Electronic Supplementary Material (ESI) for Materials Advances.


# Supporting Information

## High energy density liquid state asymmetric supercapacitor device using Co-Cr-Ni-Fe-Mn High Entropy Alloy

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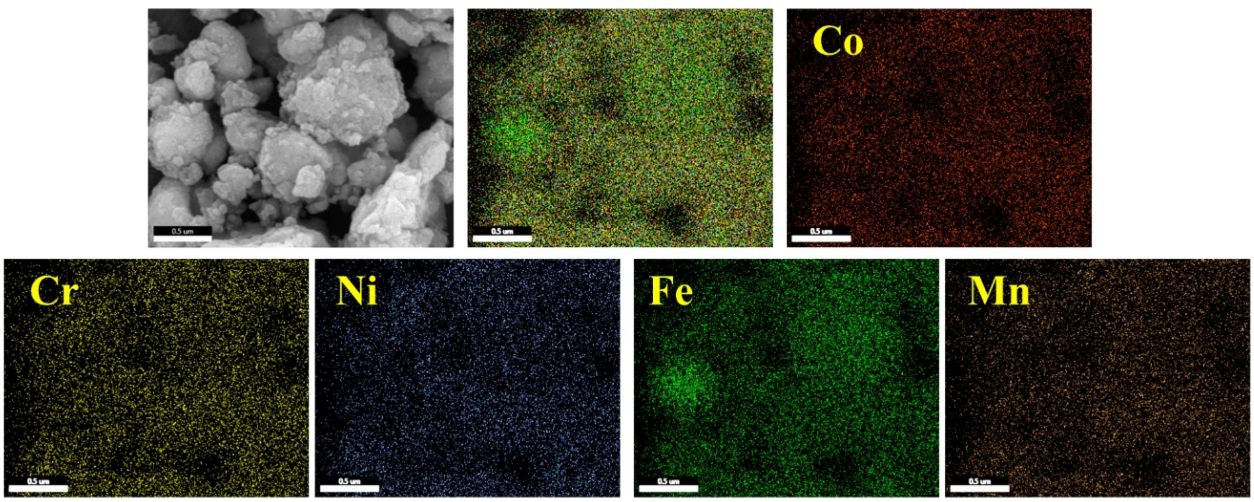


**Figure S1:** Elemental mapping of all elements (Co, Cr, Ni, Fe and Mn).

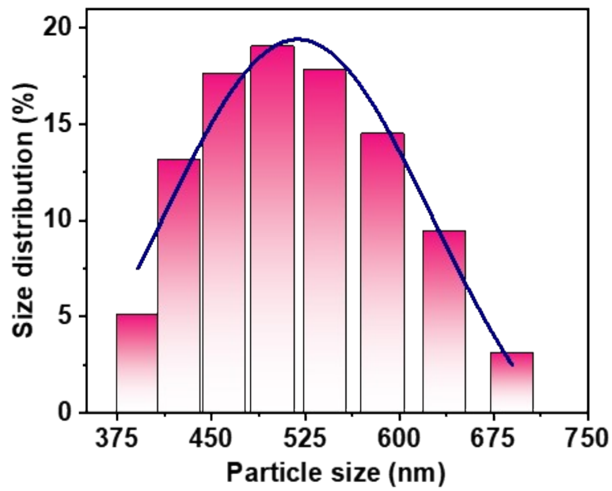


**Figure S2:** Particle size distribution of CCNFM HEA powder obtained from DLS.

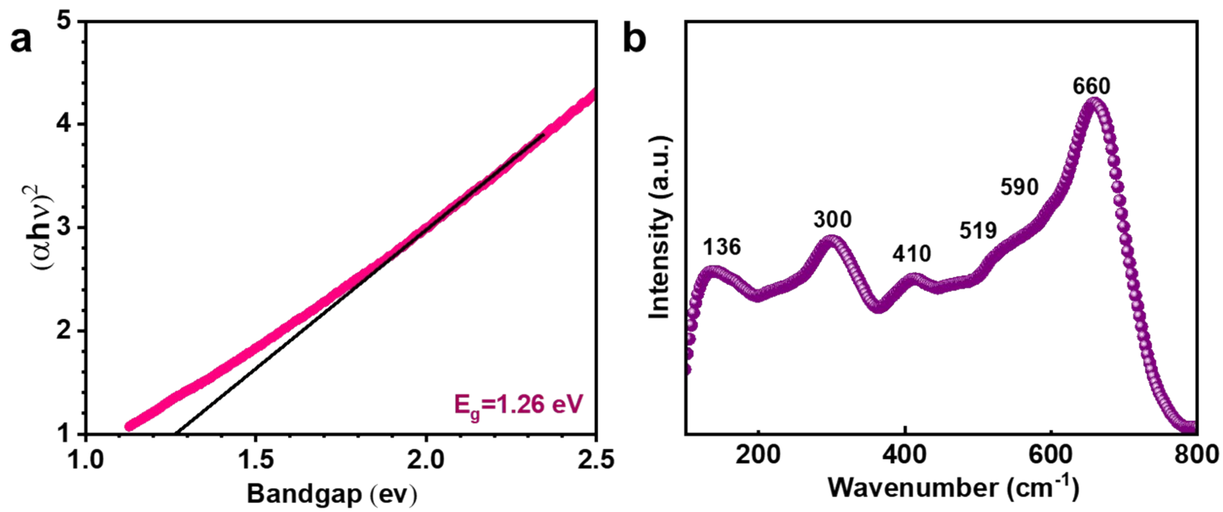


**Figure S3:** (a) Tauc plot of ball milled HEA samples and (b) Raman spectroscopic results for the same.

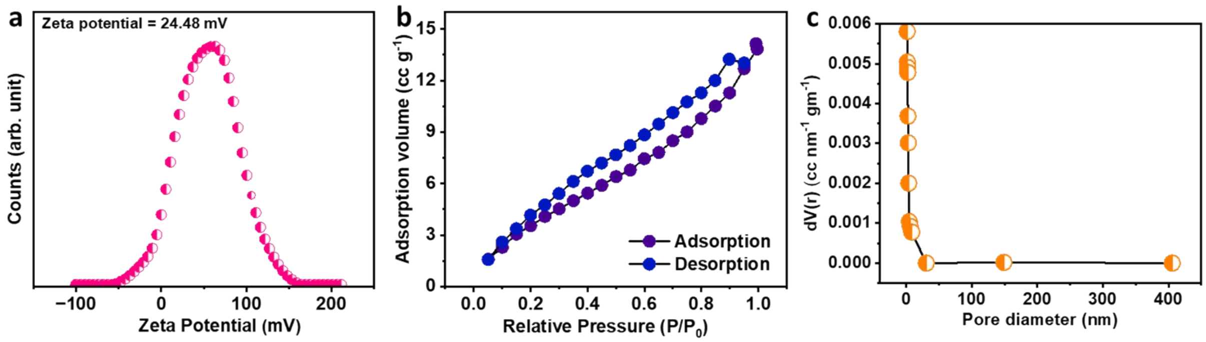


**Figure S4**: (a) Zeta potential and (b) BET $N_2$ adsorption and desorption curves obtained a specific surface area of 25 $m^2$ $g^{-1}$. (c) Pore volume vs. pore diameter.

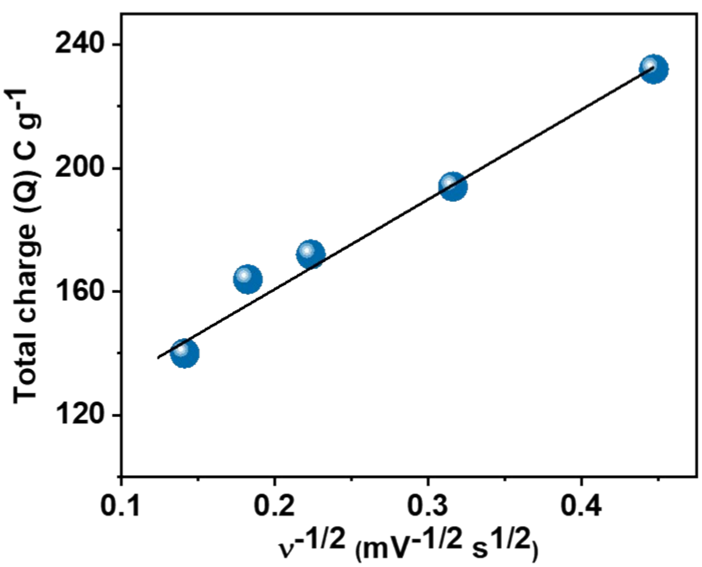


**Figure S5:** $Q(t)$ vs $\nu^{-\frac{1}{2}}$ for evaluating $Q_S$.

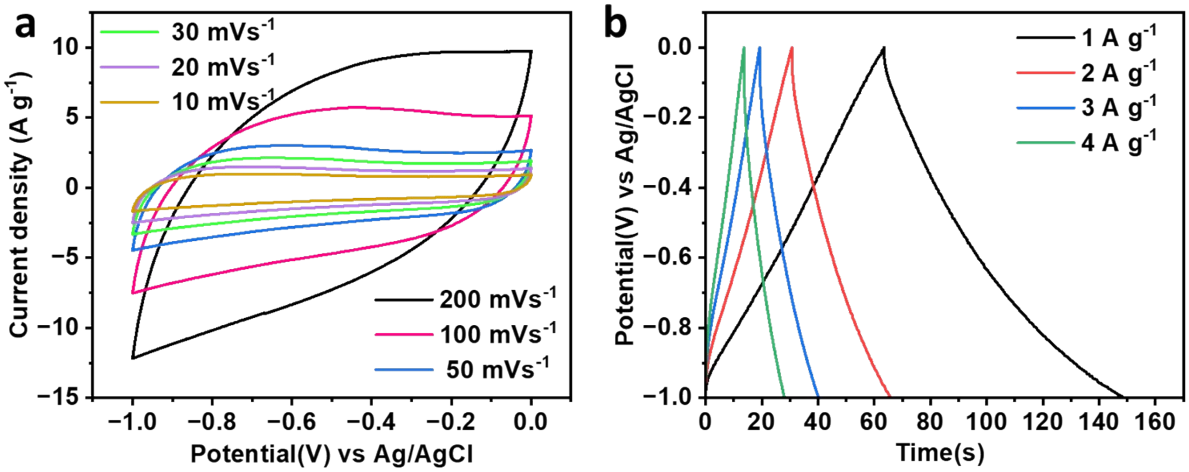


**Figure S6:** CV and GCD of activated carbon anode electrode at 3M KOH.

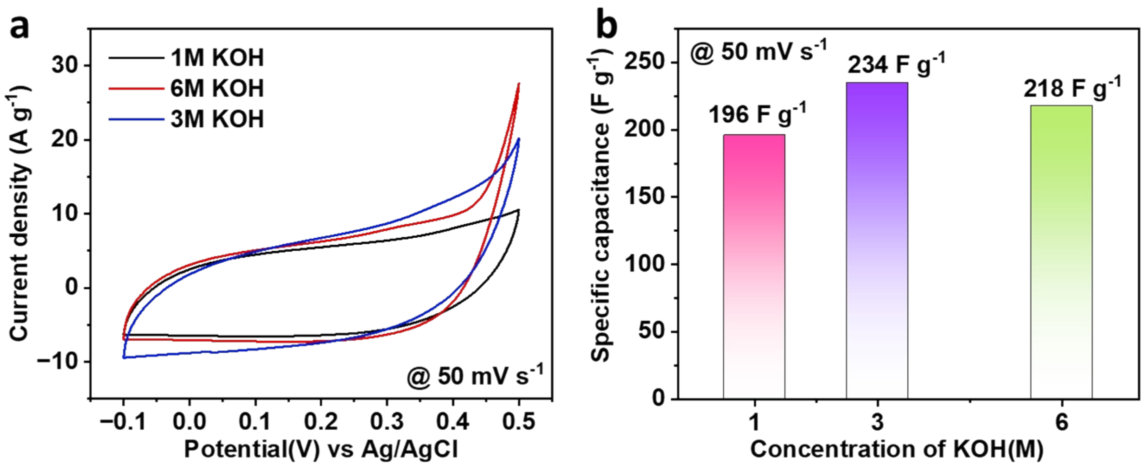


**Figure S7:** (a) CV of FCNCM HEA electrode at different concentration of aqueous KOH electrolyte at 50 mV $s^{-1}$, (b) Specific capacitance vs. concentration at 50 mV $s^{-1}$.

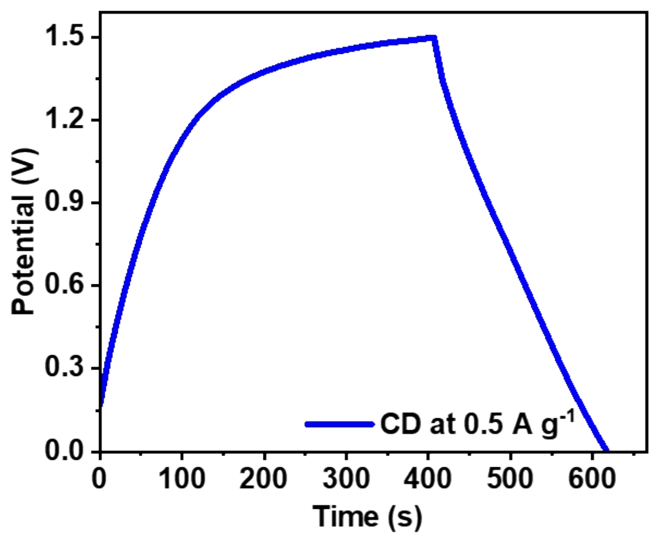


**Figure S8:** Charge discharge at 0.5 A $g^{-1}$ for ASC liquid state device.

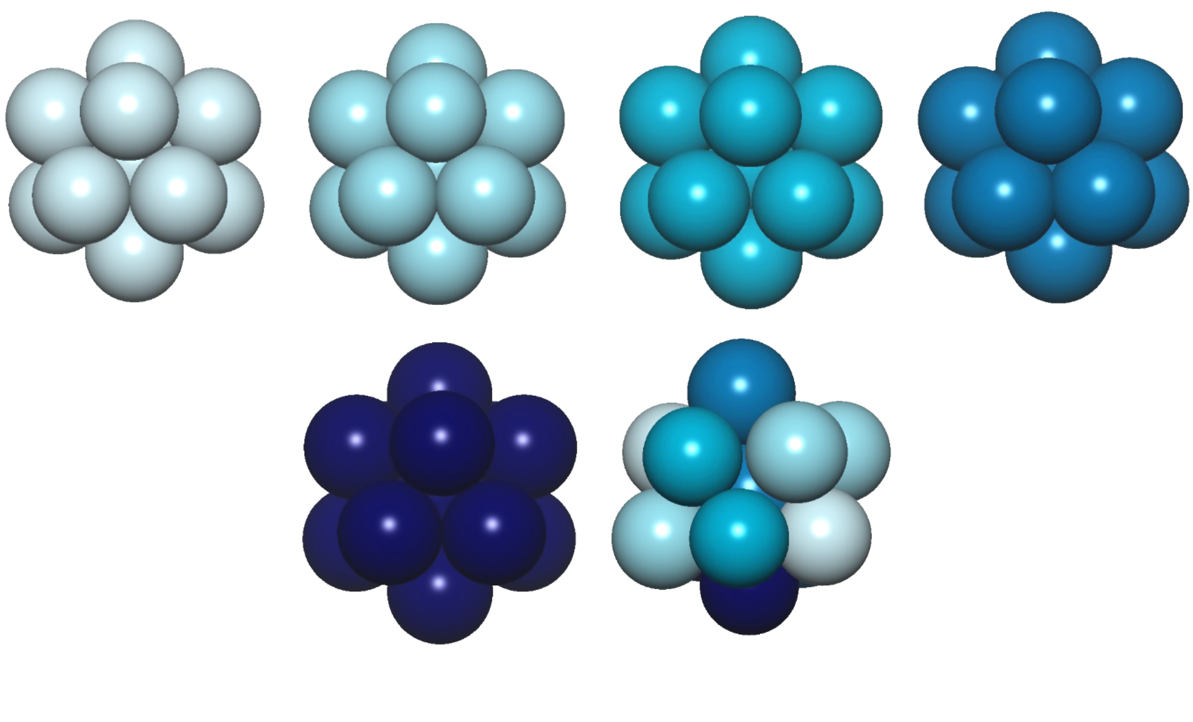

**Figure S9:** 13-atom icosahedron of Co, Cr, Fe, Mn (top left to right), Ni (bottom left) and CoCrFeMnNi HEA (bottom right).

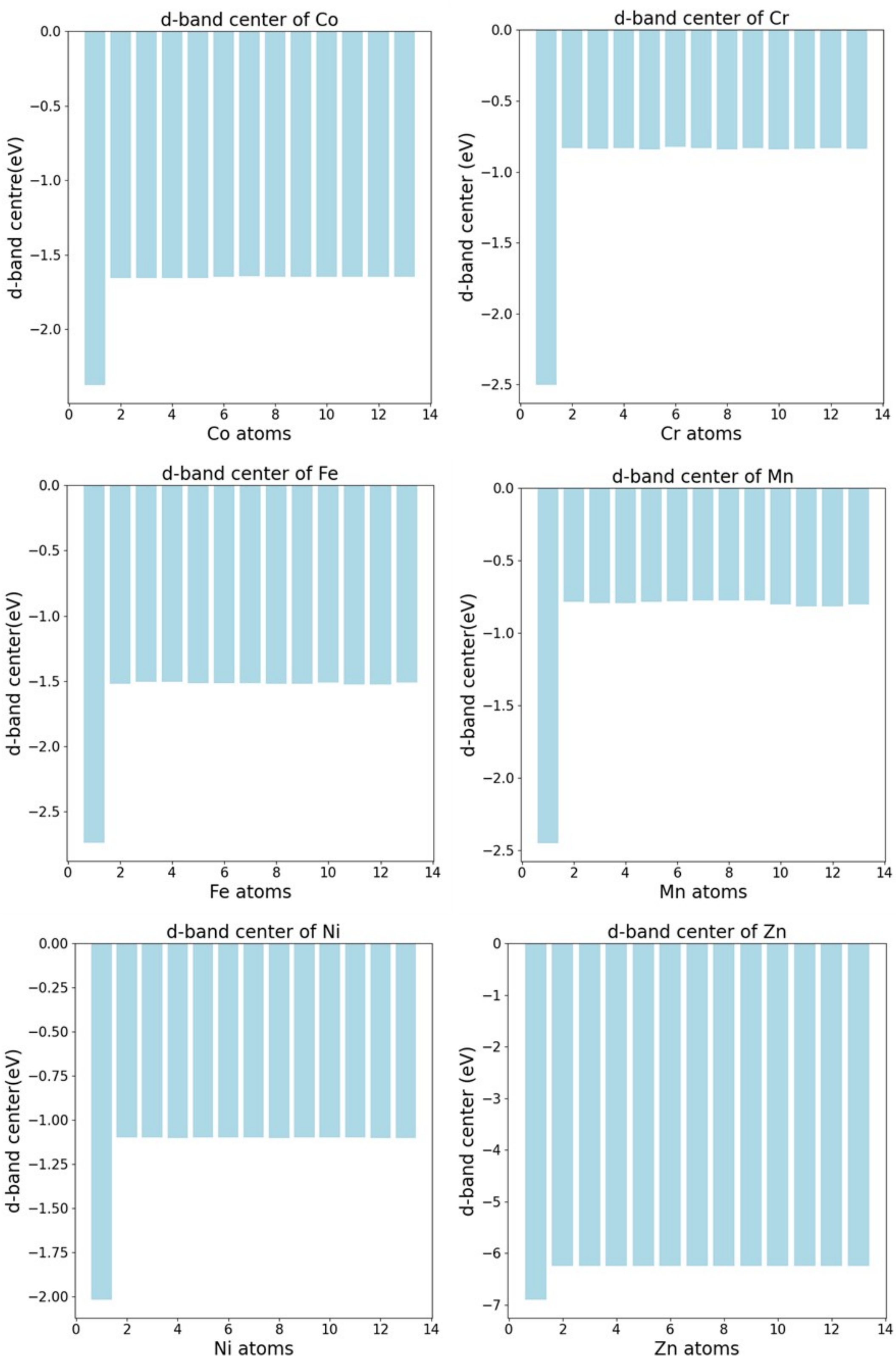


**Figure S10:** *d*-band center.

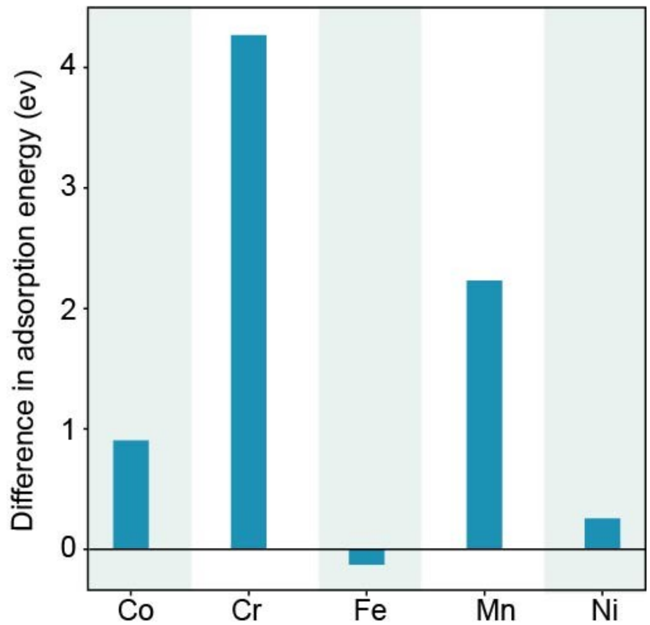


**Figure S11:** Plot showing adsorption energy difference in individual elements.

**Table 1:** Comparison among various liquid state asymmetric devices

| **Electrode material** | **Device type** | **Energy density (Wh/kg)** | **Power density (W/kg)** | **Cyclic stability** | **Ref.** |
|---|---|---|---|---|---|
| $Mn_3(PO_4)_2$ GF//AC | Asymmetric | 7.6 | 360 | 96% after 10k cycle | [3] |
| $CaCu_2O_3$//AC | Asymmetric | 11.8 | 362 | 90.9 % after 10k cycles | [4] |
| $CuCo_2O_4$//CNF | Asymmetric | 21.5 | 400 | 91.1% after 5k cycles | [5] |
| FeNiCoMnMg HEA-NPs/ACNFs | Symmetric | 21.7 | - | 85% after 2k cycles | [6] |
| HEO/f-CSAC | Symmetric | 3.55 | 862.5 | 94.4% after 500 cycles | [7] |
| ZNCO//AC | Asymmetric | 35.6 | 187.6 | 90% after 3k cycles | [8] |
| NiNTAS@ Fe2O3// | Asymmetric | 34.1 | 3197.7 | 92.3% after 5k cycle | [9] |

| | | | | | |
|---|---|---|---|---|---|
| NiNTAS@MnO2 | | | | | |
| Ni-Co-$PO_4$//AC | Asymmetric | 32.5 | 600 | 80.4% after 5k cycles | [10] |
| $NiCo_2O_4$@$MnO_2$ // AC | Asymmetric | 35 | 163 | 71% after 5k cycles | [11] |
| $CoMoO_4$@ $NiMoO_4$// AC | Asymmetric | 28.7 | 262 | 99% after 3k cycles | [12] |
| $MnO_2$/rGO//AC | Asymmetric | 25.14 | 250 | - | [13] |
| **FeCoNiCrMn// AC** | **Asymmetric** | **21** | **307** | **88.5% after 5k cycles** | **This Work** |