Electronic supplementary information

for

Hydrothermally encapsulating VO_2(A) nanorods into amorphous carbon by the carbonization of glucose as energy storage device

by

Jiqi Zheng, Yifu Zhang*, Qiushi Wang, Hanmei Jiang, Yanyan Liu, Tianming Lv, Changgong Meng

Synthesis of pure VO_2(A) nanomaterials

VO_2(A) nanomaterials was synthesized according to the previous report (*Solid State Commun.*, **2012**, *152*, 253) and modified. In a typical run, 1.82 g commercial V_2O_5 was dispersed into the mixture of 60 mL H_2O and 10 mL ethanol under magnetic stirring at a room temperature for 30 min. The solution was transferred into a 100 mL Teflon Lined stainless steel autoclave, which was sealed and maintained at 180 °C for 96 h. The as-synthesized sample was filtered off and washed several times with deionized water and ethanol, respectively, and then dried in vacuum for use. Then 0.71 g of the as-obtained sample VO_2(B) was dispersed into 60 mL H_2O and transferred to a 100 mL Teflon Lined stainless steel autoclave, which was heated at 220 °C for 12 days. The as-synthesized sample was filtered off and washed several times with deionized water and ethanol, respectively, and then dried in vacuum at 75 °C. XRD pattern (Fig. S1) revealed that pure-phase VO_2(A) was synthesized.

Synthesis of carbon spheres

The carbon spheres were synthesized by a hydrothermal method (*Angew. Chem. Int. Ed.*, **2014**, *43*, 597). 1M aqueous glucose solution was transferred into a 50 mL Teflon Lined stainless steel autoclave, which was heated at 180 °C for 4 h. After washing with deionized water and ethanol and drying, the sample was then annealed in Ar at 700 °C for 2 h.

Fig. S1

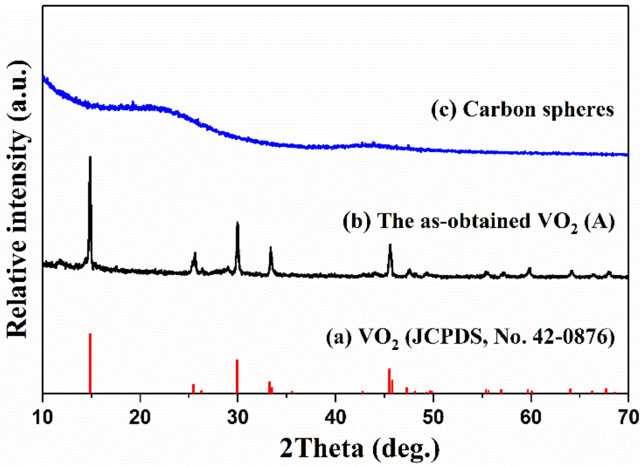

Fig. S1. XRD patterns of the as-obtained VO_2(A) and carbon spheres.

Fig. S2

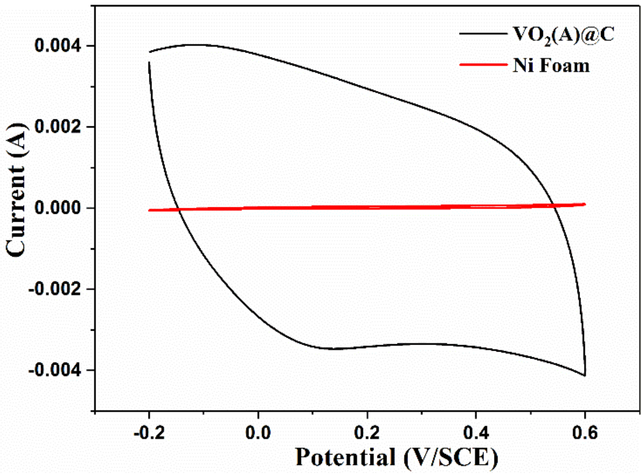

Fig. S2. CV curves of VO$_2$(A)@C composites and Ni foam collected at a scan rate of 20 mV·s^{-1}.

Fig. S3

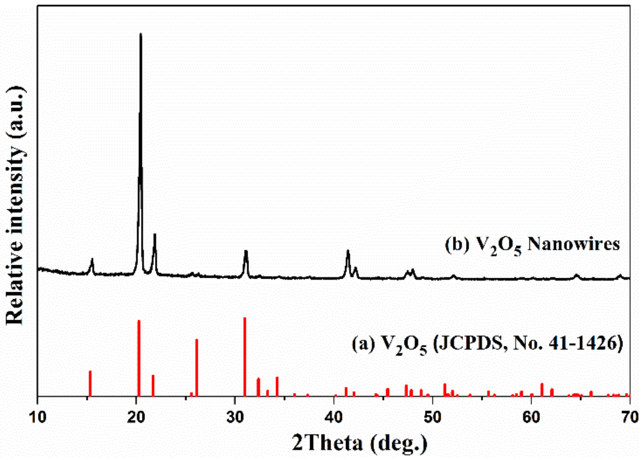

Fig. S3. XRD patterns of the synthesized V$_2$O$_5$ nanowires.

Fig. S4

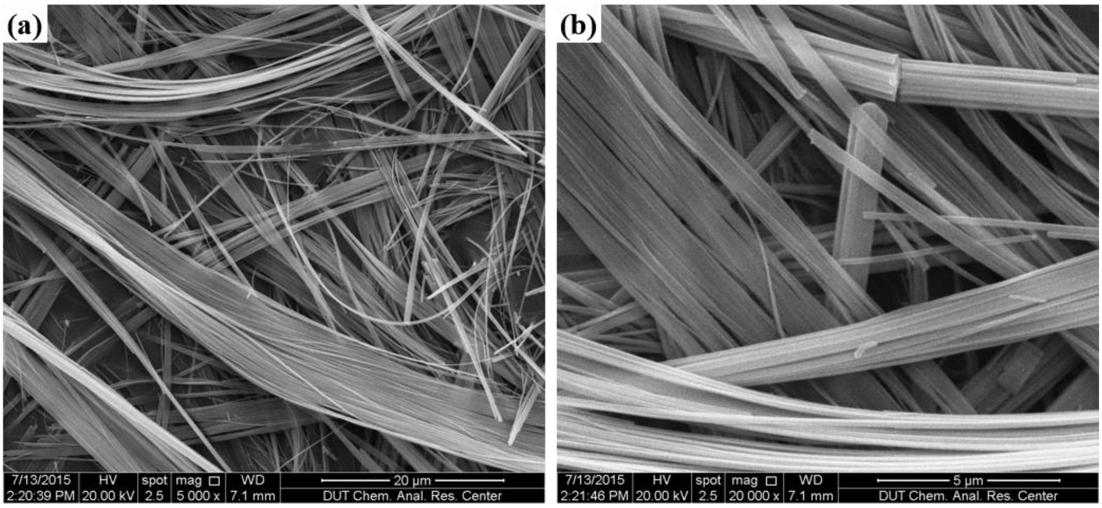

Fig. S4. SEM images of the synthesized V_2O_5 nanowires.

Fig. S5

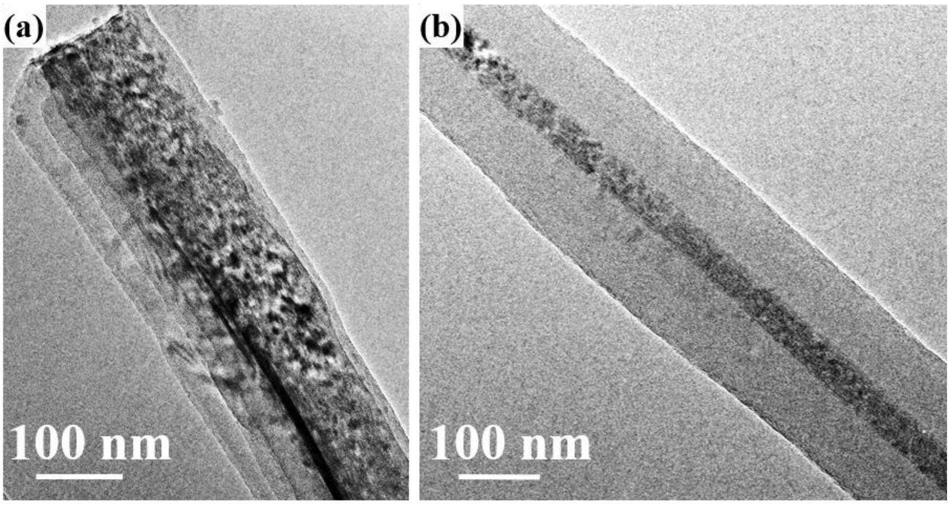

Fig. S5. TEM images of VO_2(A)@C composites synthesized with different amount of glucose: (a) 1 g; (b) 2 g.

Fig. S6

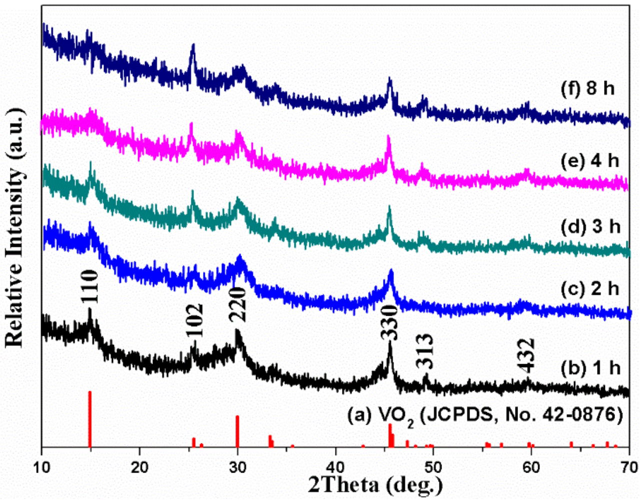

Fig. S6. XRD patterns of the products synthesized with different reaction times.

Fig. S7

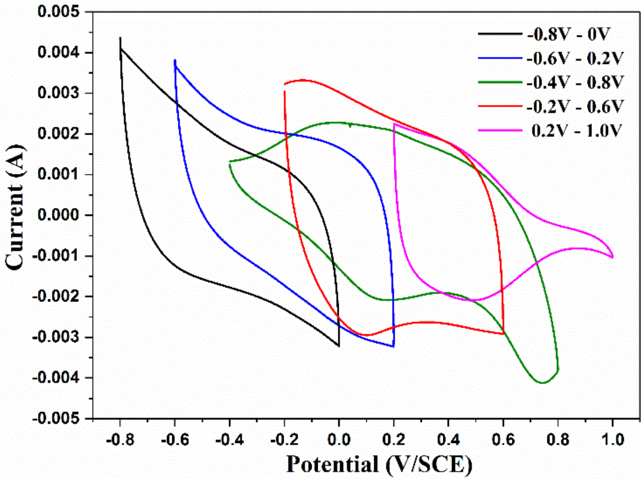

Fig. S7. CV curves of VO_2(A)@C composites on various potential limits collected at a scan rate of 20 mV·s^{-1}.

Fig. S8

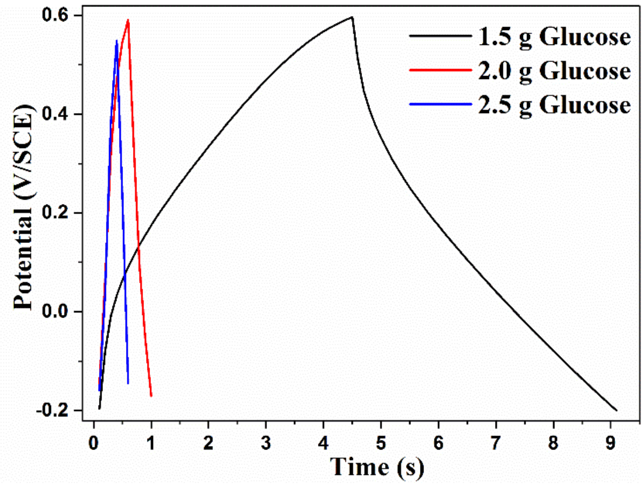

Fig. S8. Galvanostatic charge-discharge curves of VO_2(A)@C composites synthesized with different amount of glucose collected at a current density of 1 A·g^{-1}.

Fig. S9

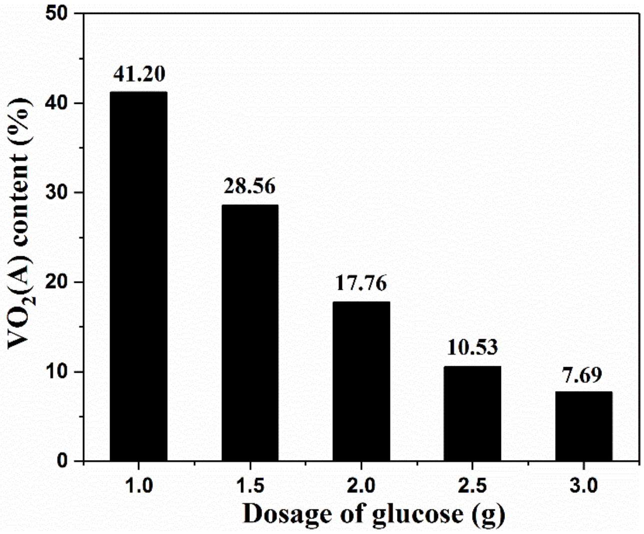

Fig. S9. VO_2 contents of the VO_2(A)@C core-shell composites synthesized with 1 g, 1.5 g, 2 g, 2.5g and 3 g glucose.

Fig. S10

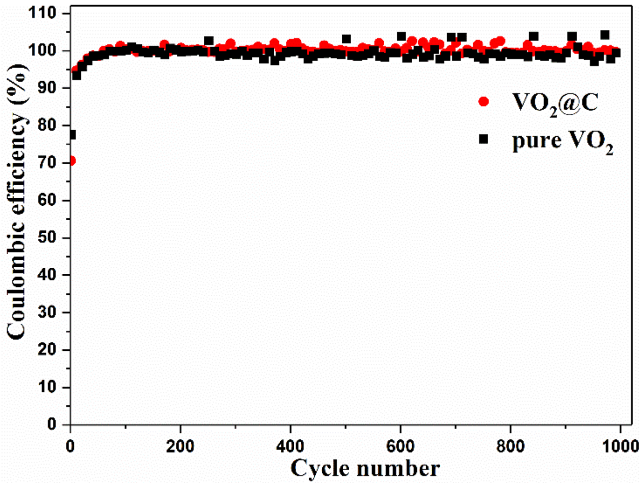

Fig. S10. The coulombic efficiency of VO_2(A)@C composites and pure VO_2(A) calculated based on the GCD curves (Fig. 4f).

Fig. S11

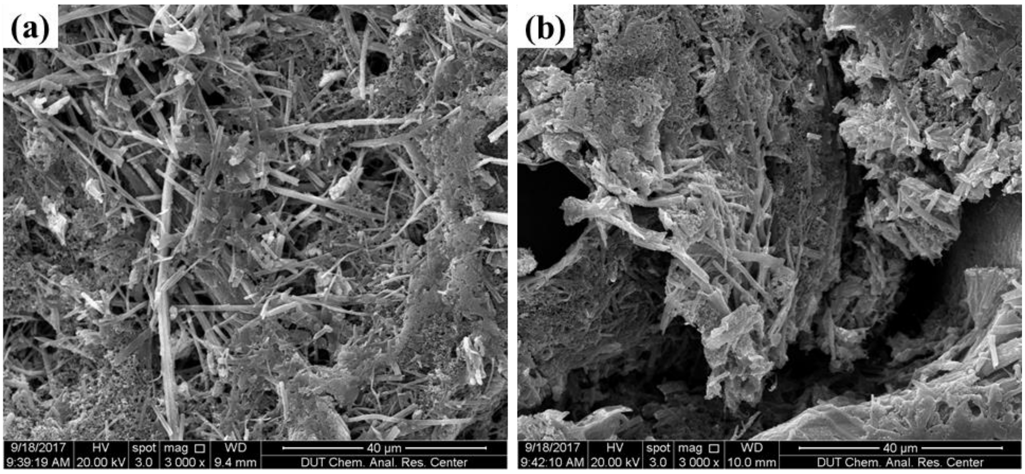

Fig. S11. SEM images of the working electrodes before (a) and after (b) the cycles in Na_2SO_4 aqueous solution.

Fig. S12

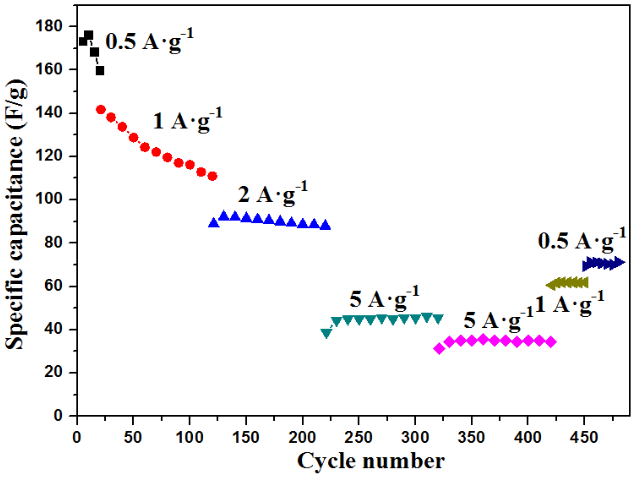

Fig. S12. Cycling performance of VO_2(A)@C composites collected at various current densities.

Fig. S13

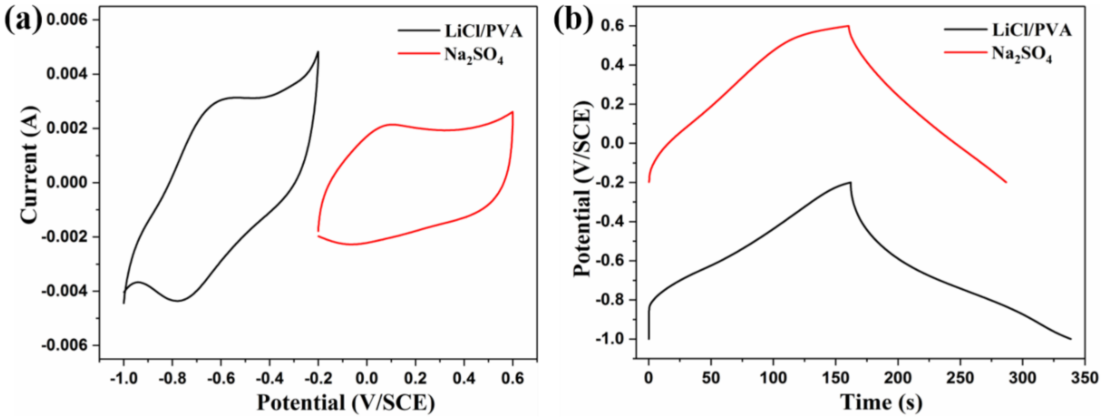

Fig. S13. CV curves collected at a scan rate of 20 mV·s^{-1} (a) and GCD curves collected at a current density of 1 A·g^{-1} (b) of VO_2(A)@C composites in 0.5 M Na_2SO_4 aqueous electrolyte and LiCl/PVA gel electrolyte.

Fig. S14

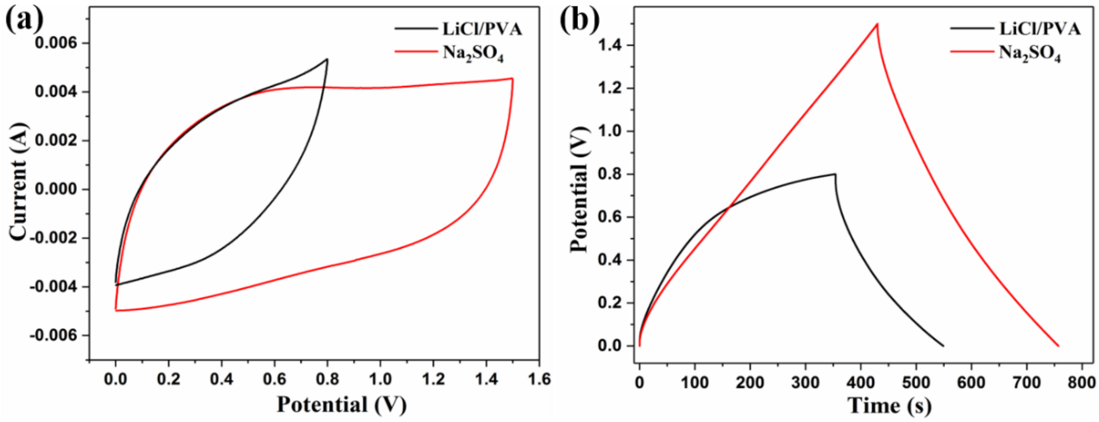

Fig. S14. CV curves collected at a scan rate of 20 mV·s^{-1} (a) and GCD curves collected at a current density of 1 A·g^{-1} (b) of the AC//VO_2(A)@C device in 0.5 M Na_2SO_4 aqueous electrolyte and

Fig. S15

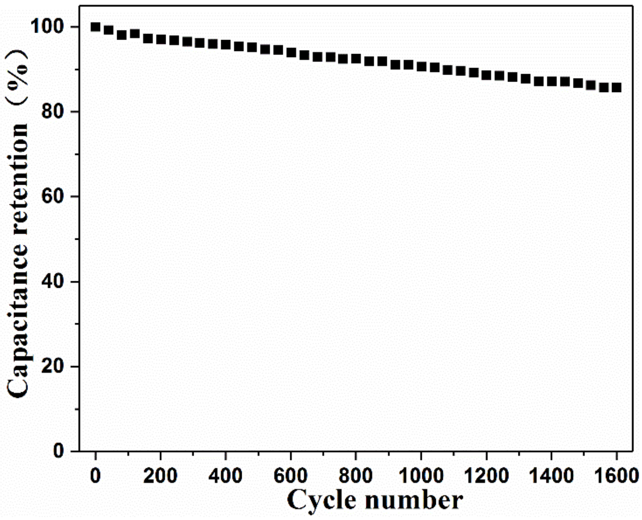

Fig. 15. Cycling performance of AC//VO_2(A)@C ASC device collected at a scan rate of 50 mV s^{-1} for 1600 cycles in LiCl/PVA gel electrolyte.

Table S1

Table 1. Comparison of the electrochemical performance of supercapacitor devices.

Types of device	Electrolyte	Specific capacitance /F·cm^{-2}	Cyclic performance	Reference
VO_2(A)//AC ASCs	0.5 M Na_2SO_4	0.50, 5 mV·s^{-1}	34.6% retention after 1000 cycles	This work
VO_2(A)//AC ASCs	5 M LiCl/PVA	0.22, 20 mV·s^{-1}	90.3% retention after 1000 cycles	This work
V_2O_5 SSCs	1 M $LiClO_4$/PVA	0.38, 1 mV·s^{-1}	88% retention after 1000 cycles	[1]
PET/Pt/MnO_2 SSCs	H_3PO_4/PVA	0.2, 10 mV·s^{-1}	82.2% retention after 10000 cycles	[2]
WO_{3-x}/MoO_{3-x}//PANI/carbon fabric ASCs	H_3PO_4/PVA	0.216, 2 mA·cm^{-1}	75% retention after 10000 cycles	[3]
PPy@MnO_2@rGO SSCs	H_3PO_4/PVA	0.41, 0.1 mA·cm^{-3}	92% retention after 4950 cycles	[4]
$NiCo_2O_4$ SSCs	KOH/PVA	0.16, 1 mA·cm^{-2}	100% after 3000 cycles	[5]
SWNT-MnO_2 SSCs	2 M Li_2SO_4	0.41	100% retention after 35000 cycles	[6]

ASCs = Asymmetric Supercapacitors; SSCs = Symmetric Supercapacitors; M = mol L^{-1}; PVA = Polyvinyl Alcohol

[1] B. Pandit, D.P. Dubal, B.R. Sankapal, Electrochimica Acta, 242 (2017) 382-389.

[2] X. Long, Z.G. Zeng, E.J. Guo, X.B. Shi, H.J. Zhou, X.H. Wang, Journal of Power Sources, 325 (2016) 264-272.

[3] X. Xiao, T.P. Ding, L.Y. Yuan, Y.Q. Shen, Q. Zhong, X.H. Zhang, Y.Z. Cao, B. Hu, T. Zhai, L. Gong, J. Chen, Y.X. Tong, J. Zhou, Z.L. Wang, Advanced Energy Materials, 2 (2012) 1328-1332.

[4] Y. Huang, H. Hu, Y. Huang, M.S. Zhu, W.J. Meng, C. Liu, Z.X. Pei, C.L. Hao, Z.K. Wang, C.Y. Zhi, ACS Nano, 9 (2015) 4766-4775.

[5] Q. Wang, X. Wang, B. Liu, G. Yu, X. Hou, D. Chen, G. Shen, Journal of Materials Chemistry A, 1 (2013) 2468-2473.

[6] L.B. Hu, M. Pasta, F. La Mantia, L.F. Cui, S. Jeong, H.D. Deshazer, J.W. Choi, S.M. Han, Y. Cui, Nano Letters, 10 (2010) 708-714.