Electronic Supplementary Material (ESI) for Nanoscale.

Supplementary file

Flexible solid-state Zn-Air battery based on polymer-oxygen functionalized g-C_3N_4 composite membrane

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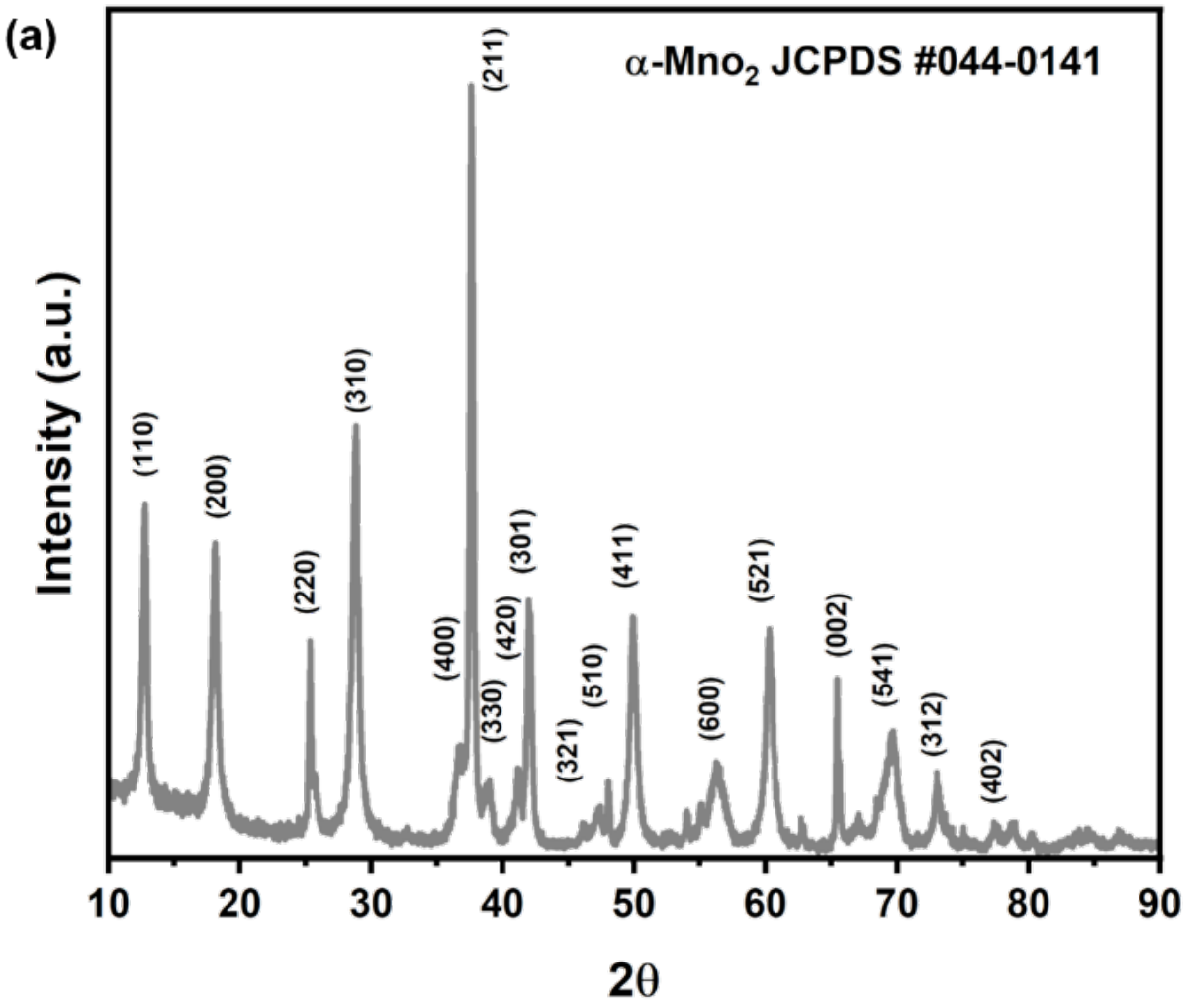

Figure 1. XRD pattern of MnO_2

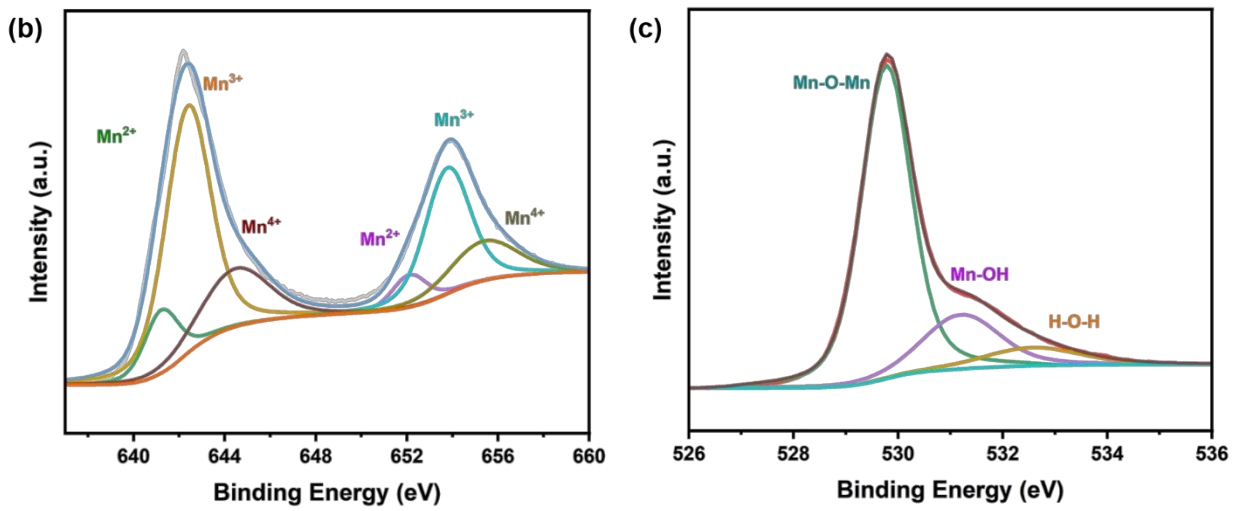

Figure 2. XPS plot of Mn and O present in MnO_2

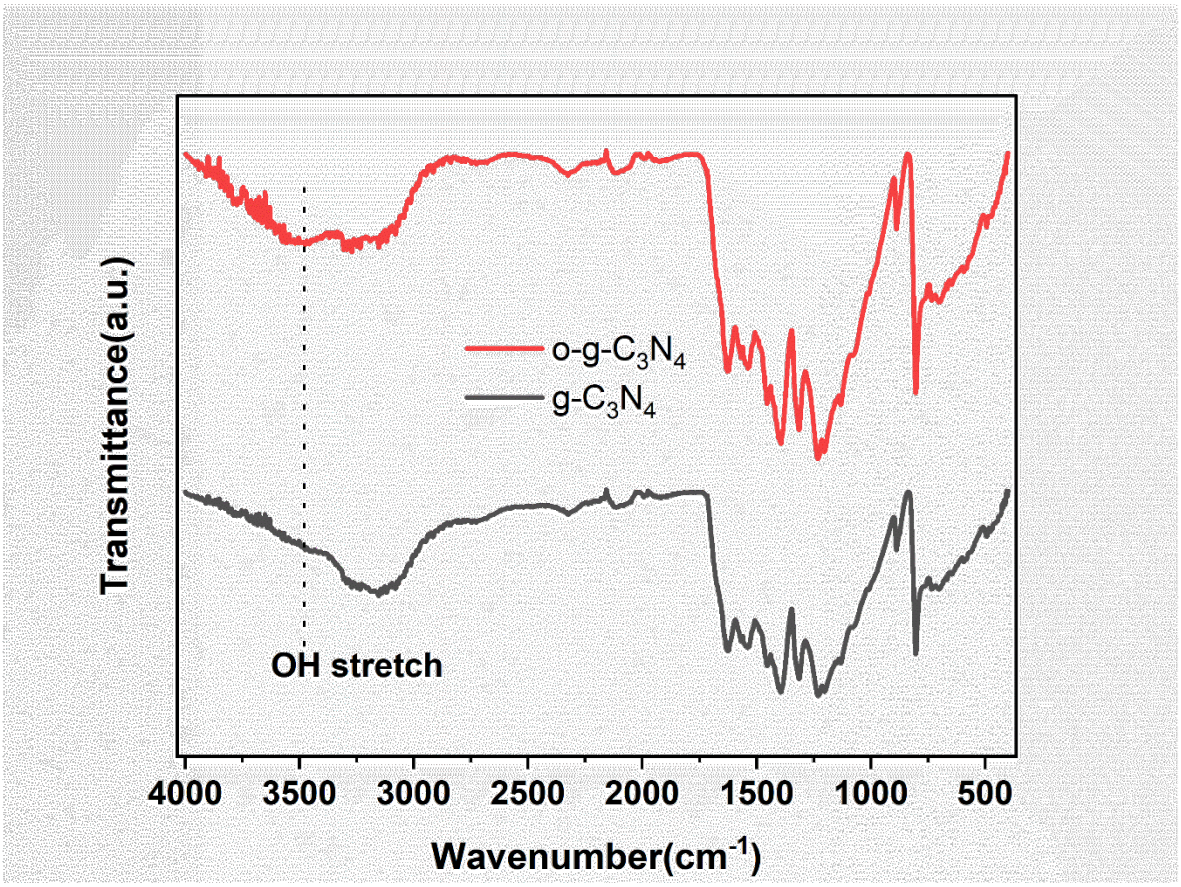

Figure 3. IR plot of g-C3N4 and o-g-C3N4

Conductivity data along with the value of resistance

Thickness – 0.55mm

Area – 3 cm^2

Formula – Thickness/resistance*area

Units for the conductivity- $mScm^{-1}$

Sr. No	PVA	0.16 wt%	0.32 wt%	0.48 wt%	0.64 wt%
1	18	19	21	17	6
2	18	19	27	17	7
3	19	22	25	17	10

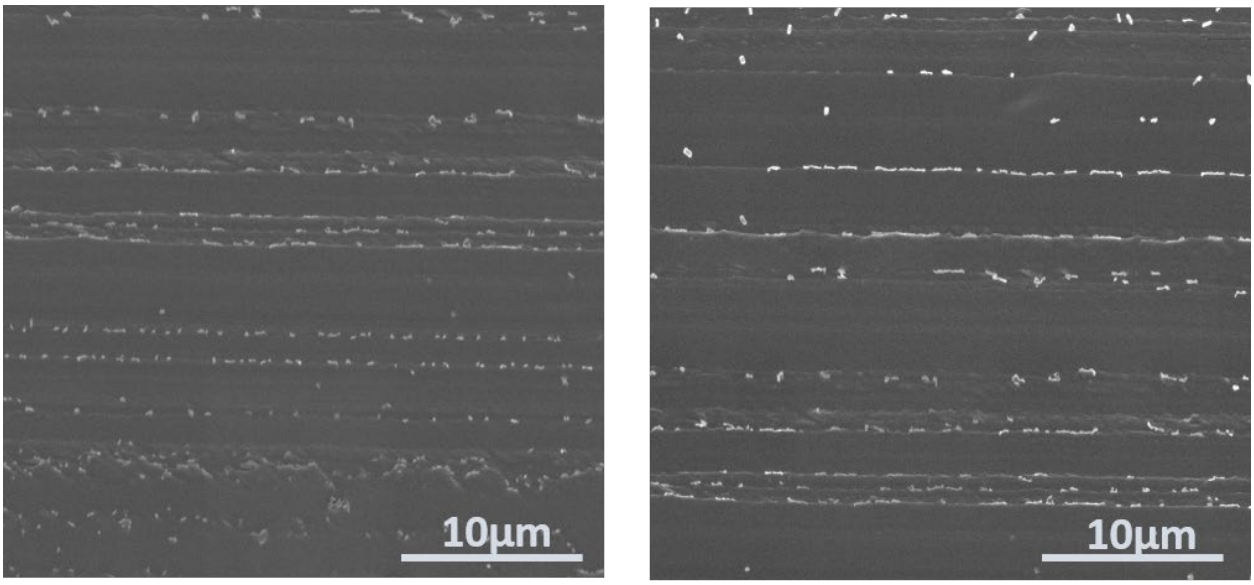

Figure 4. Cross-sectional SEM of the composite membrane

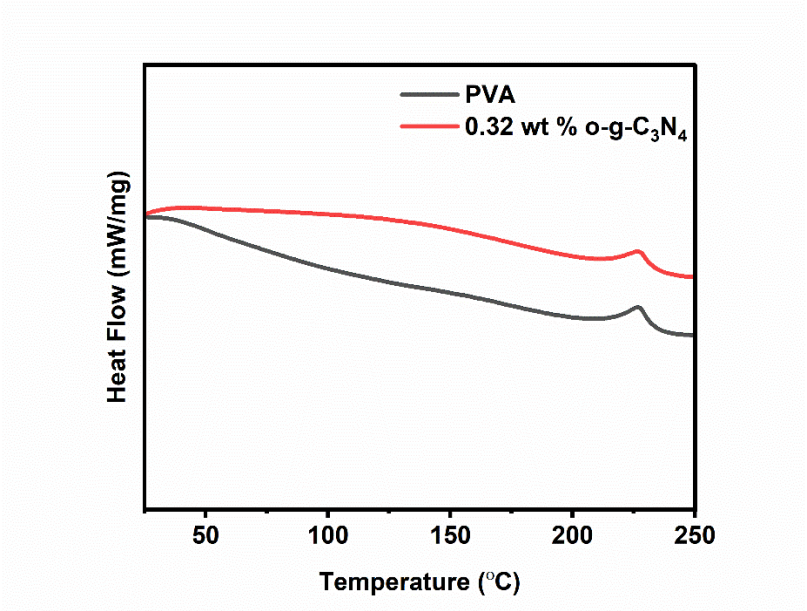

Figure 5. DSC curve of PVA and 0.32wt % o-g-C3N4@PVA

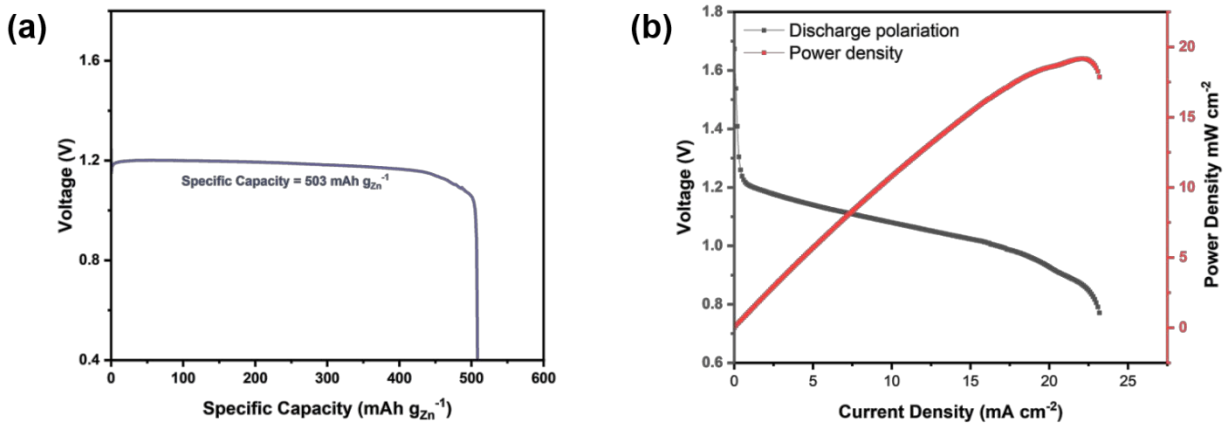

Figure 6. (a) Specific capacity measurements (b) Discharge polarisation and Power density plot (c) step discharge

Table for literature comparison of various gel polymer electrolytes for Zinc-air batteries.

Material for membrane	Feature of the membrane	Electrolyte	Device performance	Reference
0.32 wt % o-g-C_3N_4/PVA	Conductivity-27 mS cm^{-1} Young's modulus-107.63 MPa	6M KOH	OCP - 1.48V GCD stability-greater than 40 hours at 2mA/cm^2	This work
PVAA-Cellulose	Conductivity- 123 mS cm^{-1} Maximum tensile stress-0.87 MPa	KOH + $Zn(Ac)_2$	OCP - 1.41V GCD stability-53 hours	1
PANa-St-0.5	Conductivity- 82 mS cm^{-1} Tensile strength- 10.85 KPa	6M KOH	OCP - 1.40 V GCD stability-70 hours	2
BC/PVA membrane	Conductivity- 81.7 mS cm^{-1} Tensile strength - 0.951 MPa	6.0 M KOH and 0.2 M $Zn(CH_3COO)_2$	OCP-1.35V GCD stability-more than 400 hours at 0.5 current density	3
PAMPS-K/MC hydrogel	Conductivity- 105 mS cm^{-1}	5M KOH	OCP-1.35V GCD stability-more than 70 cycles 40 hours.	4
Porous PVA–5 wt% SiO2 nanocomposite GPEs	Conductivity -57.3 mS cm^{-1} Maximum stress – 705 KPa	6M KOH	OCP- 2.54 V two batteries connected in series. GCD stability-more than 50 hours.	5

1. Li, W.; Wang, Y.; Liu, R.; Chen, W.; Zhang, H.; Zhang, Z., Gel Polymer-Based Composite Solid-State Electrolyte for Long-Cycle-Life Rechargeable Zinc–Air Batteries. *ACS Sustainable Chemistry & Engineering* **2023,** *11* (9), 3732-3739.
2. Zhang, Y.; Chen, Y.; Alfred, M.; Huang, F.; Liao, S.; Chen, D.; Li, D.; Wei, Q., Alkaline sodium polyacrylate-starch hydrogels with tolerance to cold conditions for stretchable zinc-air batteries. *Composites Part B: Engineering* **2021,** *224*, 109228.
3. Zhao, N.; Wu, F.; Xing, Y.; Qu, W.; Chen, N.; Shang, Y.; Yan, M.; Li, Y.; Li, L.; Chen, R., Flexible hydrogel electrolyte with superior mechanical properties based on poly (vinyl alcohol) and bacterial cellulose for the solid-state zinc–air batteries. *ACS applied materials & interfaces* **2019,** *11* (17), 15537-15542.
4. Sun, N.; Lu, F.; Yu, Y.; Su, L.; Gao, X.; Zheng, L., Alkaline double-network hydrogels with high conductivities, superior mechanical performances, and antifreezing properties for solid-state zinc–air batteries. *ACS applied materials & interfaces* **2020,** *12* (10), 11778-11788.

5. Fan, X.; Liu, J.; Song, Z.; Han, X.; Deng, Y.; Zhong, C.; Hu, W., Porous nanocomposite gel polymer electrolyte with high ionic conductivity and superior electrolyte retention capability for long-cycle-life flexible zinc–air batteries. *Nano Energy* **2019,** *56*, 454-462.