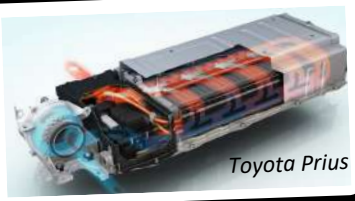
Battery

Battery Cooling

- Batteries need to operate at about [20-30°C] for optimal efficiency but also for limiting degradation and preventing thermal runaway
- Cells need to be cooled but also warmed up

Air-cooled

- Simple and easy but limited efficiency
- Neither flammable nor electrically conductive
- Low heat capacity → Big cooling channels
- Toyota Prius, Nissan Leaf…

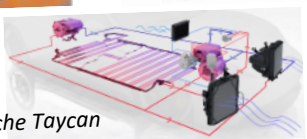

Toyota Prius

Water/Glycol

- More compact and better efficiency than air (Higher heat capacity)
- Temperature more uniform
- Often coupled with chiller
- Leakage and disposal (glycol is toxic)
- AUDI e-tron, Chevrolet Volt…
- Can be dispatched as channels "glued" on a plate (Taycan), a complete plate (ID.3) or in-cell cooling tube (Tesla)

Tesla


VW ID.3


Porsche Taycan

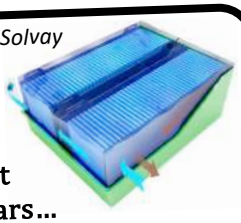
Refrigerant cooling


BMWi3

- Direct 2-phase cooling
- High heat transfer coefficient, not flammable
- Heating is difficult
- BMWi3…

Dielectric liquid immersion

Solvay



- Heat removal not only from the cells but also contactors, busbars…
- Fast charging enabling (higher C-rates)
- Motorsports or high-performance
- McLaren Speedtail, RIMAC…

OROVEL

Battery

Battery Abuse Testing

Fire Resistance

Radiant Heat

Thermal Shock

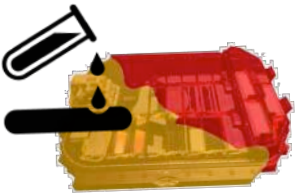
Durability

Short Circuit

Over-Charge
Over-Discharge

Immersion

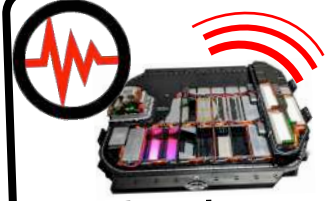
Dust/Water
Intrusion



Corrosion

Nail Penetration

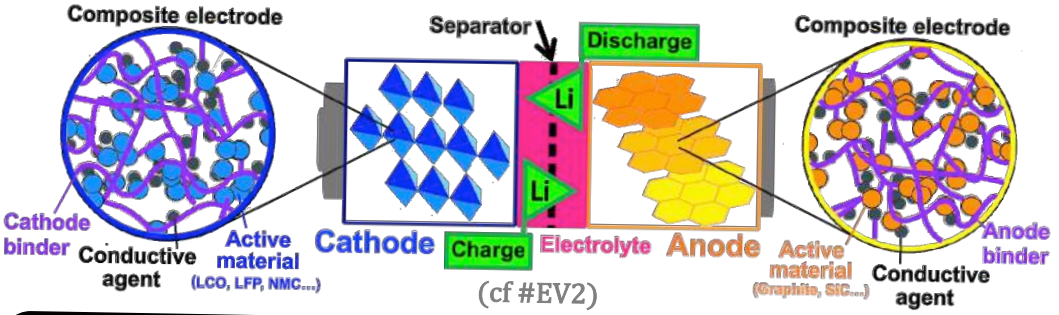
Mechanical Crush



Vibration

#EV12

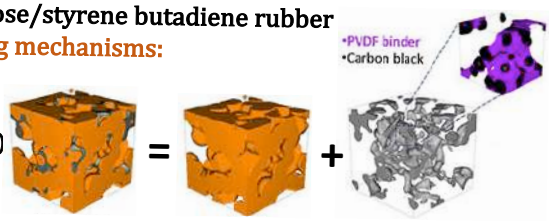
Binders



(cf #EV2)

- In addition to active materials and current collector foils, electrodes contain conductive additives and Binder Polymers
- Binders are inactive materials that:
  - maintain electrode integrity by binding ↔ active materials and conductive additives
  - facilitate Lithium ion transfer
  - allow adhesion of electrodes to the metal current collector ⚡
  - increase the viscosity of the electrode slurry ➡ uniform and smooth coating of the slurry onto the current collector

- 2 types of Binders:
  - Organic solvent soluble ➡ PVDF (polyvinylidene fluoride)
  - Water soluble ➡ carboxymethylcellulose/styrene butadiene rubber
- To maintain electrode structure, 2 binding mechanisms:
  (1) mechanical meshing force
  (2) Intermolecular forces
  (Van der Waals, electrovalent bond ...)



- Low weight ratio (≈ 5 wt. %)
- Need to cope with high voltage ⚡, excessive volume expansion, overcharge, low temperature 🥶 (limiting peeling-off of active materials)...
- Should be eco-friendly and maintain thermal stability 🌡️ during electrode drying process
- Important role in Battery technology developments

For Si anodes (#EV8), absorb structural deformation and damage due to Si swelling