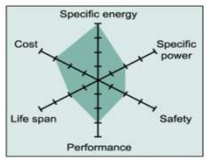

Figure 2: Snapshot of an average Li-cobalt b

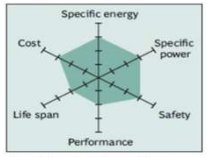

Figure 5: Snapshot of a pure Li-manganese i

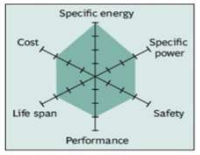

Figure 7: Snapshot of NMC.

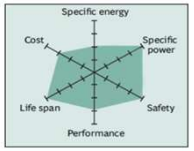

Figure 9: Snapshot of a typical Li-phosphate

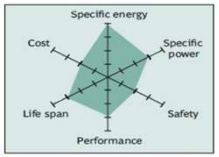

Figure 11: Snapshot of NCA.

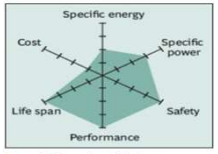

Figure 13: Snapshot of Li-titanate.

Chemistry	***Lithium Cobalt Oxide***	***Lithium Manganese Oxide***	***Lithium Nickel Manganese Oxide***	***Lithium Iron Phosphate***	***Lithium Nickel Cobalt Aluminum Oxide***	***Lithium Titanate Oxide***
Short form	Li-cobalt	Li-manganese	Li-nickel	Li-phosphate	Li-aluminum	Li-titanate
Chemical symbols	LiCoO2	LiMn2O4	LiNiMnCoO2	LiFePO4	LiNiCoAlO2	Li2TiO3 (common)
Abbreviation	(LCO)	LMO	NMC	LFP	NCA	LTO
Nominal voltage	3.60V	3.70V (3.80V)	3.60V (3.70V)	3.20, 3.30V	3.60V	2.40V
Full charge	4.20V	4.20V	4.20V (or higher)	3.65V	4.20V	2.85V
Full discharge	3.00V	3.00V	3.00V	2.50V	3.00V	1.80V
Minimal voltage	2.50V	2.50V	2.50V	2.00V	2.50V	1.50V (est.)
Specific Energy	150–200Wh/kg	100–150Wh/kg	150–220Wh/kg	90–120Wh/kg	200-260Wh/kg	70–80Wh/kg
Charge (C-rate)	0.7–1C (3h)	0.7–1C (3h)	0.7–1C (3h)	1C (3h)	1C	1C (5C max)
Discharge rate	1C (1h)	1C, 10C possible	1–2C	1C (25C pule)	1C	10C possible
Cycle life (ideal)	500–1000	300–700	1000–2000	1000–2000	500	3,000–7,000
Thermal runaway	150°C (higher when empty)	250°C (higher when empty)	210°C(higher when empty)	270°C (safe at full charge)	150°C (higher when empty)	One of safest
Cost $/kWh	x	x	420	580	350	1005
Pros		thermal stability and enhanced safety	Higher energy density, lower cost, and longer cycle	more tolerant to full charge conditions	High energy and power densities	Most safe.Fast charging and charging at low temperature
Cons		Calendar life are limited		Higher self-discharge than other Li-ion	Marginal safety	Specific energy is low
Packaging (typical)	18650, prismatic and pouch cell	prismatic	18650, prismatic and pouch cell	26650, prismatic	18650	prismatic
History	1991 (Sony)	1996	2008	1996	1999	2008
Applications	Mobile phones, tablets, laptops, cameras	Power tools, medical devices, powertrains	E-bikes, medical devices, EVs, industrial	Stationary with high currents and endurance	Medical, industrial,	UPS, EV, solar street lighting
Comments	High energy, limited power. Market share has stabilized.	High power, less capacity; safer than Li-cobalt; often mixed with NMC to improve performance.	High capacity and high power. Market share is increasing. Also NCM, CMN, MNC, MCN	Flat discharge voltage, high power low capacity, very safe; elevated self-discharge.	Highest capacity with moderate power. Similar to Li-cobalt.	Long life, fast charge, wide temperature range and safe. Low capacity, expensive.
Comments 2019 Update	Very high specific energy, limited specific power. Cobalt is expensive. Serves as Energy Cell. Market share has stabilized. Early version; no longer relevant.	High power but less capacity; safer than Li-cobalt; commonly mixed with NMC to improve performance. Less relevant now; limited growth potential.	Provides high capacity and high power. Serves as Hybrid Cell. Favorite chemistry for many uses; market share is increasing. Leading system; dominant cathode chemistry.	Very flat voltage discharge curve but low capacity. One of safest Li-ions. Used for special markets. Elevated self-discharge. Used primarily for energy storage,moderate growth.	Shares similarities with Li-cobalt. Serves as Energy Cell. Mainly used by Panasonic and Tesla; growth potential.	Long life, fast charge, wide temperature range but low specific energy and expensive. Among safest Li-ion batteries. Ability to ultra-fast charge; high cost limits to special application.