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State-of-the-art cathode materials include  
lithium-metal oxides [such as  $\text{LiCoO}_2$ ,  
 $\text{LiMn}_2\text{O}_4$ , and  $\text{Li}(\text{Ni}_x\text{Mn}_y\text{Co}_z)\text{O}_2$ ],

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vanadium oxides, olivines (such as  $\text{LiFePO}_4$ ), and rechargeable lithium oxides.<sup>11,12</sup> Layered oxides containing cobalt and nickel are the most studied materials for lithium-ion batteries.

~~What Materials Are In a Lithium Ion  
Battery?~~

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In a Li-ion battery,  $\text{Li}^+$  is the guest ion and the host network compounds are metal chalcogenides, transition metal oxides, and polyanion compounds. These intercalation compounds can be divided into several crystal structures, such as layered, spinel, olivine, and tavorite ( Fig. 4 ).

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~~Li ion battery materials: present and future  
— ScienceDirect~~

State-of-the-art cathode materials include lithium-metal oxides [such as  $\text{LiCoO}_2$ ,  $\text{LiMn}_2\text{O}_4$ , and  $\text{Li}(\text{Ni}_x\text{Mn}_y\text{Co}_z)\text{O}_2$ ], vanadium oxides, olivines (such as  $\text{LiFePO}_4$ ), and rechargeable lithium oxides. 11,12 Layered oxides containing

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cobalt and nickel are the most studied materials for lithium-ion batteries. They show a high stability in the high-voltage range but cobalt has limited availability in nature and is toxic, which is a tremendous drawback for mass manufacturing.

~~Materials and Processing for lithium ion~~



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Engineering Current Topics  
Energy & Environmental Materials. First  
Published: 16 July 2020.  $\text{Li-O}_2$  batteries  
are semi-open systems and are very  
sensitive to the atmospheric composition  
such as  $\text{CO}_2$ ,  $\text{H}_2\text{O}$ , and  $\text{N}_2$ .  $\text{CO}_2$  and  $\text{O}_2$   
dissolving in electrolyte can diffuse to  
the negative side to corrode the Li metal.

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~~Lithium Battery and Lithium Ion Battery:~~  
~~ENERGY ...~~

For the last 10 years or so, the cathode has characterized the Li-ion battery. Common cathode material are Lithium Cobalt Oxide (or Lithium Cobaltate), Lithium Manganese Oxide (also known as spinel or

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Lithium Manganate), Lithium Iron  
Phosphate, as well as Lithium Nickel  
Manganese Cobalt (or NMC)\*\* and  
Lithium Nickel Cobalt Aluminum Oxide  
(or NCA).  
Technology  
~~Lithium ion Batteries Information~~  
~~Battery University~~

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Lithium-ion batteries are gaining demand from automobile companies due to their small size and light weight compared to nickel metal batteries used in electric cars.

The lithium-ion battery market for electronic devices is quite saturated, but lithium-ion battery in industrial application is growing at a rapid pace.

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~~Lithium ion Battery Market, by  
Application, Material, and ...~~

Lithium is especially useful, because its ions can be arranged to move between the anode and the cathode, using an intercalated lithium compound as the cathode material but without using lithium

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metal as the anode material. Pure lithium will instantly react with water, or even moisture in the air; the lithium in lithium ion batteries is in a less reactive compound.

## Technology

~~Lithium battery — Wikipedia~~

A lithium-ion battery or Li-ion battery is a

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type of rechargeable battery. Lithium-ion batteries are commonly used for portable electronics and electric vehicles and are growing in popularity for military and aerospace applications. A prototype Li-ion battery was developed by Akira Yoshino in 1985, based on earlier research by John Goodenough, M. Stanley Whittingham,

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Graphite remains one of the most  
commercially attractive anode materials  
for Li-ion batteries. Electrochemically  
active graphite is popularly known as  
meso-carbon micro bead (MCMB).



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## ~~Lithium Ion Battery~~

□The explosive growth in electric vehicle sales around the world demonstrates that lithium-ion battery separator demand will experience significant growth in Asia and in Europe over the next five years.

Celanese, as a reliable materials partner

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for our customers, is committed to  
investing further in local manufacturing  
capabilities to offer ...

~~UHMWPE Expansion Caters to Lithium-  
ion Battery Growth ...~~

Lithium-Ion Battery Research "Flowers"  
Scientists increased battery capacity over

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many charge and discharge cycles with a promising high-rate electrode material featuring a unique flower-shaped ...

## ~~Lithium Ion Battery Research "Flowers"~~

Li ion batteries typically use lithium as the material at the positive electrode, and graphite at the negative electrode. The

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lithium-ion battery presents clear  
fundamental technology advantages when  
compared to alternative cell chemistries  
like lead acid.

~~Battery Materials for Lithium ion Cell  
Manufacturers | Targray~~

The hype over silicon in lithium-ion

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batteries is due to its having almost 10 times the (theoretical) capacity compared to carbon-based materials, and being one of the most abundant materials on ...

~~Tesla tip spurs Perth company's lithium-ion battery ...~~

Spent lithium-ion batteries contain

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valuable metals, such as lithium, cobalt, nickel, copper, aluminum and iron, as well as toxic materials such as lithium hexafluorophosphate and polyvinylidene...

~~Materials in lithium ion batteries may be recycled for reuse~~

During fast charging, the commonly used

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Li-ion battery anode material, graphite, has a significant shortcoming, that is, its discharge potential is too low to guarantee the safety of batteries.  $\text{Li}_3\text{VO}_4$  (LVO), an alternative anode material, has a safe discharge potential window of 0.5 V to 1.0 V vs.  $\text{Li}^+/\text{Li}$  and

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~~A safe and fast charging lithium ion  
battery anode using ...~~

Lithium-ion battery recycling activity could increase to 2.6 million units between now and 2030, and could return thousands of tonnes of key raw materials to the battery supply chain, delegates heard at Fastmarkets' latest Lithium Supply &



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~~LITHIUM CONF: Strong opportunities  
for li-ion battery ...~~

One such promising anode material is lithium titanate (LTO), which contains lithium, titanium, and oxygen. In addition to its high-rate capability, LTO has good

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cycling stability and maintains empty sites within its structure to accommodate lithium ions.

~~Lithium-ion battery research 'nanoflowers'~~

Lithium-ion Battery Megafactory capacity expected to grow 480% by 2029 to 2,925GWh, with 20% of this increase

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