

Review

Recent Advances in Rechargeable Aqueous Magnesium-ion Batteries

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Table S1. Electrochemical performances of various cathodes for AMIBs.

Cathode	Electrolyte	Current collector	Work Voltage (Mg/Mg ²⁺)	Discharge potential (Mg /Mg ²⁺)	Current density (mA g ⁻¹)	Discharge capacity (mAh g ⁻¹)	Cycle number (n)	Capacity retention (%)	Ref.
λ -MnO ₂	1 M MgCl ₂	carbon cloth	2.20~3.75	3.65	136	250.0	300	61.5	[1]
λ -MnO ₂ /MWCNTs	0.5 M MgSO ₄	carbon cloth	2.30~2.70	2.40	1000	124.1	1000	86.2	[2]
B-MnO ₂	0.5 M Mg(ClO ₄) ₂	stainless steel	2.37~2.97	2.80	2000	88.6	10000	62.5	[3]
δ -MnO ₂	1 M MgSO ₄	Ti	2.37~2.77	2.47	3000	75.0	1500	84.0	[4]
δ -MnO ₂ @CMS	0.5 M Mg(NO ₃) ₂	carbon cloths	2.40~2.75	2.65	50	224.1	300	60.5	[5]
δ -MnO ₂ @ MWCNTs/CC	0.5 M MgSO ₄	carbon cloths	2.40~2.80	2.65	1000	75.2	1150	80.0	[6]
α -MnO ₂	1 M MgSO ₄	nickel foam	2.40~2.90	2.70	500	87.5	N/A	N/A	[7]
α -MnO ₂ /CNT	1 M MgSO ₄	nickel foam	2.30~2.80	2.55	10000	67.0	1000	85.0	[7]
electro-conversion Mg-birnessite	0.5 M Mg(ClO ₄) ₂	carbon cloths	2.37~2.77	2.57	2000	130.0	3000	73.6	[8]

Cathode	Electrolyte	Current collector	Work Voltage (Mg/Mg ²⁺)	Discharge potential (Mg /Mg ²⁺)	Current density (mA g ⁻¹)	Discharge capacity (mAh g ⁻¹)	Cycle number (n)	Capacity retention (%)	Ref.
δ -MnO ₂ /MWCNTs	0.5 M MgSO ₄	carbon cloths	2.52~2.80	2.60	1000	45.1	500	>100	[9]
ϵ -MnO ₂	1 M MgCl ₂	carbon cloths	2.67~2.97	2.82	2000	100.0	400	94.3	[10]
Mn ₃ O ₄	1 M MgSO ₄	carbon cloths	2.80~3.00	2.90	200	95.8	2000	99.4	[11]
LiMn ₂ O ₄	1 M Mg(NO ₃) ₂	stainless steel	2.40~2.70	2.50	45400	42.0	20	83.3	[12]
Li _{0.21} MnO ₂ ·H ₂ O	0.5 M Mg(NO ₃) ₂	carbon cloths	2.50~3.20	2.80	100	165.8	300	56.3	[13]
Mg _{1/3} Ni _{1/3} Mn _{2/3} O ₂	1 M Mg(NO ₃) ₂	carbon cloths	2.50~3.40	3.32	1000	100.0	200	50.6	[14]
Mg-OMS-1	0.2 M MgCl ₂	carbon cloths	2.30~2.65	2.50	100	~110	200	86.0	[15]
Mg-OMS-7	0.2 M Mg(NO ₃) ₂	carbon cloths	2.40~3.00	2.80	100	102.0	200	95.3	[16]
10% Nb K-OMS-2	0.5 M Mg(NO ₃) ₂	carbon cloths	2.00~2.90	2.80	100	175.0	200	38.6	[17]
10% V K-OMS-2	0.5 M Mg(NO ₃) ₂	carbon cloths	2.00~2.90	2.80	100	180.0	200	36.8	[17]
MgMn ₂ O ₄	0.5 M MgCl ₂	carbon paper	2.45~2.90	2.70	1000	82.8	1000	94.2	[18]
MgMn ₂ O ₄ /rGO	0.5 M MgCl ₂	carbon paper	2.40~2.80	2.70	1000	140.1	1000	85.3	[18]
buserite Mg-Mn oxide	0.5 M MgCl ₂	carbon cloths	2.30~3.10	2.65	1000	~164	100	~80.0	[19]

Cathode	Electrolyte	Current collector	Work Voltage (Mg/Mg ²⁺)	Discharge potential (Mg /Mg ²⁺)	Current density (mA g ⁻¹)	Discharge capacity (mAh g ⁻¹)	Cycle number (n)	Capacity retention (%)	Ref.
T-MgMn ₂ O ₄	1 M MgSO ₄	carbon cloths	2.17~2.67	2.37	100	225.0	360	≈100	[20]
Mg ₂ MnO ₄	1 M MgSO ₄ + 0.1 M MnSO ₄	stainless steel	2.75~3.37	2.96	800	71.7	50	>100	[21]
MgMn ₂ O ₄ -7.5/MWCNTs	0.5 M MgSO ₄	carbon cloths	2.10~2.80	2.30	1000	125.8	2000	81.8	[22]
Flower-like MgMn ₂ O ₄	0.5 M Mg(NO ₃) ₂	Ti	2.35~2.90	2.75	100	20.0	50	>100	[23]
EMgMn ₂ O ₄ /MWCNTs	0.5 M MgSO ₄	carbon cloths	2.30~2.75	2.65	1000	145.0	1000	73.3	[24]
MgFe _{1.33} Mn _{0.67} O ₄	0.5 M MgCl ₂	carbon cloths	2.50~3.60	2.80	1000	~50	1000	>100	[25]
NaMnTiO-5	0.5 M MgCl ₂	carbon cloths	2.40~3.00	2.70	1000	110.0	1000	>100	[26]
Ni _{0.3} -Mg-1	0.5 M Mg(NO ₃) ₂	carbon cloths	2.00~2.65	2.40	100	105.0	300	89.7	[27]
CuHCF	1 M Mg(CH ₃ COO) ₂	Ti	2.97~3.37	3.22	1000	81.0	200	51.9	[28]
CuFe-PBA	1 M Mg(NO ₃) ₂	carbon cloths	2.87~3.57	3.47	100	50.0	N/A	N/A	[29]
D-CuHCF@CNTF	1 M MgCl ₂	carbon nanotube	2.67~3.57	3.42	10000	90.0	1000	67.0	[30]

Cathode	Electrolyte	Current collector	Work Voltage (Mg/Mg ²⁺)	Discharge potential (Mg /Mg ²⁺)	Current density (mA g ⁻¹)	Discharge capacity (mAh g ⁻¹)	Cycle number (n)	Capacity retention (%)	Ref.
NiHCF	1 M MgSO ₄	stainless steel	2.87~3.17	2.97	10000	58	2000	86.2	[31]
Na _{1.4} Cu _{1.3} Fe(CN) ₆ ·5H ₂ O	1 M MgSO ₄	stainless steel	3.22~3.47	3.27	10000	60	1000	60	[31]
Mg _{0.75} V ₁₀ O ₂₄ ·4H ₂ O	2 M Mg(CF ₃ SO ₃) ₂	carbon cloths	2.20~3.30	3.2	3000	90	100	67	[32]
V ₂ O ₅	PEG-5	carbon cloths	2.20~3.00	2.75	100	120	100	~100	[33]
Li ₃ V ₂ (PO ₄) ₃	4 M Mg(TFSI) ₂	Ti	2.72~3.52	3.42	1000	105	1000	~85	[34]

Table S2. Electrochemical performances of various anodes for AMIBs.

Anode	Electrolyte	Current collector	Work Voltage (Mg/Mg ²⁺)	Discharge potential (Mg/Mg ²⁺)	Current density (mA g ⁻¹)	Discharge capacity (mAh g ⁻¹)	Cycle number (n)	Capacity retention (%)	Ref.
FeVO ₄ ·0.9H ₂ O	1 M MgSO ₄	carbon cloths	1.70~2.40	2.10	100	98.5	50	75.1	[35]
FeVO ₄ ·0.9H ₂ O/rGO	1 M MgSO ₄	carbon cloths	1.80~2.40	2.15	100	118.2	50	82.5	[35]
FeVO ₄	1 M MgSO ₄	carbon cloths	1.50~2.20	1.99	100	150.4	50	29.9	[36]
FeVO ₄ /C	1 M MgSO ₄	carbon cloths	1.50~2.20	2.01	100	185.1	50	63.2	[37]
Polyimide	1 M MgSO ₄	stainless steel	2.37~2.67	2.07	1000	146.0	2000	90.0	[31]
PPMDA/MCNTs	4 M Mg(TFSI) ₂	Ti	1.70~2.00	1.80	100	110.0	500	87.0	[34]
3D-P(PDI-T)	1 M MgCl ₂	carbon cloths	1.60~2.50	1.90	5000	120.0	5000	93.2	[38]
PTCDI	0.5 M Mg(NO ₃) ₂	Ti	1.40~2.00	1.90	500	75.0	10000	87.2	[23]
PTCDA	1 M MgCl ₂	carbon cloths	2.00~2.13	2.05	1000	100.0	800	85.0	[10]
VO ₂	1 M MgSO ₄	carbon cloths	1.85~2.10	2.10	500	130.3	100	54.3	[5]
VO _x	4.5 M MgCl ₂	graphite foil	1.90~2.90	2.83	1300	200.0	100	98.4	[39]

Anode	Electrolyte	Current collector	Work Voltage (Mg/Mg ²⁺)	Discharge potential (Mg /Mg ²⁺)	Current density (mA g ⁻¹)	Discharge capacity (mAh g ⁻¹)	Cycle number (n)	Capacity retention (%)	Ref.
Mn-NaVO	MAU117	carbon cloths	2.10~2.30	2.10	500	105.3	60	>100	[40]
VO ₂ (B)	1 M Mg(CH ₃ COO) ₂	carbon cloths	1.60~2.30	2.15	1000	257.0	3000	81.5	[28]
V ₂ O ₅	0.075 M MgCl ₂	fluorine-doped tin oxide	1.42~1.72	1.52	5900	427.0	2000	82.0	[41]
TiO ₂	PEG-5	carbon cloths	0.70~1.30	0.88	500	157.0	200	70.0	[33]
MoTe ₂	1 M MgCl ₂	carbon cloths	1.90~2.30	2.40	1000	175.0	250	14.2	[42]

Table S3. Electrochemical performances of various full cells for AMIBs.

Cathode	Anode	Electrolyte	Work voltage (V)	Discharge plateau (V)	Current density (mA g ⁻¹)	discharge capacity (mAh g ⁻¹)	Cycle number (n)	Capacity retention (%)	Ref.
Mg-OMS-1	FeVO ₄ 0.9H ₂ O/rGO	1 M MgSO ₄	0.00~1.80	0.70	100	54.3	100	97.2	[35]
Mg-OMS-1	FeVO ₄ /C	1 M MgSO ₄	0.00~1.80	0.30	100	58.9	100	97.7	[36]
NiHCF	Polyimide	1 M MgSO ₄	0.00~1.55	0.75	500	35.0	5000	60.0	[31]
Na _{1.4} Cu _{1.3} Fe(CN) ₆ · 5H ₂ O	Polyimide	1 M MgSO ₄	0.00~1.55	1.10	500	36.5	5000	60.0	[31]
Li ₃ V ₂ (PO ₄) ₃	PPMDA@MWCNT S	4 M Mg(TFSI) ₂	0.40~1.80	1.00	2000	42.0	6000	92.0	[34]
Mg-OMS-2/rGO	AC	0.5 M Mg(NO ₃) ₂	0.00~2.00	0.70	100	46.0	500	95.8	[43]
Mn ₃ O ₄	AC	2 M MgSO ₄	0.00~2.00	0.70	500	50.0	6000	>100	[44]
EMgMn ₂ O ₄ /MWCNTs	AC	0.5 M MgSO ₄	0.00~2.00	0.60	1000	43.5	500	>100	[24]
δ-MnO ₂ @CMS	VO ₂	1 M MgSO ₄	0.00~1.80	1.30	500	~100	100	46.9	[5]
Ni _{0.3} -Mg-1	VO ₂	1M MgSO ₄	0.00~1.80	0.20	500	65.0	100	94.6	[27]

Mg ₂ MnO ₄	Polyimide	1 M MgSO ₄ + 0.1 M MnSO ₄	0.10~1.60	0.86	18000	79.4	10000	89	[21]
Cathode	Anode	Electrolyte	Work voltage (V)	Discharge plateau (V)	Current density (mA g⁻¹)	discharge capacity (mAh g⁻¹)	Cycle number (n)	Capacity retention (%)	Ref.
Li _{0.21} MnO ₂ ·H ₂ O	VO ₂	0.5 M MgSO ₄	0.00~2.00	0.60	100	57.4	50	80.5	[13]
δ-MnO ₂ /MWCNTs	VO ₂	0.5 M MgSO ₄	0.00~2.20	0.75	1000	16.2	500	>100	[9]
Electro-conversion Mg-birnessite	Polyimide	0.5 M Mg(ClO ₄) ₂	0.00~2.00	0.75	500	42.0	500	99.0	[8]
δ-MnO ₂ @MWCNTs/CC	AC	0.5 M MgSO ₄	0.00~1.60	0.80	1000	40.0	1000	>100	[6]
ε-MnO ₂	PTCDA	1 M MgCl ₂	0.00~1.60	1.00	1000	100.0	800	72.6	[10]
MMO	PTCDI	1 M MgCl ₂	0.00~1.80	1.10	200	~100.0	400	>100	[45]
MnO ₂	VO _x	4.5 M MgCl ₂	0.01~2.10	1.00	2600	33.0	1000	84.5	[39]
Flower-like MgMn ₂ O ₄	PTCDI	0.5 M Mg(NO ₃) ₂	0.20 ~1.50	0.75	1000	124.8	5000	80.9	[23]
MgMn ₂ O ₄ -7.5/MWCNTs	VO ₂	0.5 M MgSO ₄	0.00~1.90	0.70	1000	18.4	500	~100	[22]
Cathode	Anode	Electrolyte	Work	Discharge	Current	discharge	Cycle	Capacity	Ref.

			voltage (V)	plateau (V)	density (mA g ⁻¹)	capacity (mAh g ⁻¹)	number (n)	retention (%)	
CuHCF	Mg	MgCl ₂ ·6H ₂ O WIS	1.20~2.40	2.30	500	35.0	700	65.0	[46]
CuHCF	Mg	MgCl ₂ -PEO QSSEs	1.60~2.60	2.20	250	120.0	800	88.0	[47]
MnO ₂	Mg	SIW2	1.40~2.80	2.5	5000	500	1200	~99	[48]
CuHCF	V ₂ O ₅ (B)	1 M Mg(CH ₃ COO) ₂	0.10~1.70	1.10	5000	210.7	500	67.3	[28]
CuHCF	Mn-NaVO	MAU117	0.01~1.40	0.90	1000	40.0	800	>100	[40]
Buserite Mg-Mn oxide	AC	0.5 M MgCl ₂	0.00~1.80	1.20	1000	70.0	1000	100	[19]
Mg _{0.75} V ₁₀ O ₂₄ ·4H ₂ O	PTCDA	Mg(CF ₃ SO ₃) ₂ -PEO	0.00~1.70	0.70	4000	60.0	5000	62.0	[32]
Mg ₂ MnO ₄	3D-P(PDI-T)	1.0 M MgCl ₂	0.00~1.80	1.50	500	148.0	5000	100	[38]
Mg _x CuHCF	PTCDI	1 M Mg(TFSI) ₂	0.00~2.20	1.50	1000	97	2000	56.3	[49]
δ-MnO ₂ /rGO	PTCDI	2 M MgSO ₄ +2 M Mg(CH ₃ COO) ₂	0.00~2.00	1.14	2000	16.5	3000	76.4	[50]
δ-MnO ₂	VO ₂	4 M MgCl ₂	0.00~1.70	1.50	2000	42.0	1000	100	[51]
NaMnTiO-5	AC	0.5 M MgCl ₂	0.00~1.80	1.50	1000	125.0	1000	90.4	[26]
V ₂ O ₅	Mg _x TiO ₂ (B)	PEG-5	0.10~2.45	1.70	100	57.0	200	>100	[33]

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