

## High-performance hybrid supercapacitor Immobilized Wells-Dawson Polyoxometalates on Activated Carbon electrodes

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### 1. FTIR table:

Assignments	5% AC-P <sub>2</sub> W <sub>18</sub>	10% AC-P <sub>2</sub> W <sub>18</sub>	15% AC-P <sub>2</sub> W <sub>18</sub>	P <sub>2</sub> W <sub>18</sub>
O-H	3528	3535	3510	3613
P-O	1155	1161	1155	1108
W-O-W (intra)	817	822	817	824
W-O-W (inter)	947	953	947	934
W=O (terminal)	998	1004	998	996
C=C	1696	1707	1704	-

**Table S1:** FTIR Values of 5% AC-P<sub>2</sub>W<sub>18</sub>, 10 % AC-P<sub>2</sub>W<sub>18</sub> and 15 % AC-P<sub>2</sub>W<sub>18</sub> and P<sub>2</sub>W<sub>18</sub>

### 1.XPS Survey spectra:

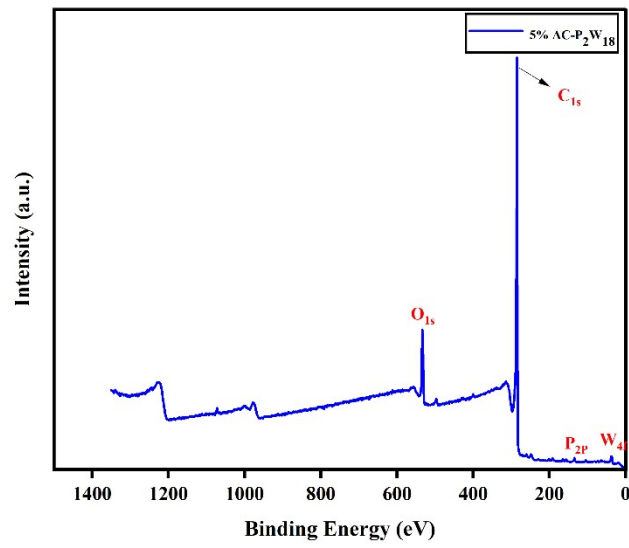


Figure S1: XPS Survey of 5% AC-P<sub>2</sub>W<sub>18</sub>

### 3.EDS spectra:

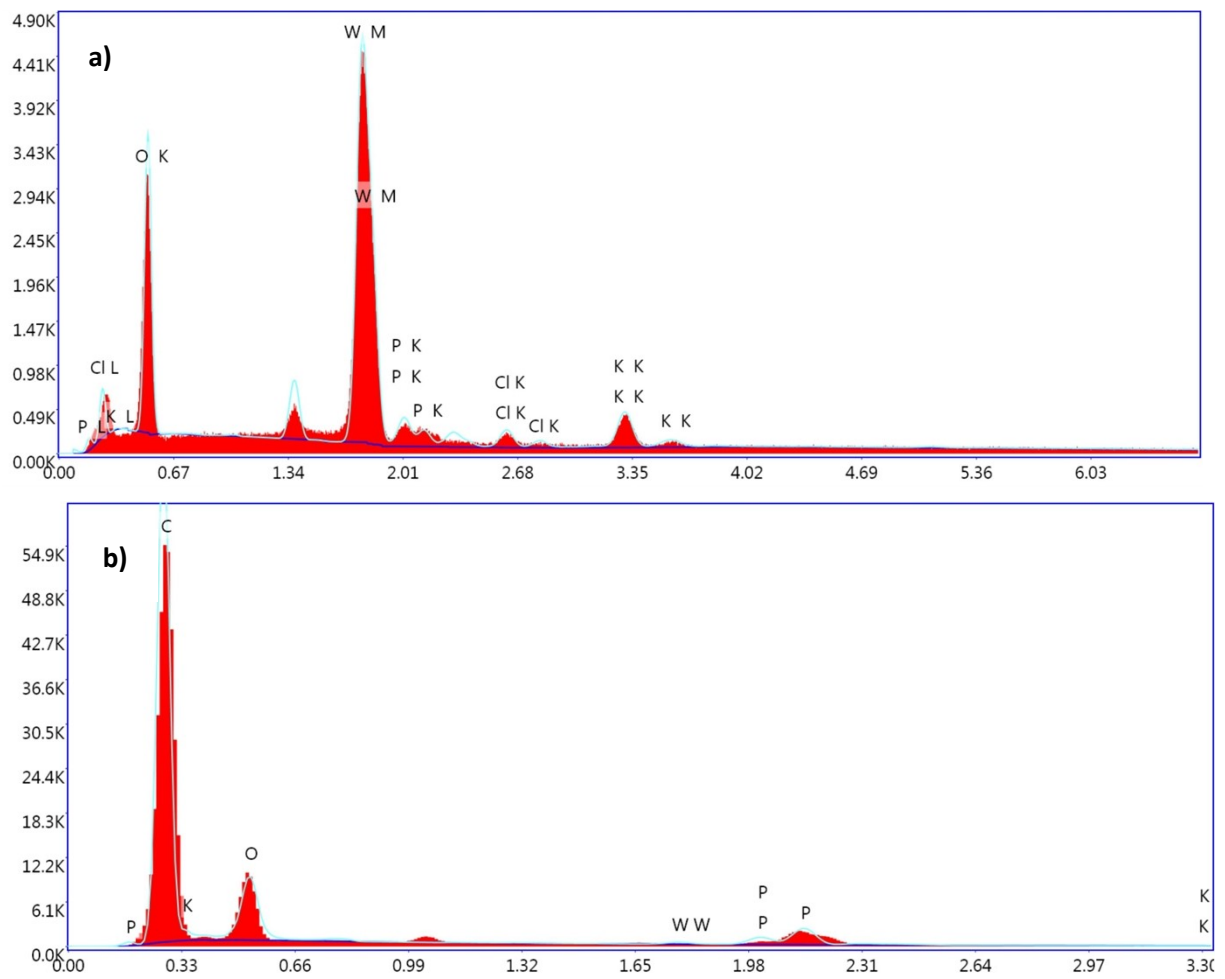


Figure S2: EDS spectra of a) Pure P<sub>2</sub>W<sub>18</sub> and b) 5% AC-P<sub>2</sub>W<sub>18</sub>

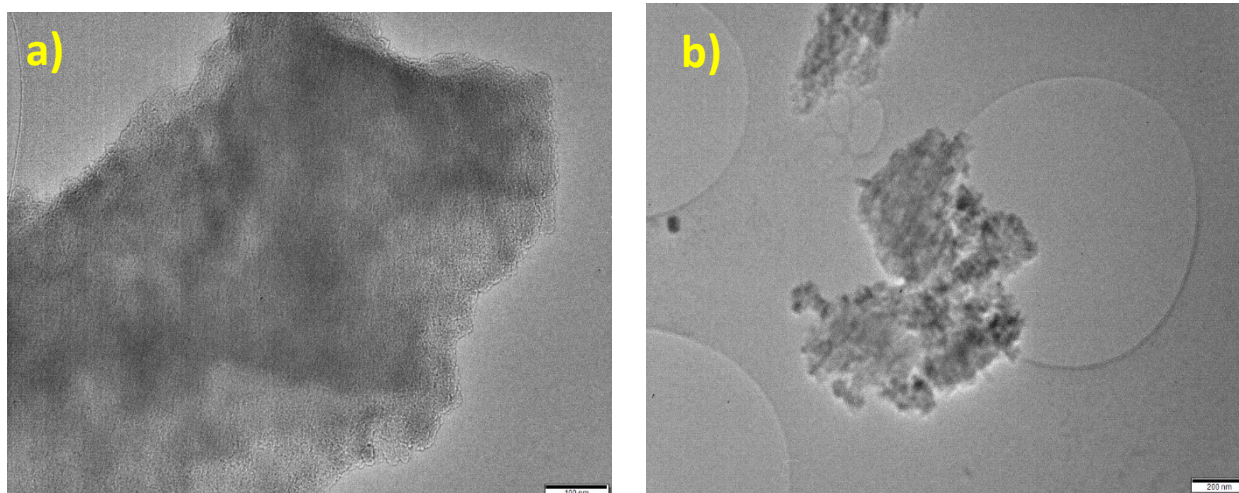


Figure S3 : TEM images of a) 5%AC-P<sub>2</sub>W<sub>18</sub> magnification of 100nm b) ) 5%AC-P<sub>2</sub>W<sub>18</sub> magnification of 200nm

#### 4.1. 5% AC-P<sub>2</sub>W<sub>18</sub>:

Scan rate(mV/s)	Potential(V)	Mass(mg)	Area (A)	Specific capacitance(F/g)
100	1	0.9	6.1016	76.8916
70	1	0.9	4.6049	82.9179
50	1	0.9	3.4174	84.8088
30	1	0.9	2.1657	85.6948

Table S2: Specific capacitance of 5% AC-P<sub>2</sub>W<sub>18</sub> by cyclic voltammetry

#### 4.2. 10% AC-P<sub>2</sub>W<sub>18</sub>:

Scan rate(mV/s)	Potential(V)	Mass(mg)	Area (A)	Specific capacitance(F/g)
100	1	0.9	5.4558	60.6204
70	1	0.9	4.0114	63.6733
50	1	0.9	2.9291	65.0915
30	1	0.9	1.7436	64.5788

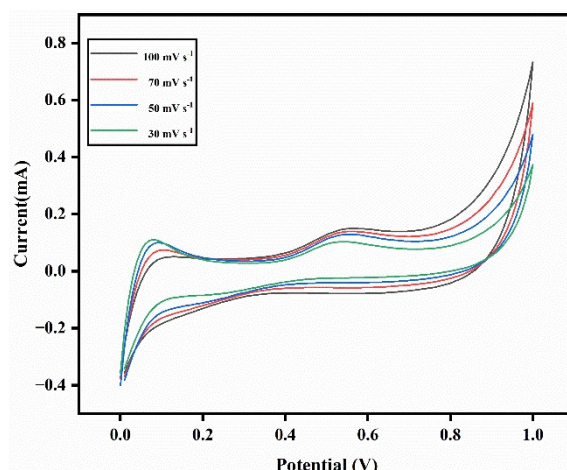
**Table S3: Specific capacitance of 10% AC-P<sub>2</sub>W<sub>18</sub> by cyclic voltammetry**

**4.3. 15% AC-P<sub>2</sub>W<sub>18</sub>:**

Scan rate(mV/s)	Potential(V)	Mass(mg)	Area (A)	Specific capacitance(F/g)
100	1	0.9	2.10426	23.3806
70	1	0.9	1.71077	27.1539
50	1	0.9	1.36774	30.3933
30	1	0.9	0.95847	35.4988

**Table S4: Specific capacitance of 15% AC-P<sub>2</sub>W<sub>18</sub> by cyclic voltammetry**

**4.4: CV Graph of pure P<sub>2</sub>W<sub>18</sub>:**



**Figure S4: CV graph of Pure P<sub>2</sub>W<sub>18</sub>**

**5. Galvanostatic Charge and Discharge Studies:**

**5.1. 5% AC-P<sub>2</sub>W<sub>18</sub>:**

Current Density (A/g)	Specific capacitance (F/g)	Energy Density (Wh/kg)	Power Density(W/kg)
0.2	288.48	40.066	1999
0.4	281.6	39.111	2000
0.6	274.56	38.133	2000
0.8	268.16	37.244	2000.95
1	263.2	36.555	2024.61
2	233.6	32.444	3999.94
3	218.4	30.333	5999.93
4	204.8	28.444	8000
5	196	27.222	9999.99

Table S5: Specific capacitance, Energy density, and power density of 5% AC-P<sub>2</sub>W<sub>18</sub>

5.2. 10% AC-P<sub>2</sub>W<sub>18</sub>:

Current Density (A/g)	Specific capacitance (F/g)	Energy Density (Wh/kg)	Power Density(W/kg)
0.2	199.36	27.688	1999
0.4	193.28	26.844	1999.66
0.6	184.32	25.600	2000
0.8	185.6	25.777	2000
1	184	25.555	2000
2	161.6	22.444	4000
3	148.8	20.666	6000
4	140.8	19.555	8000

5	132	18.333	10000
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Table S6: Specific capacitance, Energy density, and power density of 10% AC-P<sub>2</sub>W<sub>18</sub>

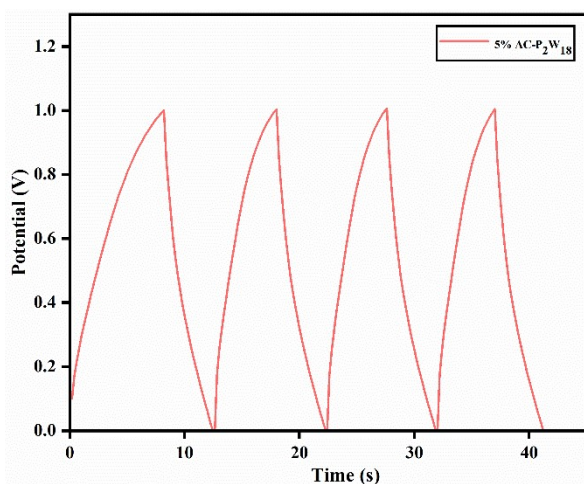
5.3. 15% AC-P<sub>2</sub>W<sub>18</sub>:

Current Density (A/g)	Specific capacitance (F/g)	Energy Density (Wh/kg)	Power Density(W/kg)
0.2	139.09	19.311	1999
0.4	129.28	17.955	2000
0.6	115.68	16.066	2001
0.8	106.24	14.755	2003
1	98.4	13.666	2040
2	49.6	6.888	3999
3	40.8	5.666	5999
4	28.8	4.000	8000
5	24	3.333	9999

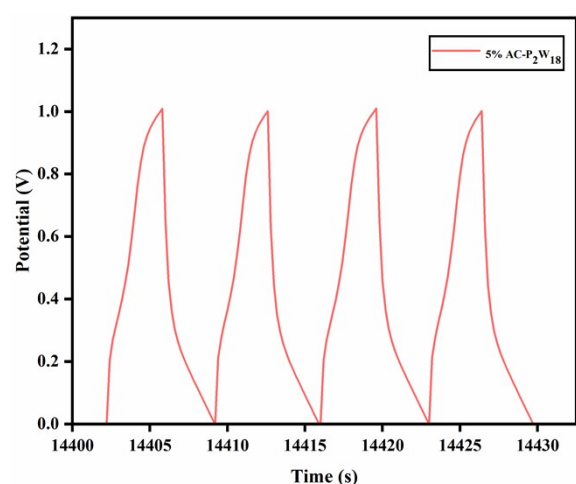
Table S7: Specific capacitance, Energy density, and power density of 15% AC-P<sub>2</sub>W<sub>18</sub>

6. Cyclic Stability:

First Four Cycles



Last Four Cycles



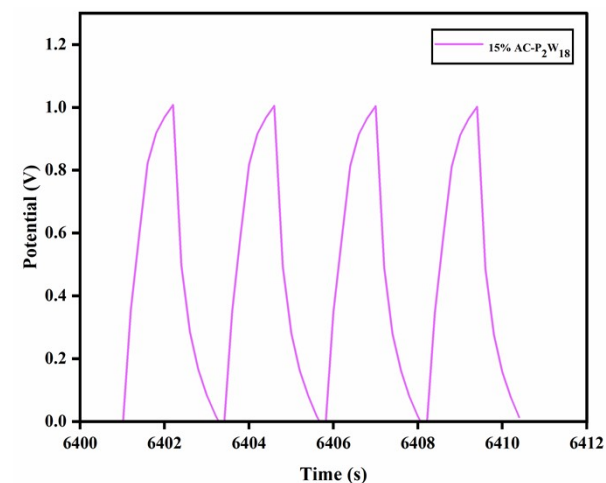
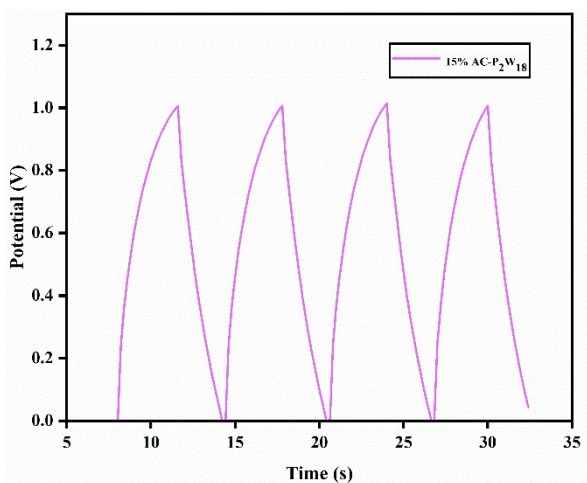
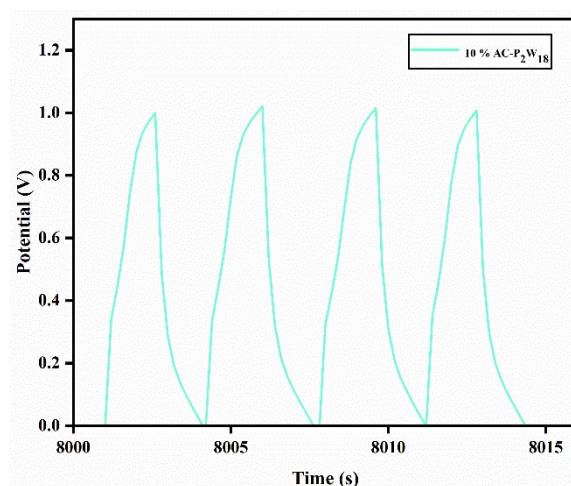
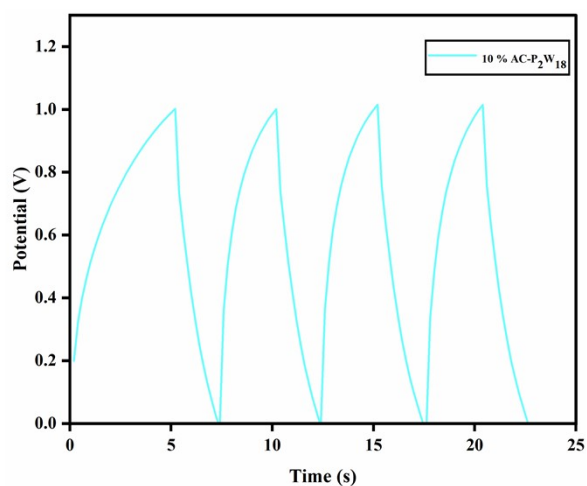


Figure S5: First four cycles and Last four cycles of 5% AC-P<sub>2</sub>W<sub>18</sub>, 10% AC-P<sub>2</sub>W<sub>18</sub>, and 15% AC-P<sub>2</sub>W<sub>18</sub>

### 7. Electro-Impedance Spectroscopy:

Materials	R <sub>s</sub> (Ω)	R <sub>p</sub> (Ω)	R <sub>CT</sub> (Ω)
5% AC-P <sub>2</sub> W <sub>18</sub>	1.313	4.667	3.354
10% AC-P <sub>2</sub> W <sub>18</sub>	0.959	5.395	4.435
15% AC-P <sub>2</sub> W <sub>18</sub>	1.528	8.210	6.682

Table S8: Equivalent circuit elements of all three 5% AC-P<sub>2</sub>W<sub>18</sub>, 10% AC-P<sub>2</sub>W<sub>18</sub>, and 15% AC-P<sub>2</sub>W<sub>18</sub> plotted using Nyquist plots.

### 8. LED VIEDO:



RED LED.mp4



Yelow LED.mp4



BLUE LED.mp4

Video S1: a) RED LED, b) Yellow LED and C) Blue LED

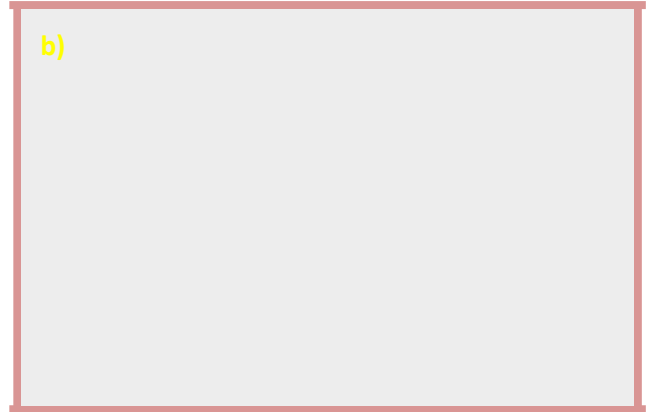
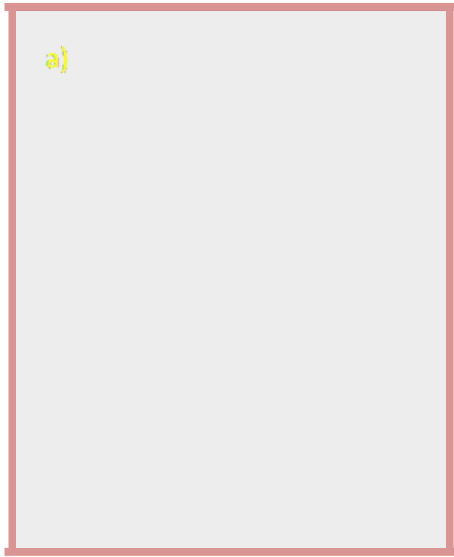




Figure S6: LED images of a) blue b) Yellow light using the 5% Ac-P<sub>2</sub>W<sub>18</sub> Electrode material