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Comparison of commercial battery types

This is a list of commercially-available battery types summarizing some of their characteristics for ready comparison.

Common characteristics

Cell chemistry	Also known as	Electrode			Re-chargeable	Commercialized year	Cutoff V	
		Anode	Electrolyte	Cathode				
Lead–acid	SLA VRLA PbAc	<u>Lead</u>	<u>KOH</u>	<u>Lead dioxide</u>	Yes	1881 ^[1]	1.75 ^[2]	
Zinc–carbon	Carbon–zinc	<u>Zinc</u>	<u>NH₄Cl</u>	<u>Manganese (IV) oxide</u>	No	1898 ^[3]	0.75–0.9 ^[3]	
Zinc–air	PR		<u>KOH</u>	<u>Oxygen</u>	No	1932 ^[5]	0.9 ^[5]	
Mercury oxide–zinc	Mercuric oxide Mercury cell		<u>NaOH/KOH</u>	<u>Mercuric oxide</u>	No	1942– ^[6] 1996 ^[7]	0.9 ^[8]	
Alkaline	Zn/MnO ₂ LR		<u>KOH</u>	<u>Manganese (IV) oxide</u>	No	1949 ^[9]	0.9 ^[10]	
Rechargeable alkaline	RAM		<u>H₂SO₄</u>		<u>KOH</u>	1992 ^[13]	0.9 ^[14]	
Silver-oxide	SR		<u>NaOH/KOH</u>	<u>Silver oxide</u>	No	1960 ^[15]	1.2 ^[16]	
Nickel–zinc	NiZn		<u>KOH</u>	<u>Nickel oxide hydroxide</u>	Yes	2009 ^[13]	0.9 ^[13]	
Nickel–iron	NiFe		<u>Iron</u>		<u>KOH</u>	Yes	1901 ^[18]	0.75 ^[19]
Nickel–cadmium	NiCd NiCad	<u>Cadmium</u>	<u>KOH</u>		Yes	c. 1960 ^[25]	0.9–1.05 ^[26]	
Nickel–hydrogen	NiH ₂ Ni-H ₂	<u>Hydrogen</u>	<u>KOH</u>		Yes	1975 ^[29]	1.0 ^[30]	
Nickel–metal hydride	NiMH Ni-MH	<u>Metal hydride</u>	<u>KOH</u>		Yes	1990 ^[1]	0.9–1.05 ^[26]	
Low self-discharge nickel–metal hydride	LSD NiMH				Yes	2005 ^[34]	0.9–1.05 ^[26]	
Lithium–manganese dioxide	Lithium Li-MnO ₂ CR Li-Mn	<u>Lithium</u>			<u>Manganese dioxide</u>	No	1976 ^[37]	2 ^[38]
Lithium–carbon monofluoride	Li-(CF) _x BR					<u>Carbon monofluoride</u>	No	1976 ^[37]
Lithium–iron disulfide	Li-FeS ₂ FR				<u>Iron disulfide</u>	No	1989 ^[42]	0.9 ^[42]
Lithium–titanate	Li ₄ Ti ₅ O ₁₂ LTO				Lithium manganese oxide or Lithium nickel manganese cobalt oxide	Yes	2008 ^[44]	1.6–1.8 ^[45]

Cell chemistry	Also known as	Electrode			Re-chargeable	Commercialized year	Cutoff
		Anode	Electrolyte	Cathode			V
Lithium cobalt oxide	LiCoO ₂ ICR LCO Li-cobalt ^[47]	Graphite [‡]	LiPF ₆ /LiBF ₄ / LiClO ₄	Lithium cobalt oxide	Yes	1991 ^[48]	2.5 ^[49]
Lithium iron phosphate	LiFePO ₄ IFR LFP Li-phosphate ^[47]			Lithium iron phosphate	Yes	1996 ^[51]	2 ^[49]
Lithium manganese oxide	LiMn ₂ O ₄ IMR LMO Li-manganese ^[47]			Lithium manganese oxide	Yes	1999 ^[1]	2.5 ^[57]
Lithium nickel cobalt aluminium oxides	LiNiCoAlO ₂ NCA NCR Li-aluminium ^[47]			Lithium nickel cobalt aluminium oxide	Yes	1999	3.0 ^[58]
Lithium nickel manganese cobalt oxide	LiNi _x Mn _y Co _{1-x-y} O ₂ INR NMC ^[47] NCM ^[50]			Lithium nickel manganese cobalt oxide	Yes	2008 ^[59]	2.5 ^[49]

^{^†} Cost in USD, adjusted for inflation.

^{^‡} Typical. See [Lithium-ion battery § Negative electrode](#) for alternative electrode materials.

Rechargeable characteristics

Cell chemistry	Charge efficiency	Cycle durability
	%	# 100% depth of discharge (DoD) cycles
<u>Lead–acid</u>	50–92 ^[2]	50–100 ^[60] (500@40%DoD ^{[2][60]})
<u>Rechargeable alkaline</u>		5–100 ^[13]
<u>Nickel–zinc</u>		100 to 50% capacity ^[13]
<u>Nickel–iron</u>	65–80	5000
<u>Nickel–cadmium</u>	70–90	500 ^[25]
<u>Nickel–hydrogen</u>	85	20000 ^[31]
<u>Nickel–metal hydride</u>	66	300–800 ^[13]
<u>Low self-discharge nickel–metal hydride battery</u>		500–1500 ^[13]
<u>Lithium cobalt oxide</u>	90	500–1000
<u>Lithium–titanate</u>	85–90	6000–10000 to 90% capacity ^[46]
<u>Lithium iron phosphate</u>	90	2500 ^[54] –12000 to 80% capacity ^[61]
<u>Lithium manganese oxide</u>	90	300–700

Thermal runaway

Under certain conditions, some battery chemistries are at risk of thermal runaway, leading to cell rupture or combustion. As thermal runaway is determined not only by cell chemistry but also cell size, cell design and charge, only the worst-case values are reflected here.^[62]

Cell chemistry	Overcharge	Overheat		
	Onset	Onset	Runaway	Peak
	SOC%	°C	°C	°C/min
<u>Lithium cobalt oxide</u>	150 ^[62]	165 ^[62]	190 ^[62]	440 ^[62]
<u>Lithium iron phosphate</u>	100 ^[62]	220 ^[62]	240 ^[62]	21 ^[62]
<u>Lithium manganese oxide</u>	110 ^[62]	210 ^[62]	240 ^[62]	100+ ^[62]
<u>Lithium nickel cobalt aluminium oxide</u>	125 ^[62]	140 ^[62]	195 ^[62]	260 ^[62]
<u>Lithium nickel manganese cobalt oxide</u>	170 ^[62]	160 ^[62]	230 ^[62]	100+ ^[62]

NiCd vs. NiMH vs. Li-ion vs. Li–polymer vs. LTO

Types	Cell Voltage	Self-discharge	Memory	Cycles Times	Temperature	Weight
NiCd	1.2V	20%/month	Yes	Up to 800	-20 °C to 60 °C	Heavy
NiMH	1.2V	30%/month	Mild	Up to 500	-20 °C to 70 °C	Middle
Low Self Discharge NiMH	1.2V	3%/year–1%/month ^[63]	No	500–2000	-20 °C to 70 °C	Middle
Li-ion (LCO)	3.6V	5–10%/month	No	500–1000	-20 °C to 60 °C	Light
LiFePO ₄ (LFP)	3.2V	2–5%/month	No	2500–12000 ^[61]	-20 °C to 60 °C	Light
LiPo (LCO)	3.7V	5–10%/month	No	500–1000	-20 °C to 60 °C	Lightest
Li–Ti (LTO)	2.4V	2–5%/month ^[46]	No	6000–20000	-40 °C to 75 °C	Light

[64]

See also

- Battery nomenclature
- Experimental rechargeable battery types
- Aluminium battery
- List of battery sizes
- List of battery types
- Search for the Super Battery (2017 PBS film)

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