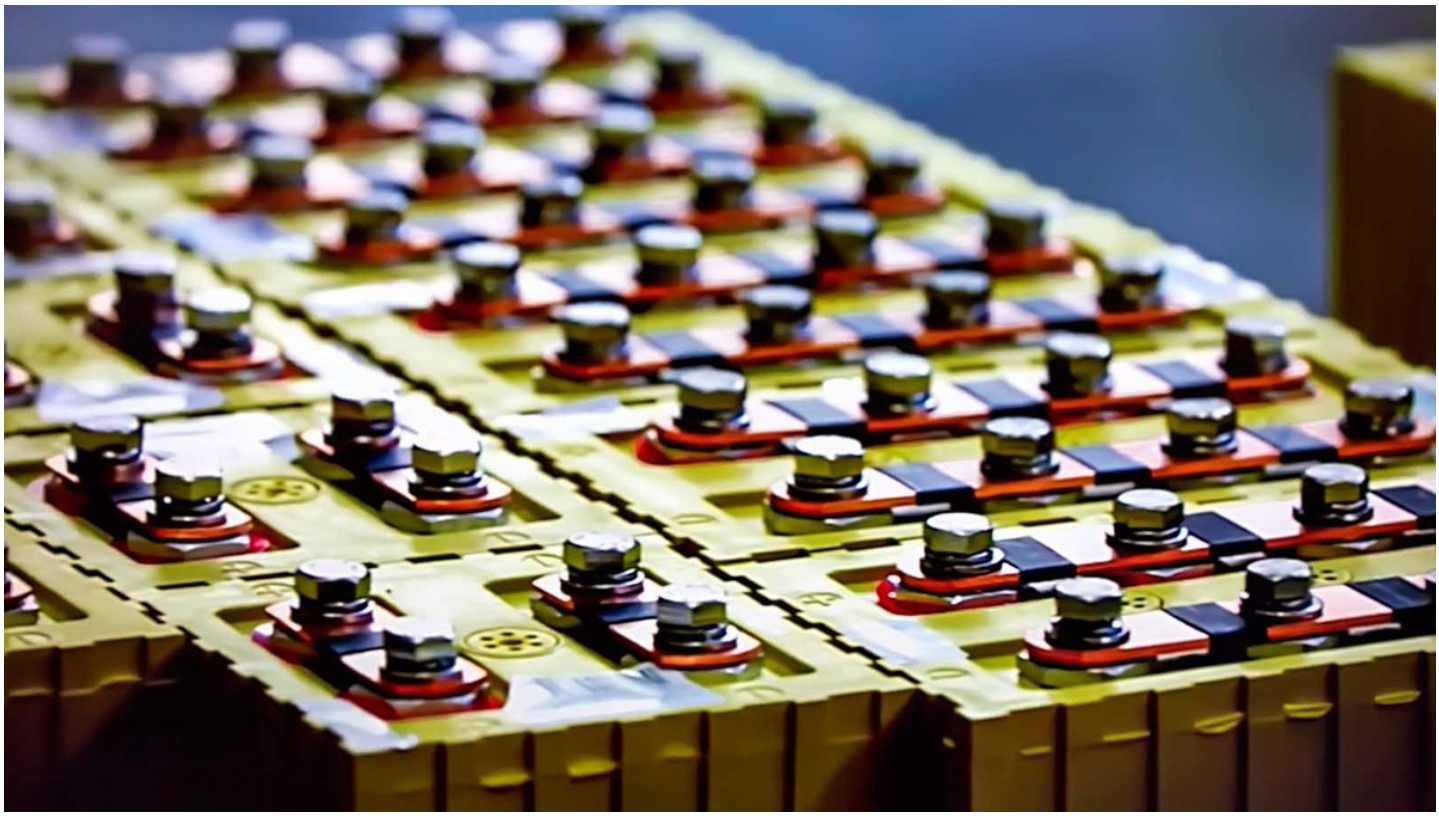
Twitter Thread by Mukund Mohan



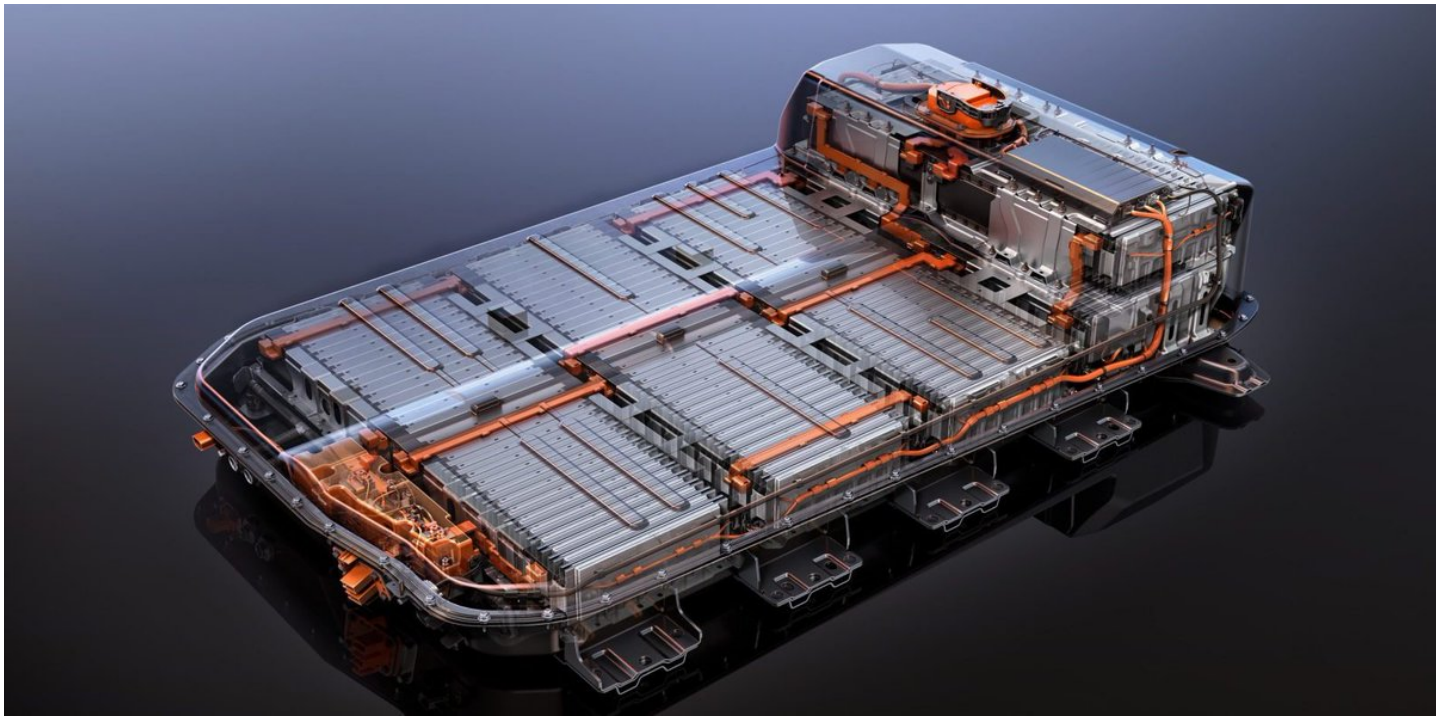
Mukund Mohan
@mukund

EV Battery overview

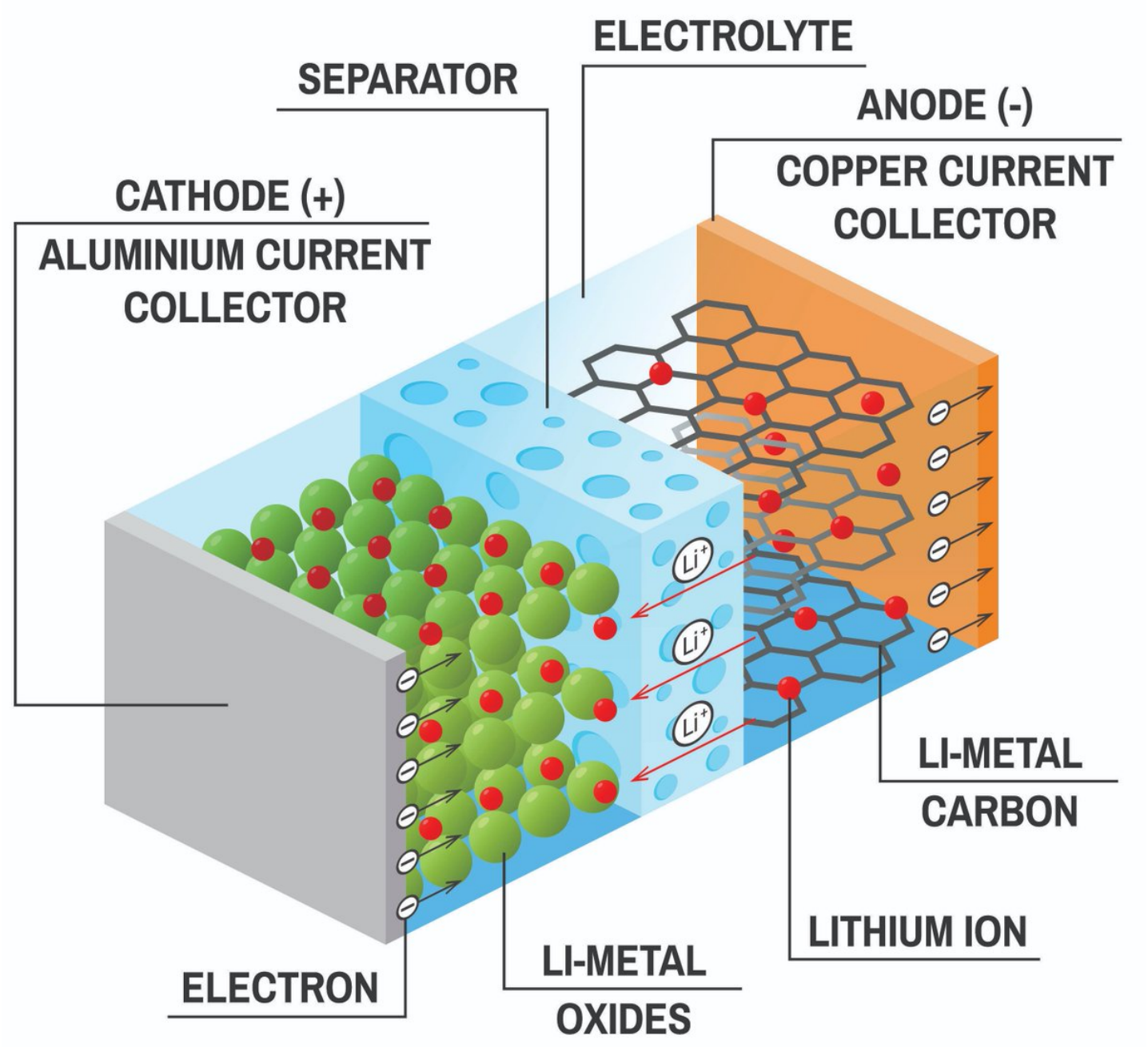
Batteries are the key differentiator between the various EV manufacturers. The amount of energy stored in the battery determines the range of the EV, thought to be a major limitation on EV sales.



Consumers tend to worry that an EV with a range of 80 to 250 miles on a single charge would be inconvenient for long trips due to the time it takes to recharge the battery. Commercial batteries need to ensure there is quick recharge and less time between charges

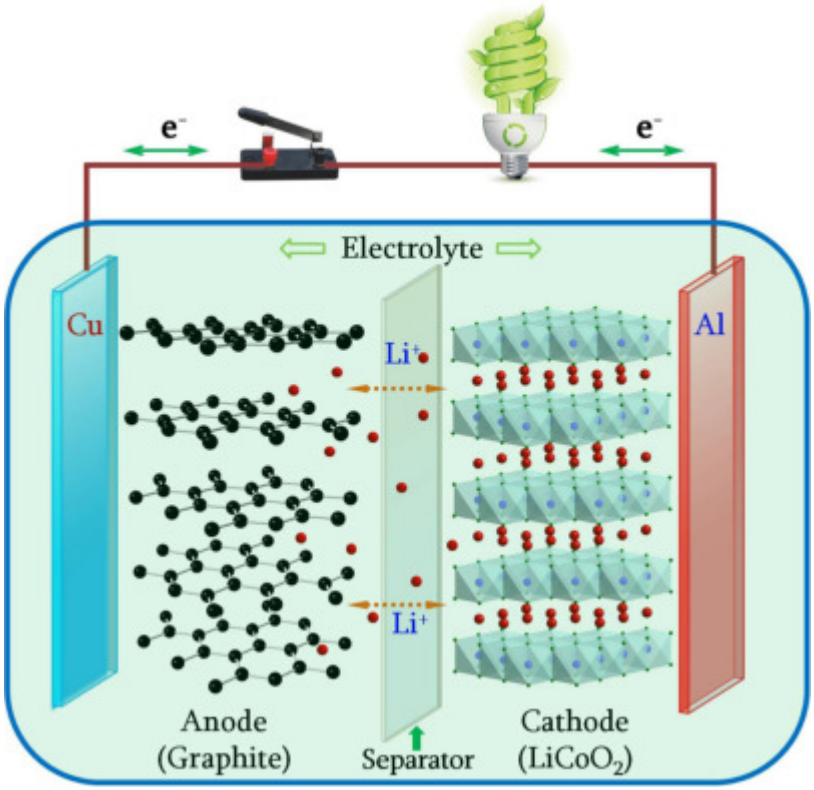


The lithium-ion battery is important because it makes EVs expensive than ICEs. Battery costs per kilowatt-hour (kWh) declined from roughly $1,000 per kWh in 2010 to $227 in 2016



Lithium-ion batteries made up 70 percent of the rechargeable battery market in 2016

BNEF projects that global production capacity for lithium-ion batteries will increase from 103 gigawatt-hours (GWh) in the first quarter of 2017 to 273 GWh by 2021.

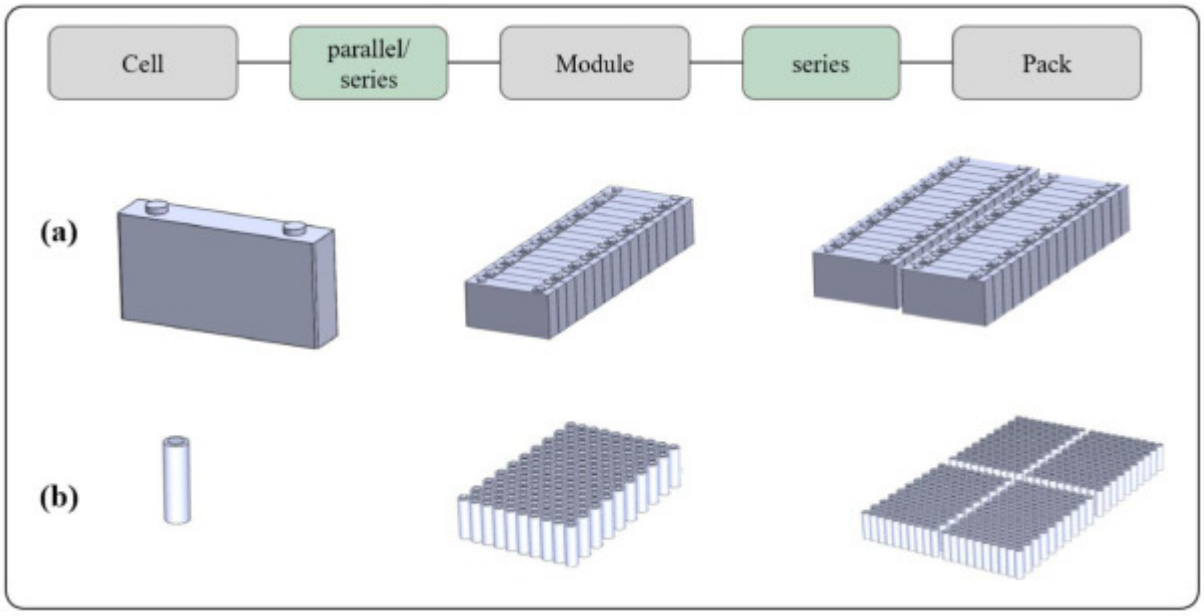


The battery manufacturing supply chain has three main parts:

cell manufacturing,

module manufacturing, and

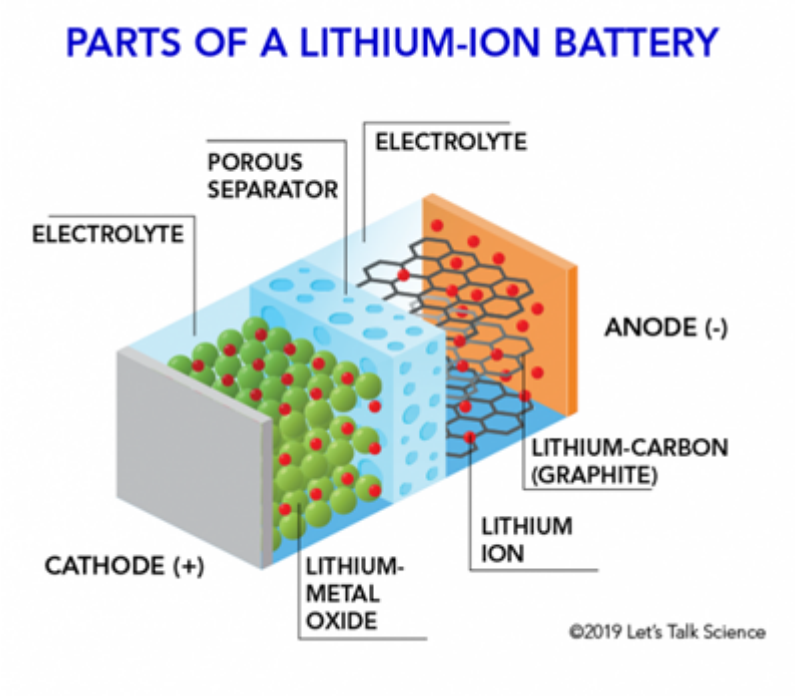
pack assembly.



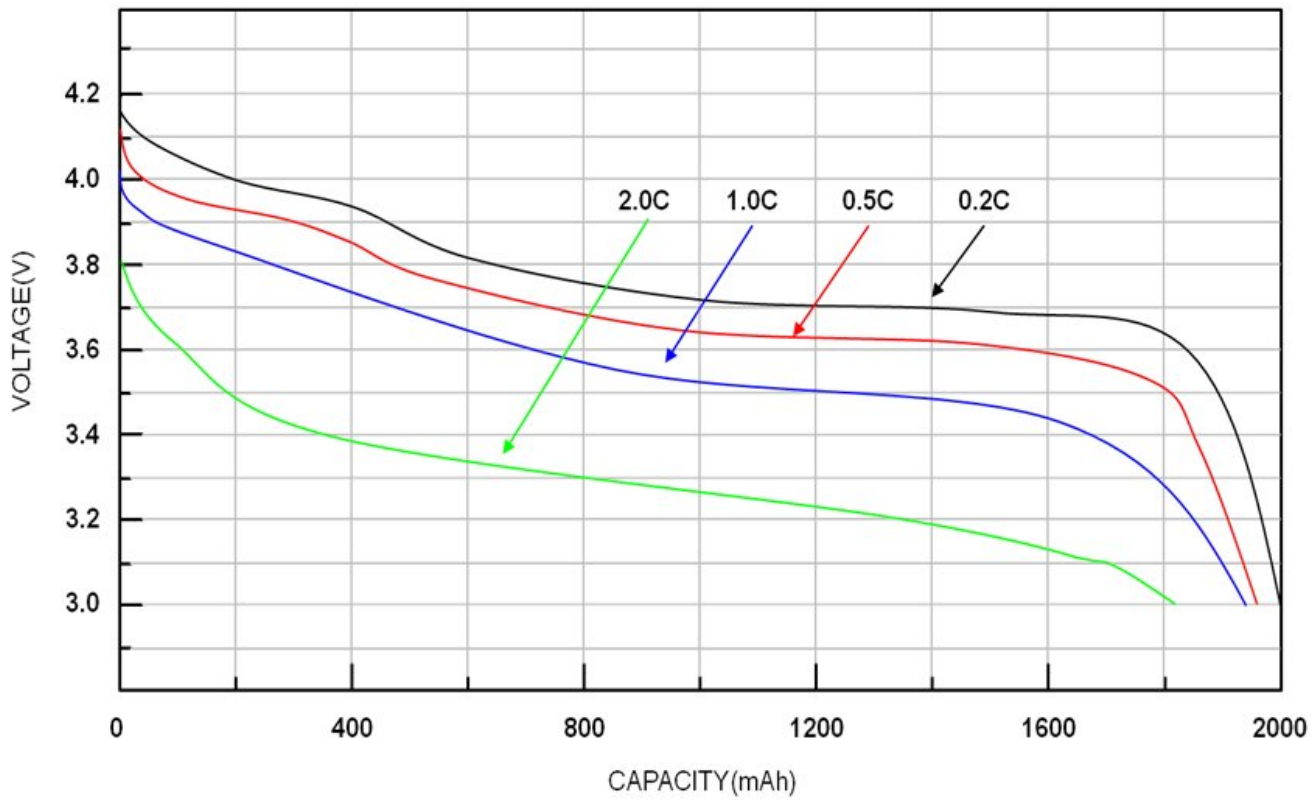
The smallest, but most important, component of the lithium-ion batteries that power EVs is the

electrochemical cell,

which consists of three major parts: a cathode and an anode separated physically but connected electrically by an electrolyte.



A battery's discharge results from the diffusion of lithium ions from the anode to the cathode through the electrolyte.

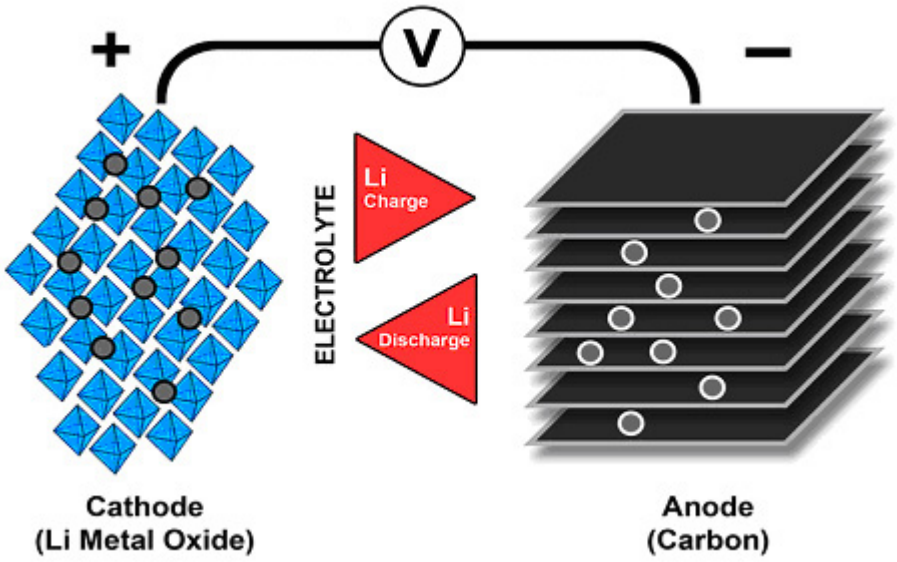


$TSLA Tesla produces its own modules and packs at both its "Gigafactory," which opened in Nevada in 2017, and at its vehicle assembly plant in Fremont, California.

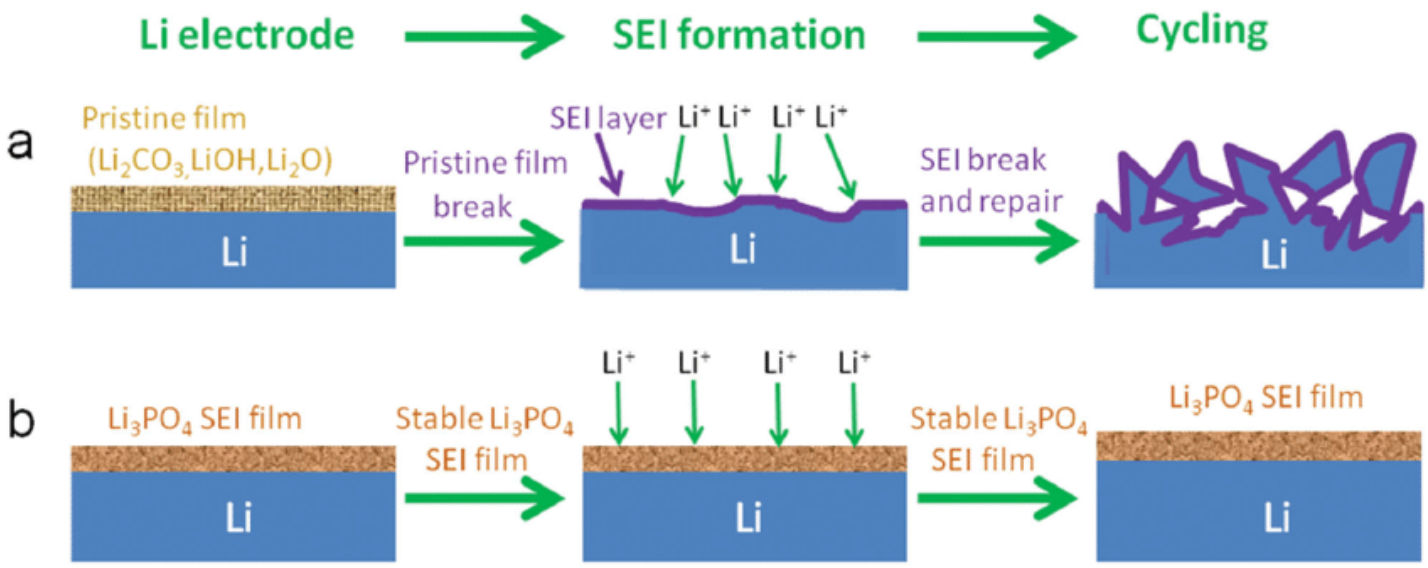
Tesla’s battery packs use cells from Gigafactory, while cells for the Model S & X are produced by Panasonic



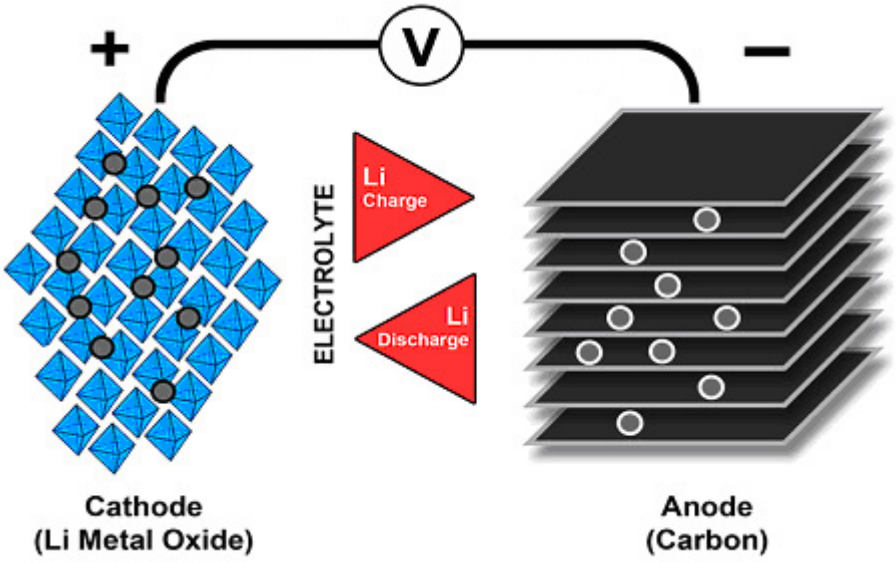
The anode is typically made of graphite, while the electrolyte typically consists of organic carbonate solvents with dissolved lithium salts.



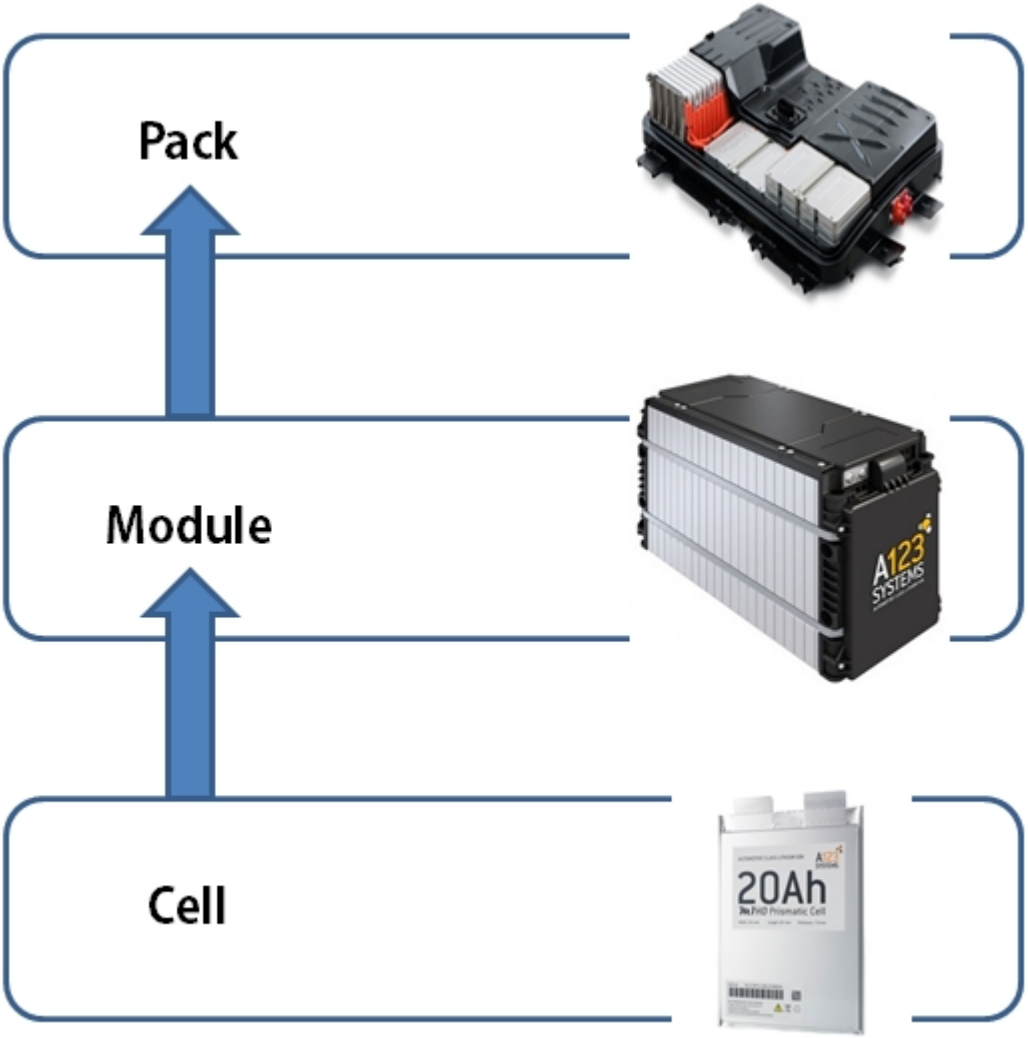
The anode is physically and electronically isolated from the cathode by a separator, often a thin porous plastic film through which the liquid electrolyte permeates.



The cathode has the most variation in its different form. 20 percent of the total cost of a finished lithium-ion battery pack comes from the cell stage of production.



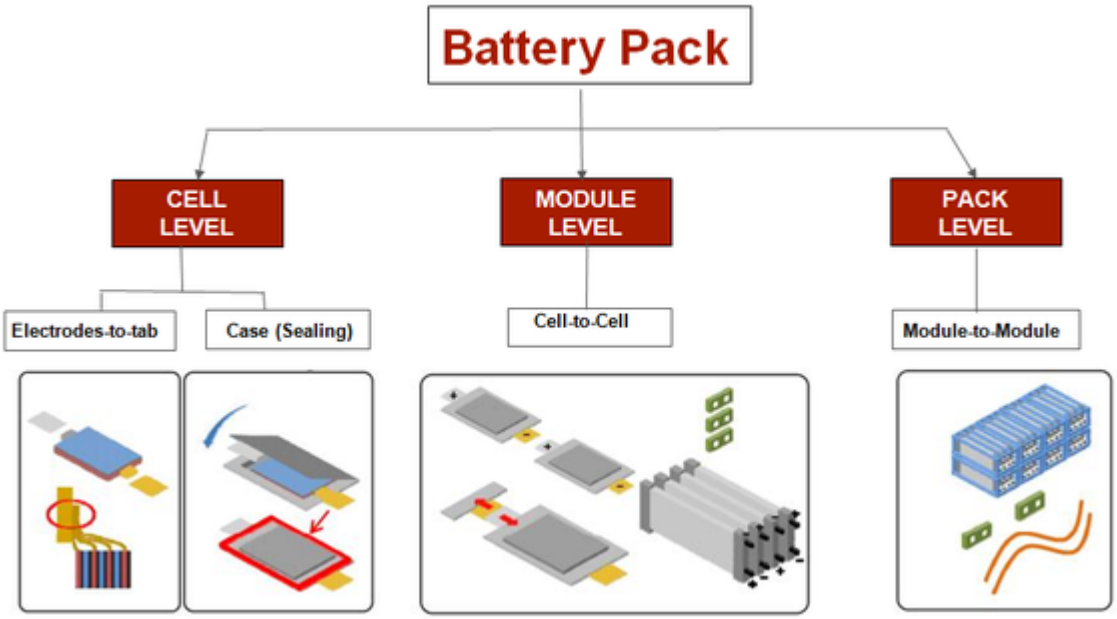
Cells are assembled only as an intermediate good as part of the larger battery assembly process, for insertion into both EV batteries and batteries for other uses. Cells make up 75 percent of the cost of a battery pack, on average.



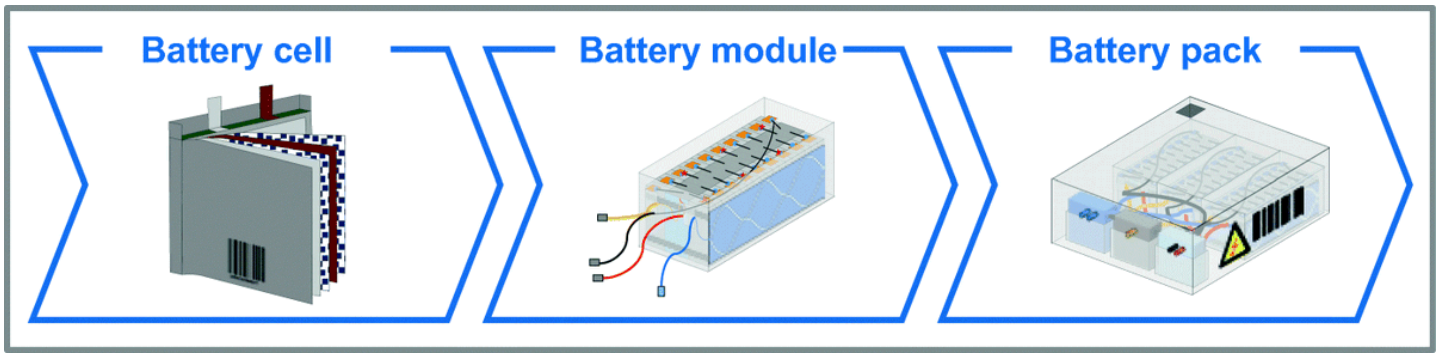
Multiple cells in a case with terminals attached form a module.



EV battery packs are the final stage of EV battery production. Battery packs consist of battery modules, electrical connections, and cooling equipment. 14 percent of the total cost of a finished lithium-ion battery pack comes from the pack stage of production.



Battery manufacturers design EV battery packs for specific vehicle models and tend to assemble them near the vehicle assembly plant.
Graphite is used in the anode of many EVs.



LG Chem batteries were a common brand of batteries among vehicles sold in the US. LG Chem assembles packs in Michigan and South Korea for Ford, General Motors, and Chrysler using Korean or U.S.-made cells, depending on the model.

Table 3: Battery pack assembly and cell production locations for vehicles sold in the United States

Battery pack manufacturer	Number of battery packs installed in U.S. vehicles, 2017	Pack assembly location	Cell production location
Tesla/Panasonic	50,147	United States	United States and Japan
LG Chem	26,113	United States	United States and South Korea
AESC	11,230	United States[a]	United States
Samsung SDI	9,810	Hungary	South Korea
Bosch (formerly SB LiMotive)	5,380	United States	United States
SK innovation	2,157	South Korea	South Korea

Today battery packs cost $10–$12K depending on their capacity. Low battery prices are the key to unlock more affordable, higher volume electric cars.
$TSLA is aiming to reduce the cost of future packs to less than $6,000, which would put the cell cost at well under $100/kWh.

Item	$/kWh	75 kWh Pack
Today's Battery Cost	$ 158.00	$ 11,850.00
Larger Cell	$ (15.80)	$ (1,185.00)
Tabless Design	?	?
Reduced Cobalt	$ (6.50)	$ (487.50)
Increased Density	$ (15.80)	$ (1,185.00)
Dry Electrode	$ (23.70)	$ (1,777.50)
Cell To Pack	$ (15.80)	$ (1,185.00)
Manufacturing Enhancements	$ (7.90)	$ (592.50)
Transportation Savings	$ (7.90)	$ (592.50)
Eliminate Supplier Margins	$ (7.90)	$ (592.50)
Total Reductions	$ (101.30)	$ (7,597.50)
New Predicted Cost	$ 56.70	$ 4,252.50
Percent Reduction	-64%	-64%

Other Battery manufacturers that supply to EV customers include CATL, Toshiba, Samsung SDI, BYD

Other EV Battery Manufacturers

Company	Battery Type	Key customers
LG Chem	Lithium Polymer Lithium-ion	Ford Renault Hyundai Tesla VW Volvo
Toshiba	Lithium-ion	
CATL (Contemporary Amperex Technology Co., Ltd.)	Lithium-ion	BMW Volkswagen Daimler Toyota Honda
Panasonic Corp		Tesla
BYD Co.		BYD
Samsung SDI		VW Kia Jaguar Daimler
SK Innovation		BAIC
Automotive Energy Supply Co		Nissan
SB LiMotive		VW

In my next thread I will outline the new challengers, $QS, $THCB (Microvast), A123 Systems.

The current leaders are:
CATL $CATL
BYD $BYDDF
Guoxuan
Lishen Battery
AVIC Lithium Battery

Company	Capacity (MWh)
CATL	928.7
Pride Power	614.2
BYD	352.3
Guoxuan	206.1
Dongfeng	163.5
VREMTS	161
XPT	156
GAC	129.3
Chang' an	126
Zhongdi	117.5
Weima	96.2
Great Power	68.7
CCIT	63.9
JAC Huating	61.9
ATBS	59.5
JEVE	56.8
SAIC-CATL	49.7
DFD	47.7
CENAT	37.7
Brilliance BMW	30.7

Source: SPIR

Glossary:
1. ICE - Internal Combustion Engine
2. EV - Electric Vehicle

3. BNEF - Bloomberg New Energy Finance