Supporting Information

A high energy efficiency and long life aqueous Zn-I_2 battery

Wei Li, Kangli Wang,* and Kai Jiang*

State Key Laboratory of Advanced Electromagnetic Engineering, School of Electrical and Electronic Engineering, Huazhong University of Science and Technology, Wuhan 430074, P. R. China.

E-mail: klwang@hust.edu.cn; kjiang@ hust.edu.cn

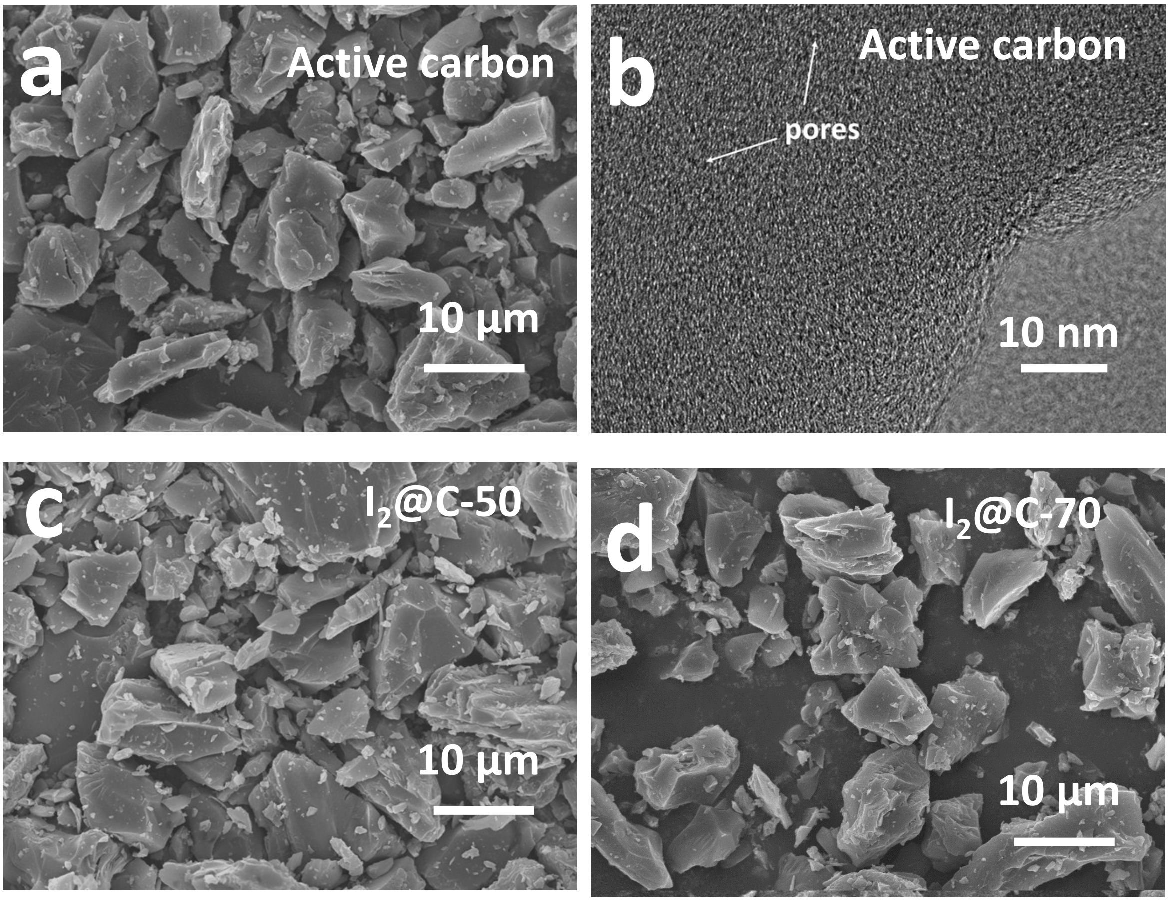

Figure S1. SEM images of (a, c, d) activated carbon, I_2@C-50 and I_2@C-70 composite,(b) TEM image of active carbon.

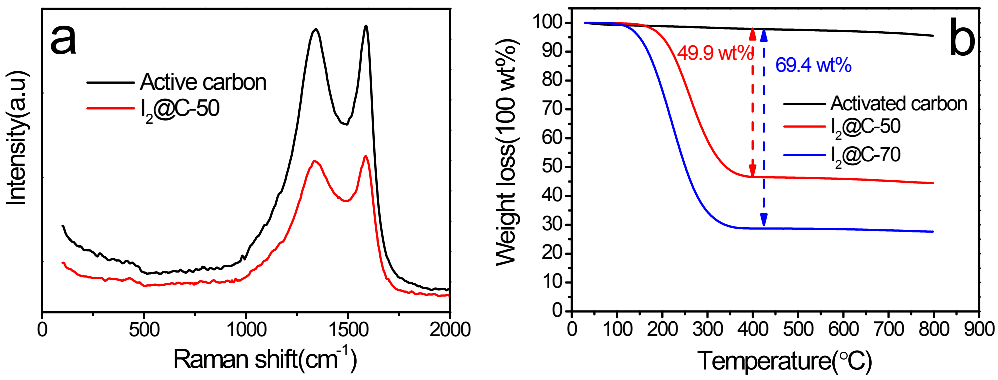

Figure S2. (a) Raman spectra of activated carbon and I_2@C-50 composite,(b) TG curves of activated carbon, I_2@C-50 and I_2@C-70 composite.

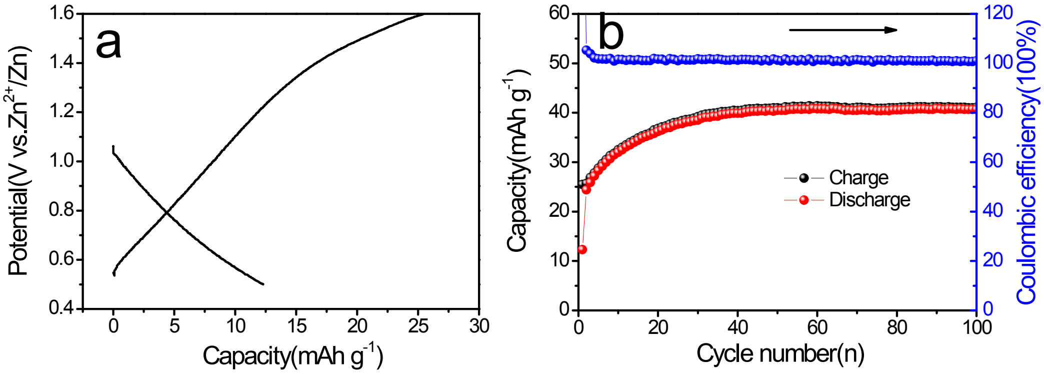

Figure S3. (a) The initial charge and discharge profiles and (b) cycling performance of active carbon at a current denstisy of 100 mA g^{-1} in 2 M $Zn(CF_3SO_3)_2$.

The initial charge capacity of active carbon is 26 mAh g^{-1}. Given the active carbon content (50 wt%, 40wt% active carbon + 10wt% acetylene black) in I_2@C-50 electrode, the capacity contribution from active carbon is about 13 mAh g^{-1}.

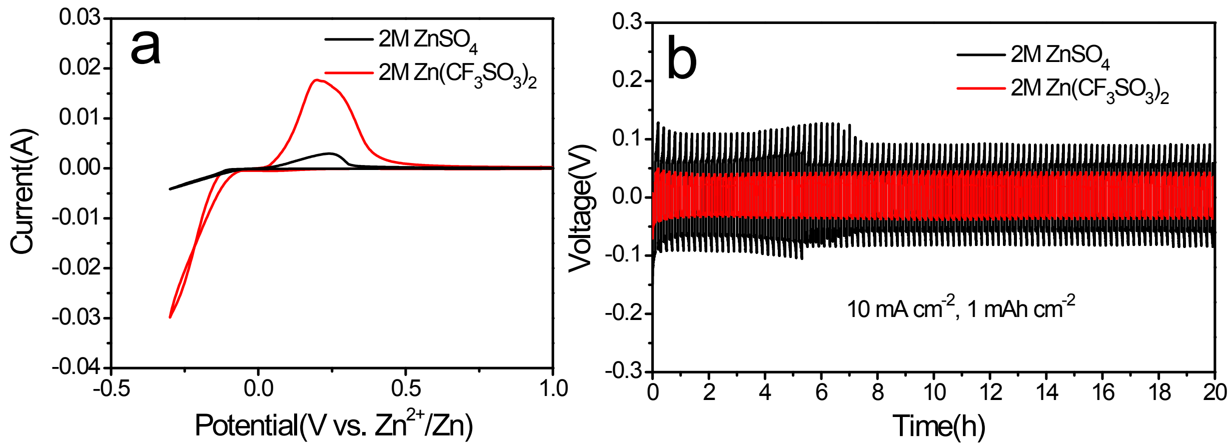

Figure S4. (a) CV curves of Zn electrode in aqueous electrolytes of 2 M $ZnSO_4$ and 2 M $Zn(CF_3SO_3)_2$ at the scan rate of 0.5 mV s^{-1} between -0.3 and 1.0 V. (b) Galvanostatic cycling of Zn/Zn symmetrical cells at 10 mA cm^{-2} in 2 M $ZnSO_4$ and 2 M $Zn(CF_3SO_3)_2$ electrolytes.

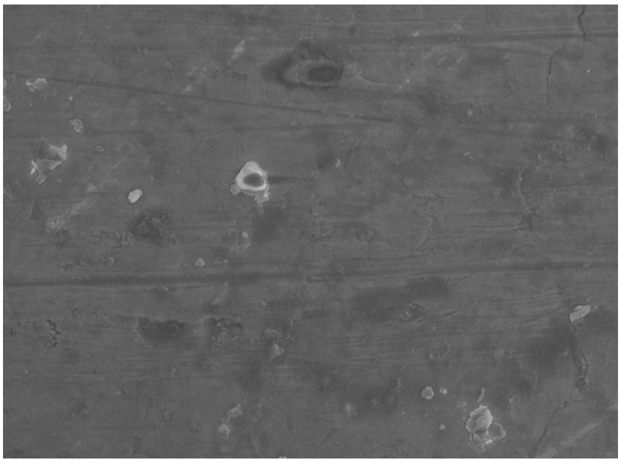

Figure S5. SEM image of Zn fresh foil

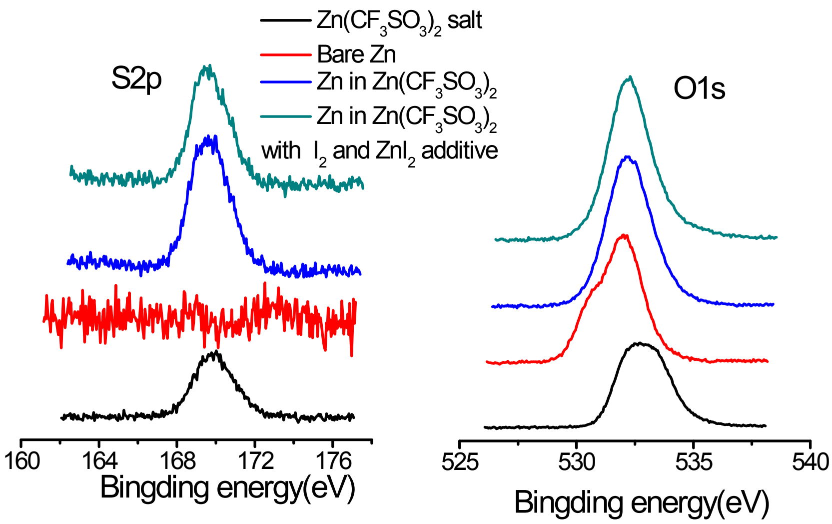

Figure S6. XPS spectra of S2p and O1s of $Zn(CF_3SO_3)_2$, Zn foil, and Zn soaked in electrolyte of 2M $Zn(CF_3SO_3)_2$ with or without I_2 and ZnI_2 additive.

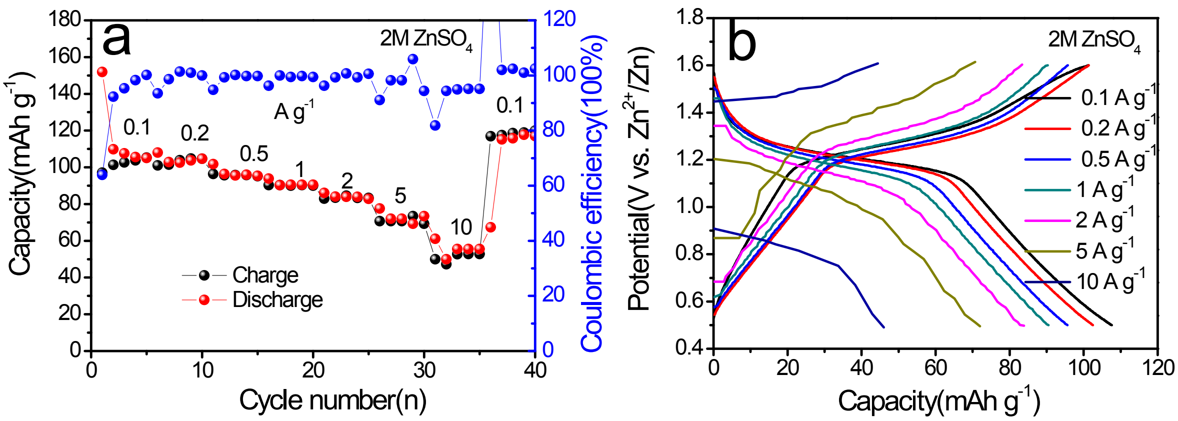

Figure S7. (a) Rate capacities and (b) discharge and charge profiles of I_2@C-50 electrode in 2 M $ZnSO_4$ at current densities from 0.1 to 10 A g^{-1}.

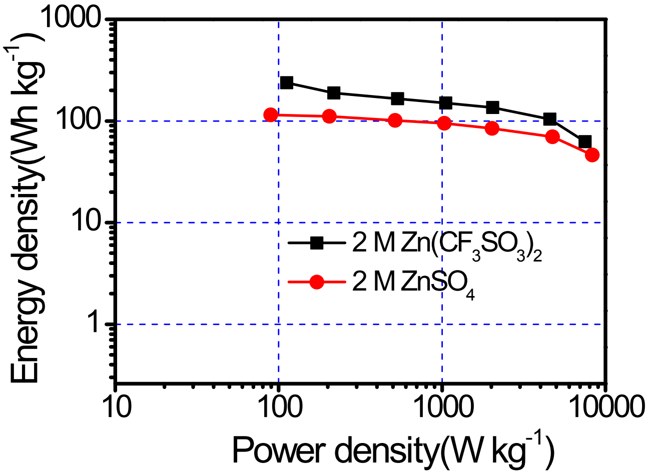

Figure S8. Ragone plots of I_2@C-50 electrode in 2 M $ZnSO_4$ and 2 M $Zn(CF_3SO_3)_2$ electrolytes at current densities from 0.1 to 10 A g^{-1}.

Table S1 Comparison of I_2@C-50 and I_2@C-70 with recently reported aqueous Zn-based batteries

System	Voltage (V)	Energy density (Wh kg^{-1})	Current density (A g^{-1})	Cycling	Ref.
I_2@C-50	1.2	-	1	5000	This work
I_2@C-70	1.2	-	1	10000	This work
I_2@C-50	1.2	237	5	10000	This work
MnO_2	1.44	-	1.54	5000	Nat. Energy 2016 ,1,16039
$Zn_{0.25}V_2O_5\cdot nH_2O$	0.7	250	2.4	1000	Nat. Energy 2016,1, 16119
I_2/ACC	1.2	-	1.055	1500	Nano Research 2018, 11, 3548
$Na_3V_2(PO_4)_2F_3$	1.62	100	1	4000	Energy Storage Mater. 2018,15, 14
ZnHCF	1.7	100	0.06	100	Adv. Energy Mater. 2015, 5, 1400930
$Na_3V_2(PO_4)_3$	1.1	100	0.05	100	Nano Energy 2016, 25, 211
VS_2	0.6	123	0.5	200	Adv. Energy Mater. 2017, 7, 1601920
$Na_{1.1}V_3O_{7.9}$	0.7	□	□	100	Energy Storage Mater. 2018, 13, 168.
ZnHCF@MnO_2	1.7	149	□	1000	J. Mater. Chem. A, 2017, 5, 23628
$Zn_3V_2O_7(OH)_2\cdot 2H_2O$	0.7	150	0.2	300	Adv. Mater. 2017, 1705580
$Zn_2(OH)VO_4$	0.8	200	4	2000	Adv. Mater. 2018, 1803181
$H_2V_3O_8$	0.7	168	6	2000	Adv. Energy Mater. 2018, 1800144
$K_2V_6O_{16}\cdot 2.7H_2O$	0.8	172	6	500	J. Mater. Chem. A 2018, 6, 15530
VO_2	0.6	160	4	1000	Energy Storage Mater.2019,17, 143
$ZnMn_2O_4$	1.4	202	0.5	500	J. Am. Chem. Soc. 2016, 138, 12894
$LiV_2(PO_4)_3$	1.4	218	1.5	4000	Energy Environ. Sci. 2018, 11, 3168
$Ca_{0.25}V_2O_5\cdot nH_2O$	0.8	267	-	5000	Angew. Chem. Int. Ed. 2018, 57, 3943
$Na_2V_6O_{16}\cdot 3H_2O$	0.8	287	14.4	1000	Nano Lett. 2018, 18, 2402−2410
$V_2O_5\cdot nH_2O$	0.7	290	6	900	Adv. Mater. 2017, 1703725
$V_2O_5\cdot nH_2O$	0.7	322	5	4000	ACS Energy Lett. 2018, 3, 1366
$Mg_xV_2O_5\cdot nH_2O$	0.7	-	1	1000	ACS Energy Lett. 2018, 3, 2602
$Zn_2V_2O_7$	0.8	166	4	1000	J. Mater. Chem. A 2018, 6, 3850
$Li_xV_2O_5$ nH_2O	0.8	-	10	1000	Energy Environ. Sci. 2018, 11, 3157
Co_3O_4	2.2	360.8	4	5000	Energy Environ. Sci. 2018, 11, 2521
a-MnO_2	1.3	-	2.772	1000	Energy Environ. Sci. 2018, 11, 941
PTO	0.8	186.7	3	1000	Angew. Chem. Int. Ed. 2018, 57, 1173
C4Q	1	220	0.5	1000	Sci. Adv. 2018, 4, 1761
PANI	1.1	-	5	3000	Adv. Funct. Mater. 2018, 28, 1804975

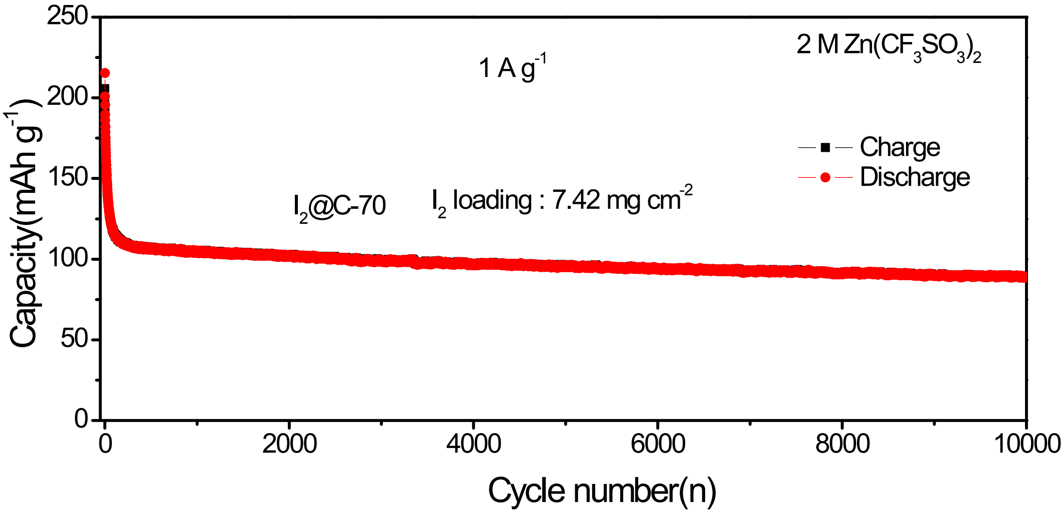

Figure S9. Cycling performance of I_2@C-70 composite with a I_2 mass loading of 7.42 mg cm^{-2} in 2 M $Zn(CF_3SO_3)_2$ at 1 A g^{-1}.

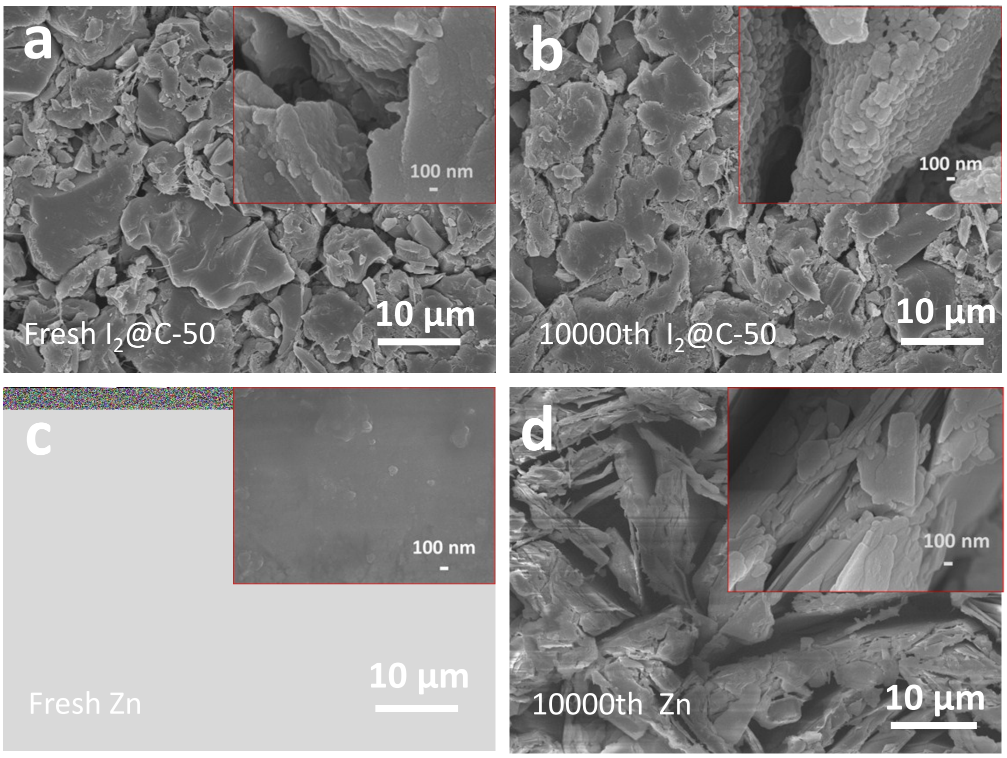

Figure S10. SEM images of pristine and cycled (a, b) I_2@C-70 and (c, d) Zn foil in 2 M $Zn(CF_3SO_3)_2$ at a current density of 5 A g^{-1}.

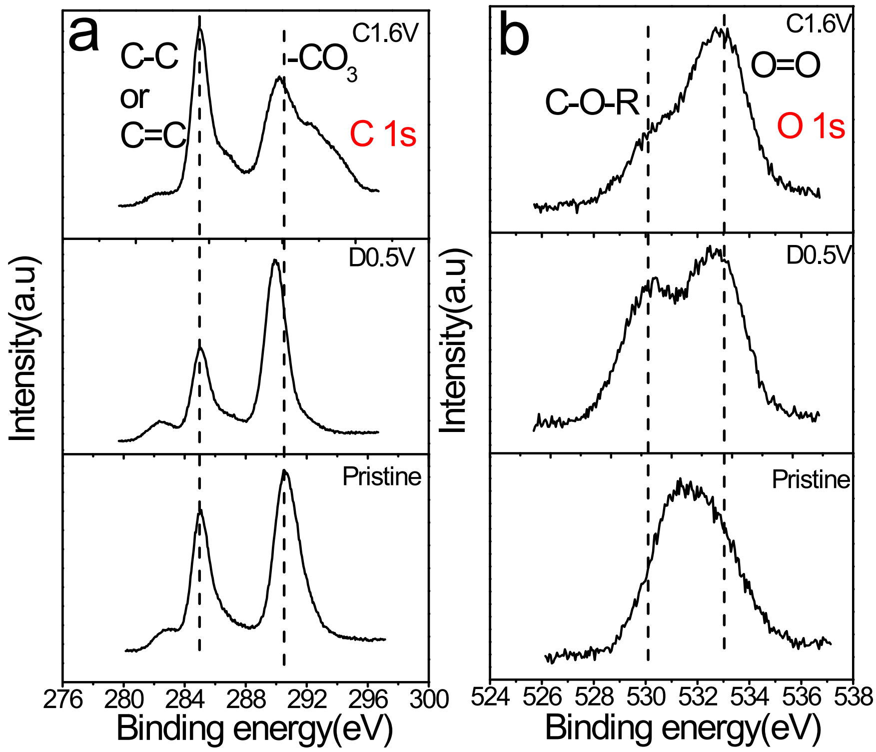

Figure S11. XPS spectra of (a) C1s and (b) O1s at pristine, discharged and charged states.