Niobium in Lithium Ion Batteries
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Niobium Benefits for Lithium Ion Batteries

- Fast charging
- Increased electronic conductivity
- Greater chemical stability
- Lower operating temperature
- High energy density
- Safety
- Long life
- Increased ionic conductivity
- Higher voltage operation
- Lower materials cost
- Lower operating temperature
- Increased electronic conductivity
- High input/output
- Safety
How does Niobium work in Lithium Ion Batteries?

**CATHODE**
- LiNbO$_3$ coating
- Nb and Nb$_2$O$_5$ coating
- Li$_3$NbO$_4$-based cation-disordered rock-salt structure
- Nb and Nb$_2$O$_5$ doping

**ELECTROLYTE**
- Nb/Nb$_2$O$_5$ layers on LiLaZrO$_x$ composite
- Nb-S glass

**ANODE**
- TiNb$_2$O$_7$ (TNO) composite
- MNb$_3$O$_8$ (M=H, Li, Na, K)

**CHARGE**

**DISCHARGE**
Tradeoff Profile of Lithium Ion Battery Technologies

Lithium-Nickel-Cobalt-Aluminium (NCA)

Lithium-Nickel-Manganese-Cobalt (NMC)

Lithium-Manganese Spinel (LMO)

Lithium-Iron Phosphate (LFP)

Lithium-Titanate (LTO)

Titanium Niobate (TNO)

Source: The Boston Consulting Group, 2010 / CBMM internal records for TNO