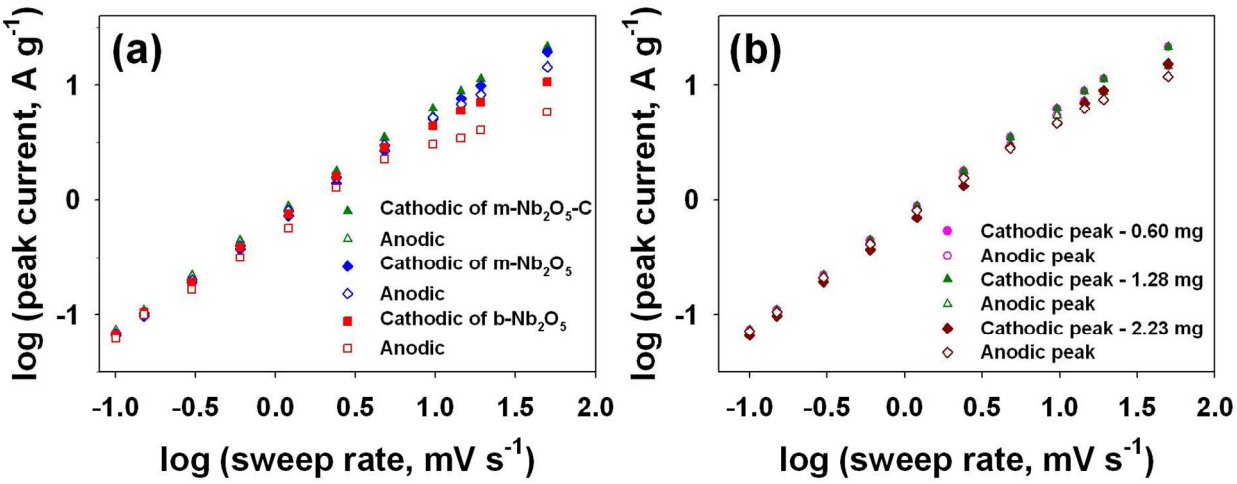

Figure S4. Specific peak current with respect to various sweep rates of (a) m-Nb_2O_5-C, m-Nb_2O_5, and b-Nb_2O_5 and (b) different mass loadings of m-Nb_2O_5-C between 0.1 and 50 mV s^{-1}.

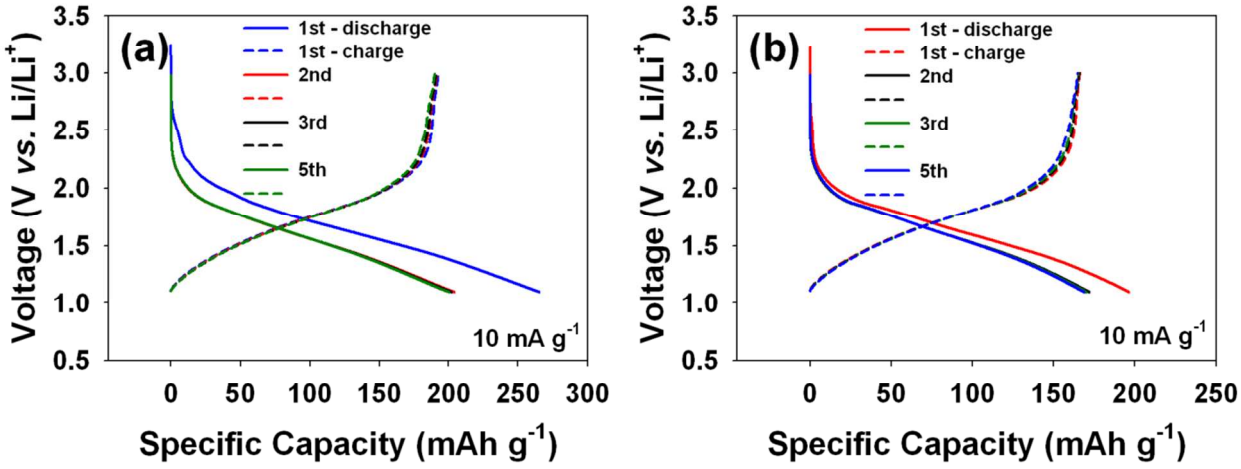

Figure S5. Charge-discharge voltage profiles of (a) m-Nb_2O_5 and (b) b-Nb_2O_5 at 10 mA g^{-1}.

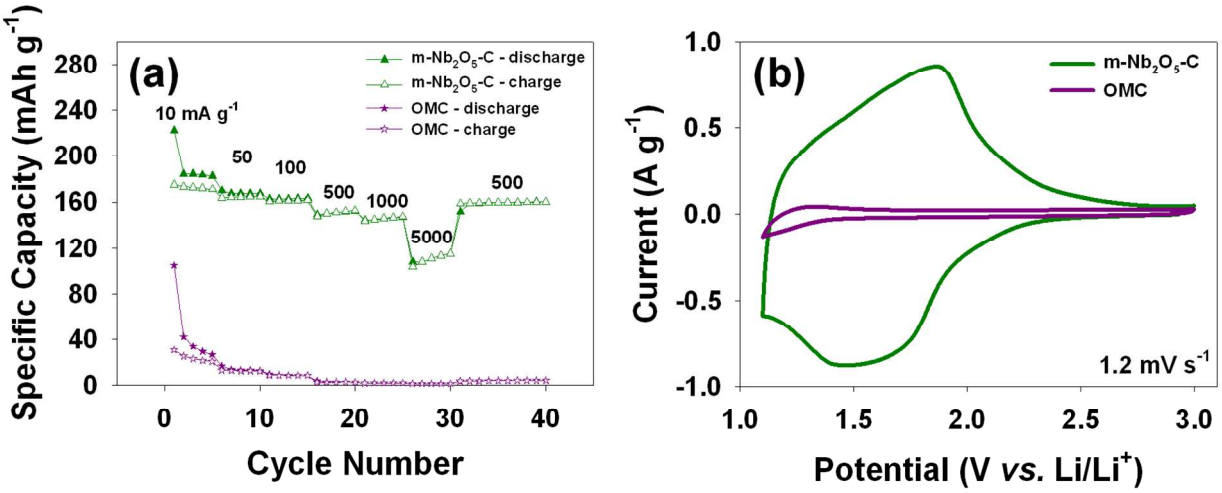

Figure S6. (a) Comparison of capacities of the m-Nb_2O_5-C/Li and ordered mesoporous carbon (OMC)/Li half cells under different current densities varying from 10 to 5000 mA g^{-1}. (b) CV analysis at 1.2 mV s^{-1} for the m-Nb_2O_5-C/Li and OMC/Li half cells (OMC, main pore size: 32 nm, specific surface area: 521 m^2 g^{-1}).

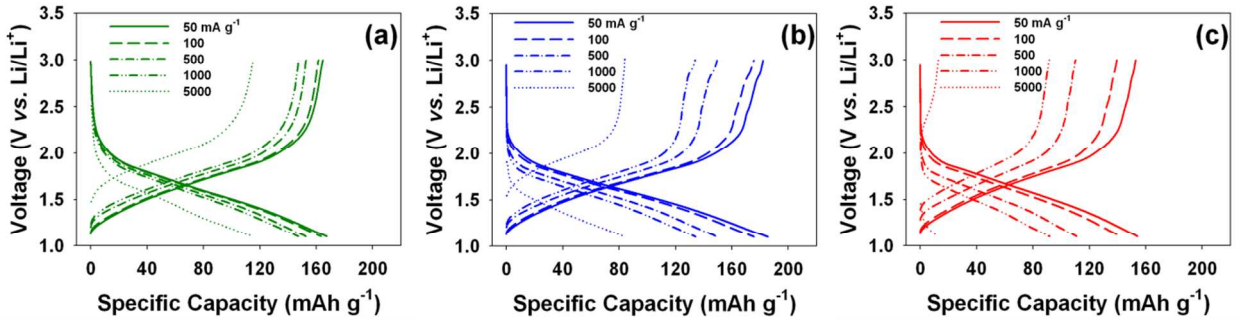

Figure S7. Charge-discharge voltage profiles of (a) m-Nb_2O_5-C, (b) m-Nb_2O_5, and (c) b-Nb_2O_5 at various current densities (50 to 5000 mA g^{-1}).

Table S1. The electrical conductivity of m-Nb_2O_5-C and m-Nb_2O_5.

Sample	Electrical conductivity (S cm^{-1})
m-Nb_2O_5-C	3.49×10^{-3}
m-Nb_2O_5	1.44×10^{-7}

The electrochemical conductivity was measured by using Van der Pauw four-probe methods.[1]

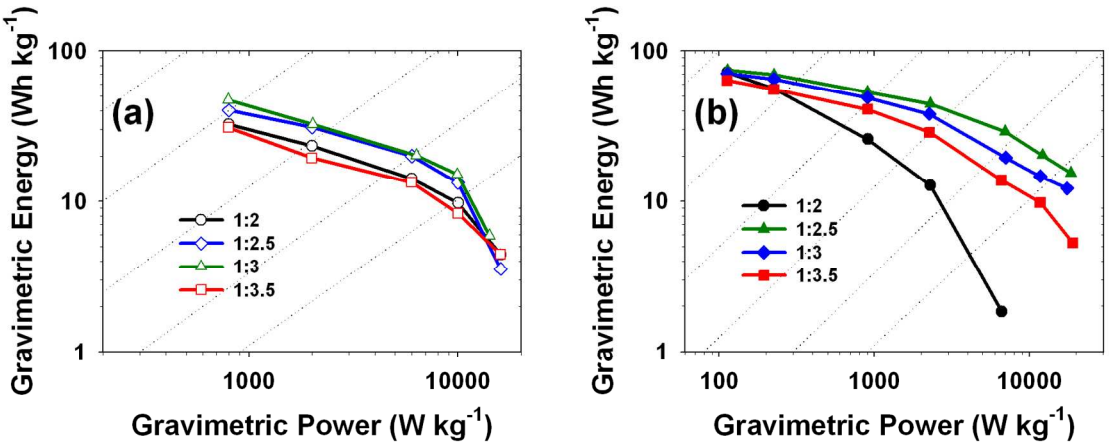

Figure S8. Ragone plots of hybrid supercapacitors based on m-Nb_2O_5-C and MSP-20 with different mass ratio of anode and cathode active materials in the voltage range of (a) 0.5-3.0 V and (b) 0.5-3.5 V.

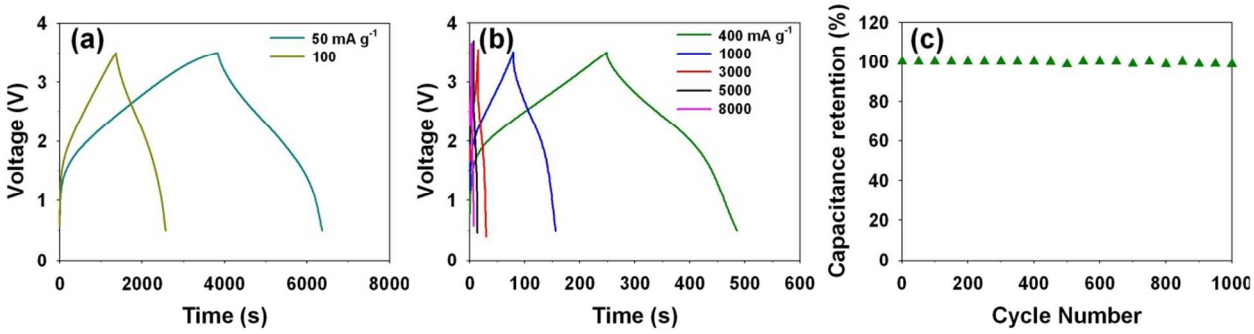

Figure S9. (a, b) Charge-discharge profiles of hybrid supercapacitor based on m-Nb_2O_5-C anode between 0.5 and 3.5 V at different current rates. (c) Cycling performance of hybrid supercapacitor based on m-Nb_2O_5-C anode between 0.5 and 3.5 V at a current rate of 5000 mA g^{-1}.

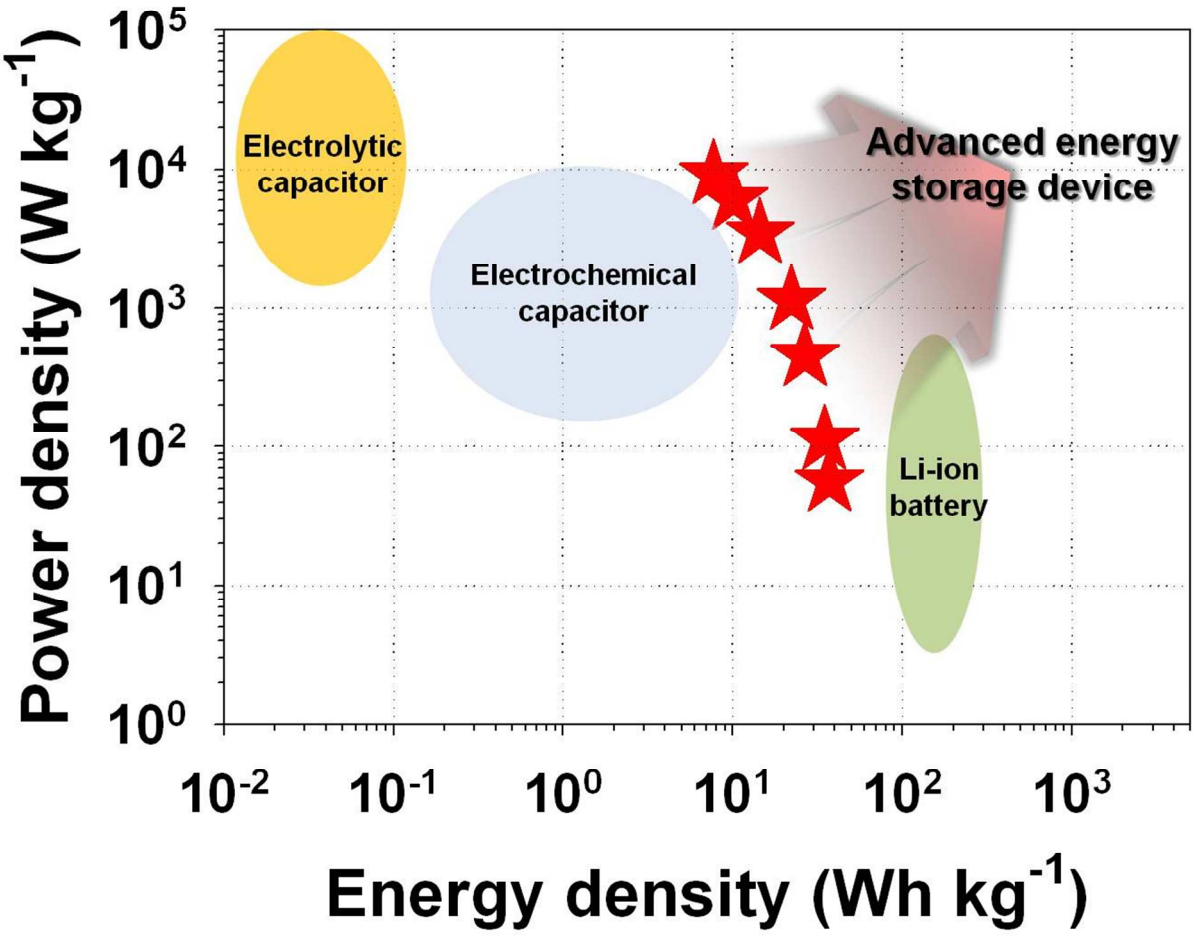

Figure S10. Ragone plots of commercial energy storage devices and the hybrid supercapacitor using m-Nb_2O_5-C (★). In order to consider commercialization of the hybrid supercapacitor using m-Nb_2O_5-C, the gravimetric energy and power densities of the hybrid supercapacitor using m-Nb_2O_5-C (★) were calculated by dividing the values of the energy and power densities of the electrode by a factor of 2.[2-4]

REFERENCES AND NOTES

1. Kang, E.; An, S.; Yoon, S.; Kim, J. K.; Lee, J. Ordered Mesoporous WO_{3-x} Possessing Electronically Conductive Framework Comparable to Carbon Framework toward Long-Term Stable Cathode Supports for Fuel Cells. *J. Mater. Chem.* **2010**, 20, 7416-7421.
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4. Kim, H.; Cho, M.-Y.; Kim, M.-H.; Park, K.-Y.; Gwon, H.; Lee, Y.; Roh, K. C.; Kang, K. A Novel High-Energy Hybrid Supercapacitor with an Anatase TiO_2-Reduced Graphene Oxide Anode and an Activated Carbon Cathode. *Adv. Energy Mater.* **2013**, 3, 1500-1506.