



# LTO VS NMC VS LFP VS GODZILLA AND ANY OTHER TLA'S ON THE PLANET



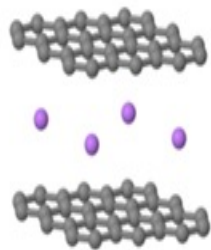
SOLAR ENERGY INTERNATIONAL

Renewable Energy Education for a Sustainable Future

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# WHATS THE MAGIC??

Graphite (Carbon)



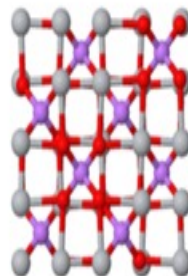
2D structure

Limited surface area

Expands ~10% when fully charged

Prone to dendrites

Lithium Titanate



3D structure

30X surface area

No expansion



	NCA	NMC	LFP	LTO
Anode	Graphite	Graphite	Graphite	Lithium Titanate Oxide
Cathode	Nickel Cobalt Alum. Oxide	Nickel Manganese Cobalt Oxide	Lithium Iron (Fe) Phosphate	Lithium Cobalt Oxide

# NMC, LFP, LTO COMPARISON



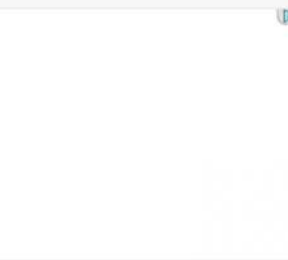

phosphate and Li-titanate have lower voltages and have less capacity, but are very durable. These batteries are mainly found in wheeled and stationary uses. **Table 1** summarizes the characteristics of major Li-ion batteries.

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	NMC	Li-phosphate	Li-aluminum	Li-titanate
Abbreviation	LiCoO <sub>2</sub> (LCO)	LiMn <sub>2</sub> O <sub>4</sub> (LMO)	LiNiMnCoO <sub>2</sub> (NMC)	LiFePO <sub>4</sub> (LFP)	LiNiCoAlO <sub>2</sub> (NCA)	Li <sub>2</sub> TiO <sub>3</sub> (common) (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 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 pulse)	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 Li-ion batteries
Maintenance	Keep cool; store partially charged; prevent full charge cycles, use moderate charge and discharge currents					
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, EV (Tesla)	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.

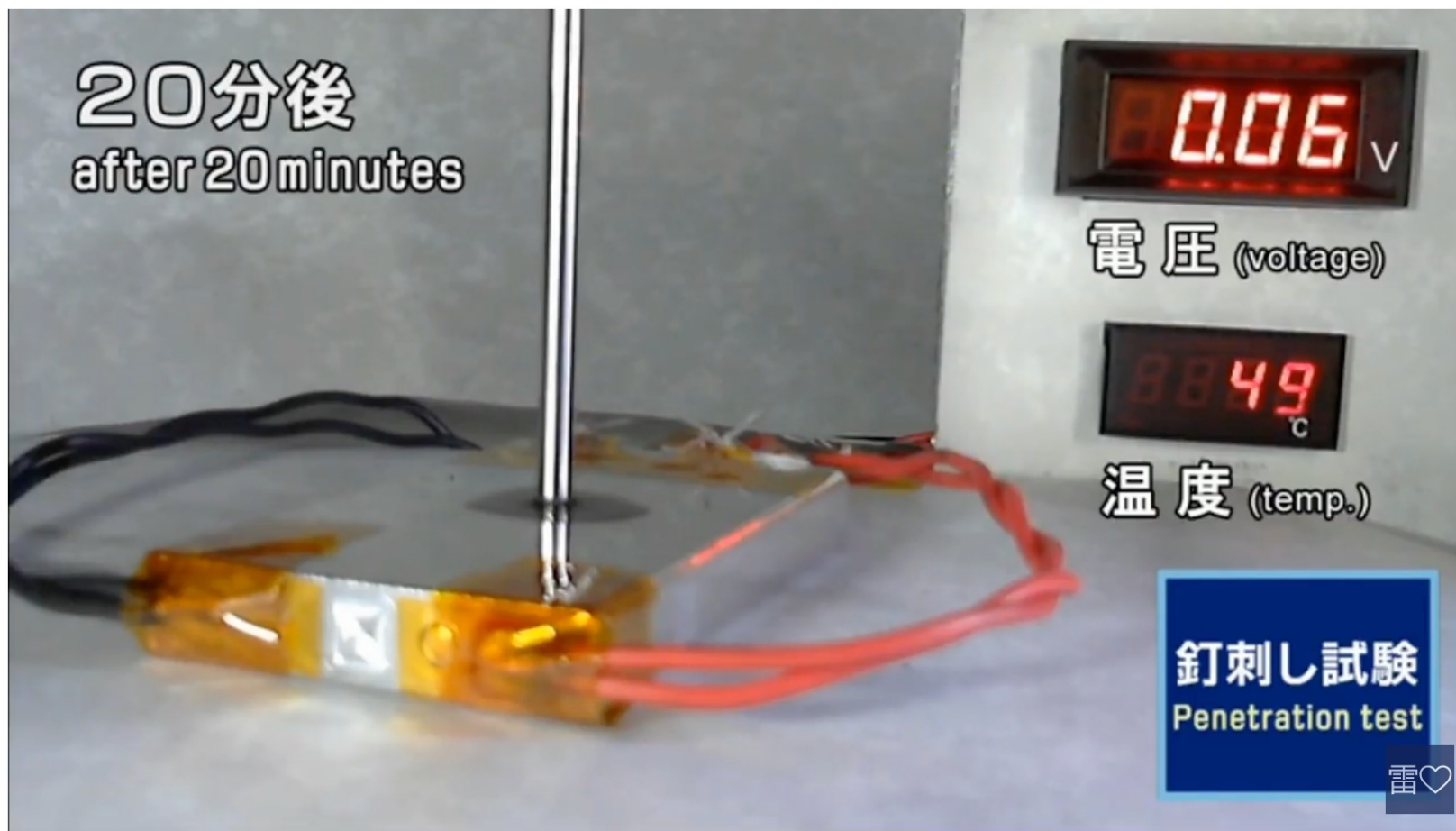
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# SAFETY



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# VILLAGRID

## POWER

10 kilowatts continuous power. Double the power of legacy lithium ion batteries.

## SAFETY

Lithium Titanate is the safest battery chemistry on the market, with the industry's first non-flammable, carbon-free anode.

## LONGEVITY

20 year standard warranty. Double the industry norm. Lithium Titanate just doesn't degrade like legacy lithium ion batteries.



## EFFICIENCY

Lithium Titanate offers extremely low internal resistance, turning even more solar power into usable energy.

## VERSATILITY

Lithium Titanate works even in extreme temperatures (-22°F to 131°F) and at high altitudes (10,000 feet).

## VALUE

Lower cost per megawatt hour of lifetime energy.

	VILLAGRID Avoid Peak Rates	VILLAGRID+ Power Through The Night	VILLAGRID++ Extended Backup
USABLE CAPACITY	5.75 kWh	11.5 kWh	23 kWh
WEIGHT	252 lbs.	407 lbs.	814 lbs.
ROUND TRIP EFFICIENCY	99%	98%	98%
VOLTAGE	53v	53v	53v
WARRANTY	20 Years	20 Years	20 Years
CONTINUOUS POWER	10 kW	10 kW	20 kW
OPERATING TEMPERATURES	-22°F to 131°F	-22°F to 131°F	-22°F to 131°F
MAX ALTITUDE	10,000 ft.+	10,000 ft.+	10,000 ft.+
DIMENSIONS	w41in. x h56 in. x d6.8 in.	w41in. x h56 in. x d6.8 in.	w41in. x h56 in. x d6.8 in.

# DISCLOSURE

All material presented here was stolen without shame, consent, or remorse.

Sincerely,

Donald Keyote

# THANKS KEN!!



# VINO FAUX PAS





# CORK CRADLE/ GO FISHING



# YOU'RE A HERO!

