Supplementary Information

Visible-Light Driven Photo-enhanced Zinc-Air Batteries using Synergistic Effect of Different Type of MnO_2 Nanostructures

Ankita Mathur[a] , Ravinder Kaushik [b] and Aditi Halder[*b]

[a] School of Engineering, Indian Institute of Technology Mandi, Mandi, H.P., India

[b] School of Basic Science, Indian Institute of Technology Mandi, Mandi, H.P., India

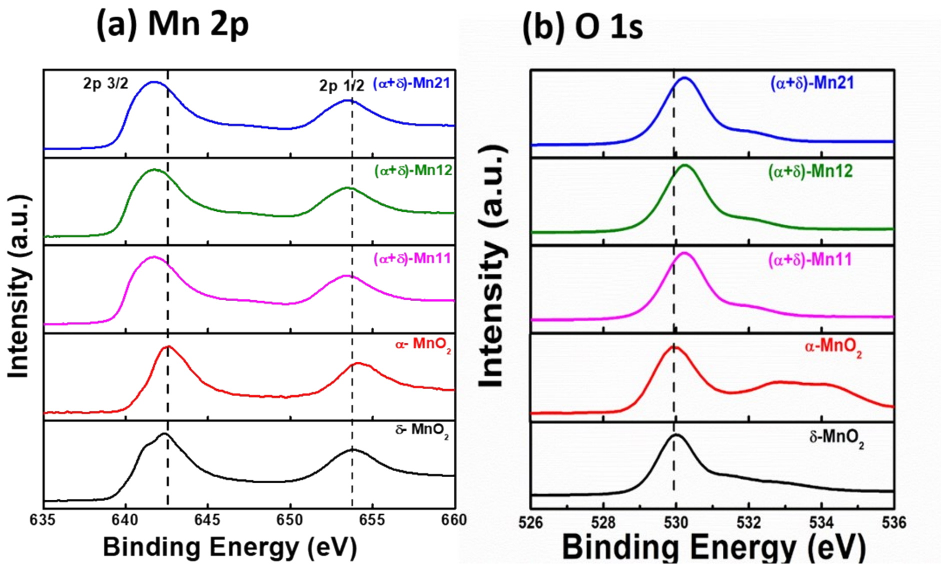

Figure S1. XPS spectra of (a) Mn 2p and (b) O 1s for all electrocatalysts.

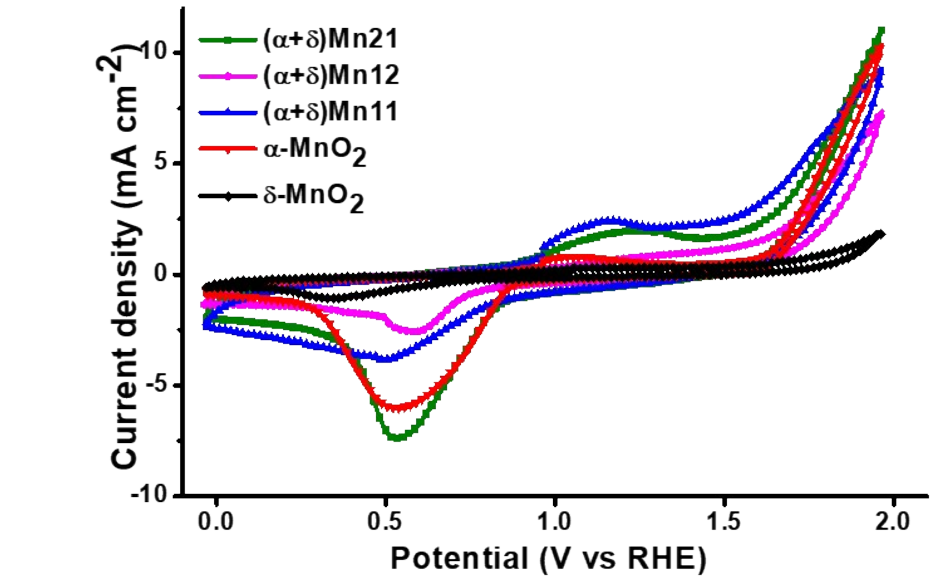

Fig. S2 Cyclic voltammetry studies of composite (α+δ)- Mn21, (α+δ)- Mn12 and (α+δ)-Mn11, along with α- MnO_2 and δ- MnO_2 taken in 0.1 M KOH electrolyte in O_2 atmosphere.

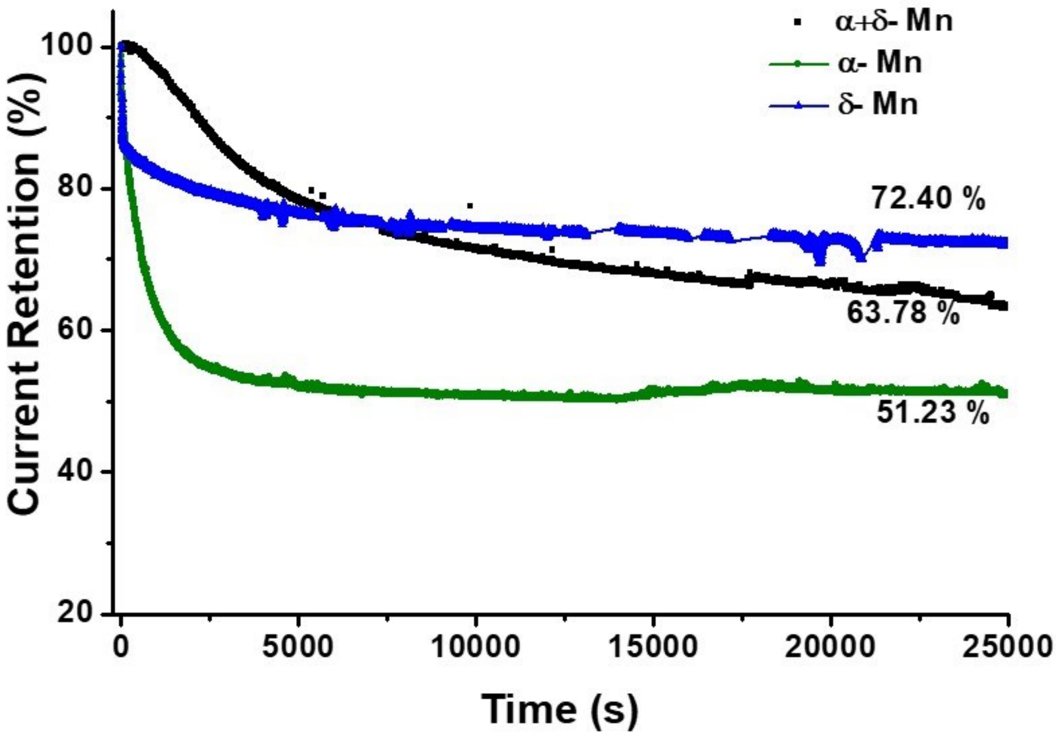

Fig. S3 Chronoamperometric response of (α+δ)-Mn11, α - MnO_2 and δ- MnO_2 composite taken at -0.6 V (vs Ag/AgCl) and 600 rpm in O_2 saturated 0.1 M KOH electrolyte solution.

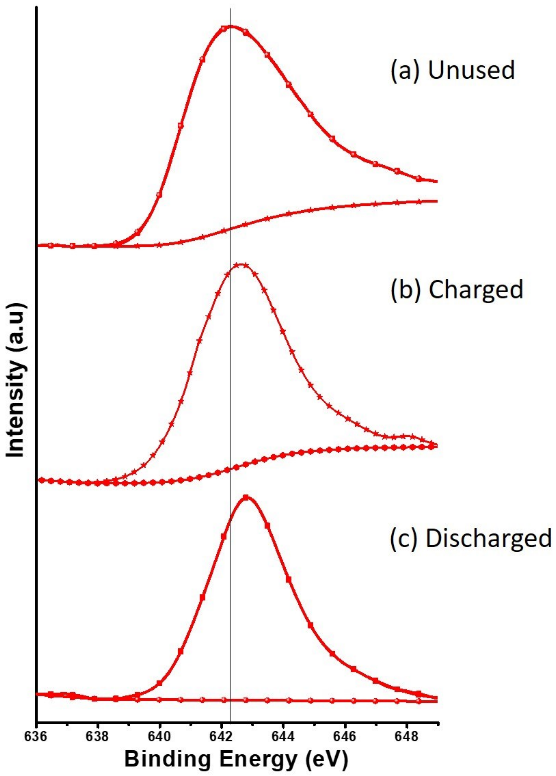

Fig. S4 XPS of Mn 2p for (a) Unused; (b) After charging; and (c) After discharging (α+δ)-Mn11 sample, showing a shift in the peak binding energy.

Table 1 showing atomic percentage of Mn in various oxidation states calculated from XPS

	Atomic percentage				
	α- MnO_2	δ- MnO_2	(α+δ)- Mn11	(α+δ)- Mn12	(α+δ)- Mn21
Mn (VI)	28.01	11.15	21.50	14.26	9.96
Mn(IV)	71.99	81.91	53.71	63.68	69.33
Mn(III)	---	2.87	6.86	12.23	10.08
Mn(II)	---	1.63	5.33	4.88	5.05

Table 2 showing surface area and pore radius measurement

	α- MnO_2	δ- MnO_2	(α+δ)- MnO_2
Specific surface area (m^2/g)	57.63	171.40	52.03
Pore diameter (Å)	38.14	34.02	31.28

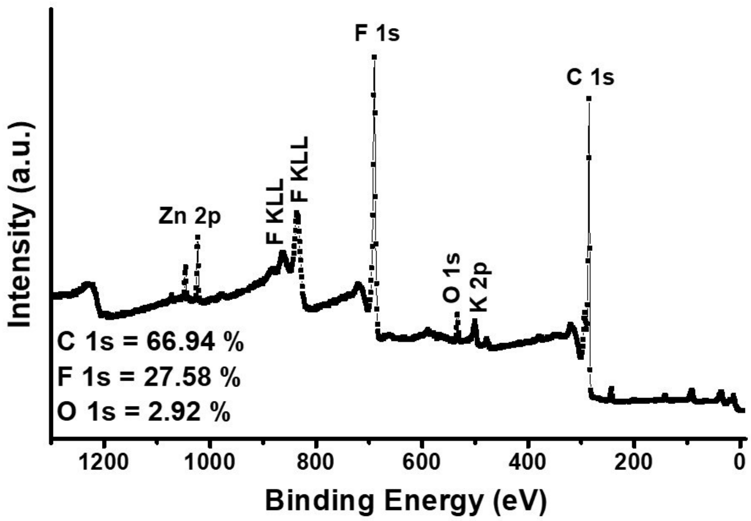

Fig. S5 Survey scan of bare carbon paper used as substrate for (α+δ)-Mn11 battery analysis.

Table 3 showing survey of various cathode materials used for Zn-air battery

	Specific Capacity at 5 mA cm^{-2}	Power density (mW cm^{-2})	Reference
δ- MnO_2	169.5 mAh	---	[1]
δ- MnO_2	160.3 mAh	---	[1]
α- MnO_2	175.2 mAh	---	[1]
α- MnO_2	171.5 mAh	---	[1]
Fe doped α-MnO_2	669.0 mAh g^{-1}	30.65	[2]
α- MnO_2 /CNT10	---	66.30	[3]
α- MnO_2 /CNT20	----	65.40	[3]
α- MnO_2 /DWCNT	---	61.60	[3]
α- MnO_2 /XC72	---	61.50	[3]
α- MnO_2 /SWCNT	---	59.50	[3]
α- MnO_2 /AC	---	57.60	[3]
α- MnO_2 /SMGP	---	40.50	[3]
MnO_2-$IL_{0.5}$	762.0 mAh g^{-1}	166.00	[4]
$CoMn_2O_4$/rGO	460.0 mAh g^{-1} (20 mA cm^{-2})	---	[5]
$CoMn_2O_4$/N- rGO	610.0 mAh g^{-1} (20 mA cm^{-2})	---	[5]
Co_3O_4/ MnO_2	---	43.00	[6]
Co_3O_4	---	15.00	[6]
MnO_2	---	32.00	[6]
Pt/C	625 mAh g^{-1}	140.00	[7]
α- MnO_2	710.0 mAh g^{-1}	6.91	This work
δ- MnO_2	671.0 mAh g^{-1}	15.77	This work
(α+δ)- MnO_2	715.0 mAh g^{-1}	28.53	This work

Reference:

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