

MATERIAL SOLUTIONS TO ENABLE CELL-TO- PACK BATTERY DESIGN

MARCH 19, 2025





WELCOME!

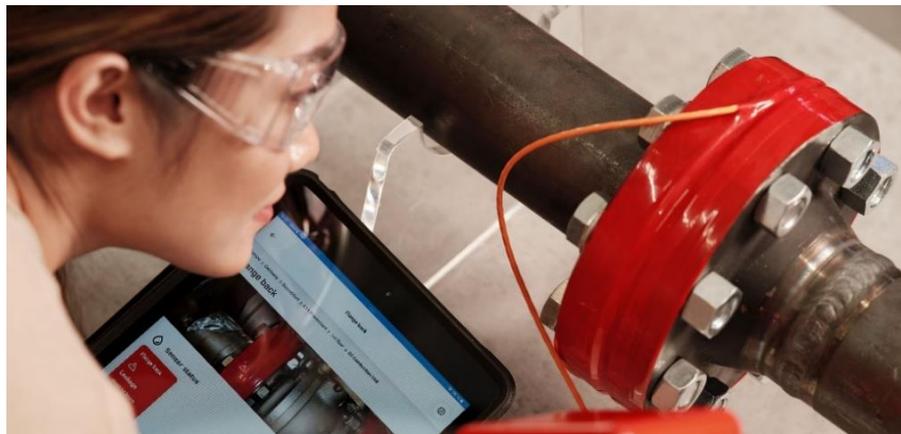
SPEAKER

DALTON CONLON

Business Development Manager, eMobility
Henkel Adhesive Technologies, North America
dalton.conlon@henkel.com
[linkedin.com/in/daltonconlon](https://www.linkedin.com/in/daltonconlon)



WHO WE ARE – LEADING POSITIONS IN INDUSTRIAL & CONSUMER BUSINESSES



ADHESIVE TECHNOLOGIES



CONSUMER BRANDS

LOCTITE **TECHNOMELT** **BONDERITE**


schwarzkopf

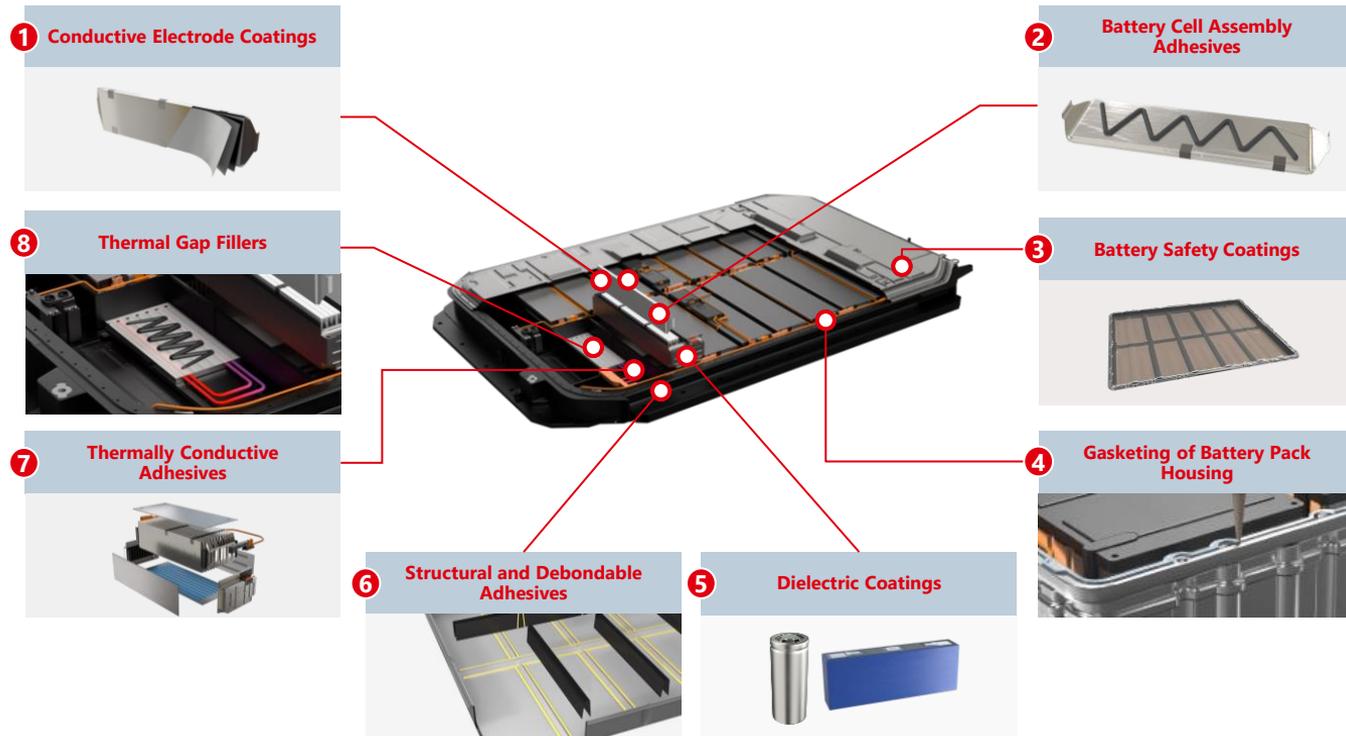
Persil

syoss



HENKEL'S E-MOBILITY SOLUTIONS

KEY TECHNOLOGIES FOR BATTERY SYSTEMS



Our solutions are applicable for different battery cell types

Pouch cells



Cylindrical cells

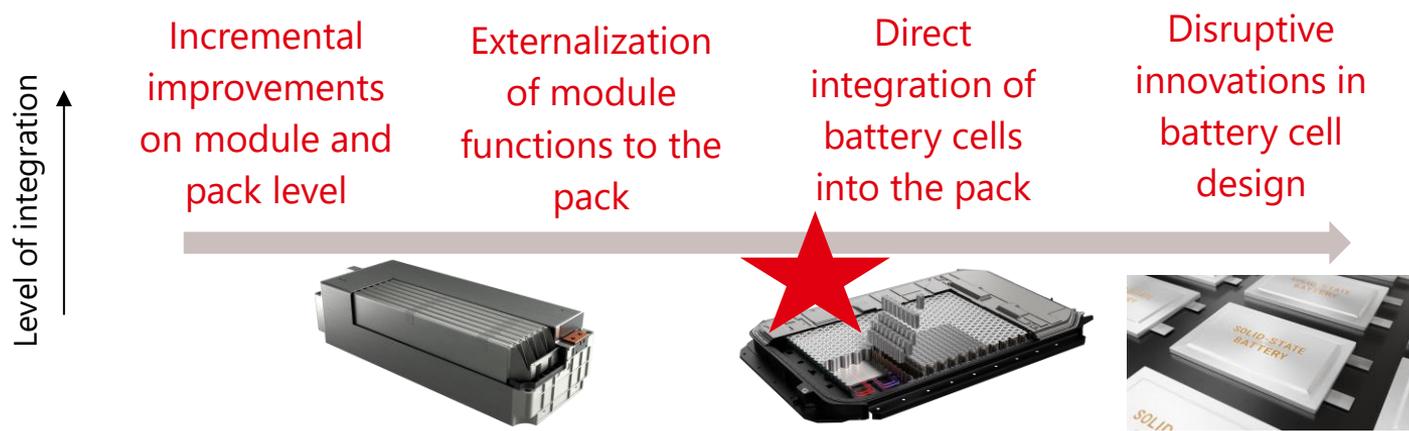


Prismatic cells



BATTERY DESIGN CHANGES

FUTURE TRENDS IN BATTERY PACK DESIGN



+	Low development effort	Simple adaption of existing structures	Improve energy density, reduce weight and volume, enhance thermal management, simplify manufacturing, reduce cost	Potentially higher energy density and higher safety
-	Limited potential for improvement	Less flexibility and scalability	Larger effort for safety, maintenance, debonding	High development effort and technology risk

Cell to Pack Design Implication:

Strong interaction of OEMs, cell manufacturer and material suppliers during the development necessary for success.

KEY BENEFITS

CELL-TO-PACK DESIGN



Improved Energy Density

- More compact arrangement of cells
- Frees up volume inside the case for the cells → increases volumetric energy density at pack level
- Enables longer range and improved performance



Reduced Weight and Volume

- Reduces the need for module casings and interconnects
- Increases efficiency gains



Enhanced Thermal Management

- More uniform temperature distribution across the cells ensuring optimal performance under various operating conditions



Simplified Manufacturing Process

- Reduces the number of production steps and lowers complexity of assembly lines → faster production times, lower manufacturing costs, increased scalability



Lower Cost

- Reduced weight, volume and manufacturing complexity contributes to a lower overall battery pack cost

KEY CHALLENGES

CELL-TO-PACK DESIGN



Loss of structural support – loss of side wall and enclosure of the modules

- Causes issues over time because the cells will experience more shock and vibration; can lead to damage of cells, wire bonds and electrical systems.



Loss of sealing effectiveness

- Removal of sealed lids of the modules; only 1 seal on the battery pack lid



Increased risk of battery fire

- Cells in direct contact with the frame or body; increases chances of thermal runaway or eventual thermal propagation

WELL-SUITED CELL TYPES FOR CELL-TO-PACK DESIGN



Prismatic Cells

- Better structural strength due to aluminum or steel alloy housing
- Both electrical terminals on the top of the cells (enables easier access)
- Large capacity cells available to meet the need for high-volume applications → reduce manufacturing time



Cylindrical Cells

- Tight metal case helps prevent breaking and leakage
- Even distribution of internal pressure across the cell circumference; more tolerant to pressure
- High temperature resistance

ENABLING STRUCTURAL INTEGRITY

THERMALLY CONDUCTIVE ADHESIVES

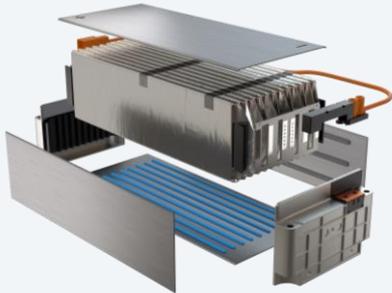
1

Replace conventional thermal gap fillers with thermally conductive adhesives (TCA)



TCA AS A MULTIFUNCTIONAL MATERIAL

Withstand high mechanical loads & exposure to temperature extremes, humidity & other harsh environmental conditions



Strong Adhesion

Thermally Conductive Adhesives

Thermal Management



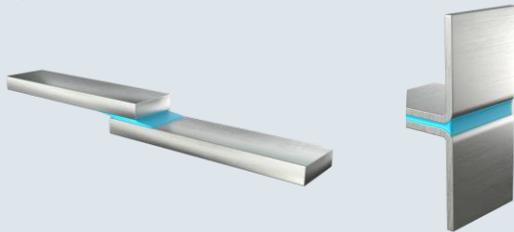
Improve heat dissipation, reduce thermal stress, enhance safety, extend battery life

SELECTING THE RIGHT TCA

Structural Performance

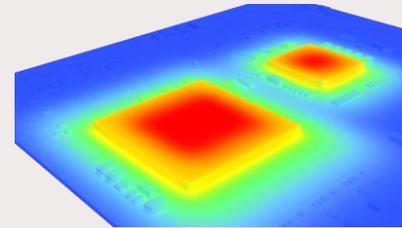


- **Bond strength specifications** → Elongation to break, Youngs Modulus, Lap Shear Strength & Tensile Shear Strength
- **Type of surface** → Formulated to adhere to multiple substrates



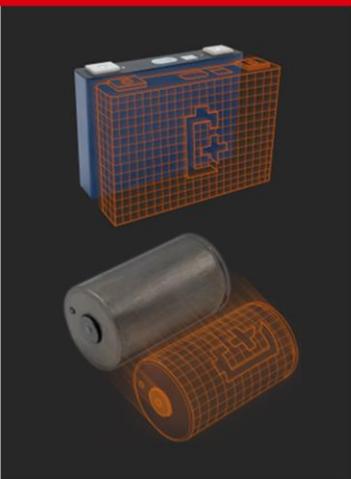
Thermal Performance

- Thermal conductivity specifications
- Temperature stability rating
- UL Flammability rating
- Material viscosity, working time & curing schedule



MODELING & SIMULATION FOR MORE EFFICIENT PRODUCT DEVELOPMENT

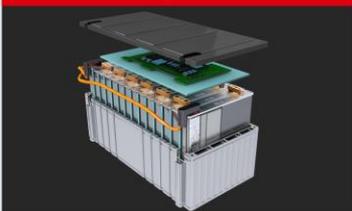
1 Input Cell Models



Digital twin cell models



2 Build Module/Pack Model



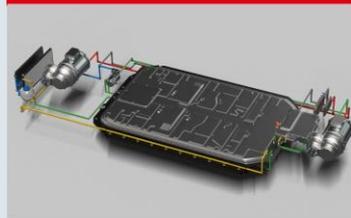
Henkel material solutions and applications



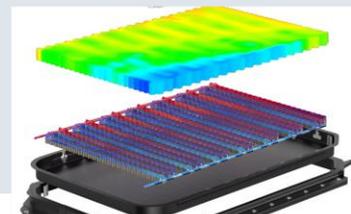
Henkel digital battery Pack designs



3 Simulate System



System-level thermal model



Battery thermal & flow simulation



AVL
Battery Module/Pack TS™

4 Validation & Calibration



HENKEL TCA PORTFOLIO

Portfolio Features

- Thermal conductivity ranges between 1.2 and 3.4 W/mK
- Bead dispensable TCAs
- Slump or sag resistant TCAs
- Injectable TCAs for small cavities and small cavity filling where modules and packs are pre-assembled
- Lap Shear Strength of 1 MPa to 10 Mpa (gap fillers generally at max 0.3 MPa)
- Elasticity from 3 to 25%
- Multi-metal bonding, including aluminum, PET, KTL and dielectric coatings



**Global presence and
experienced team of
innovators and product
development experts**

ENABLING STRUCTURAL INTEGRITY

DIELECTRIC COATINGS

2

Replace conventional PET foil with dielectric coatings



FROM CONVENTIONAL TAPE TO DIELECTRIC COATING AS SOLUTION

Conventional PET Foil



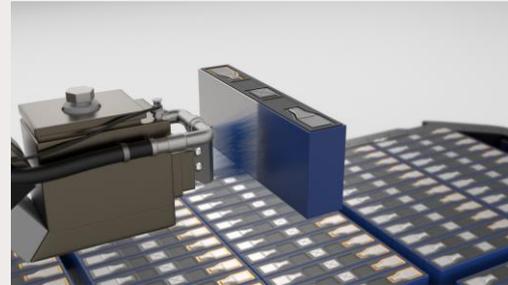
Established process, but with a risk of shock-induced **delamination**, **surface defects** and lack of **mechanical stability** due to **higher structural integrity**



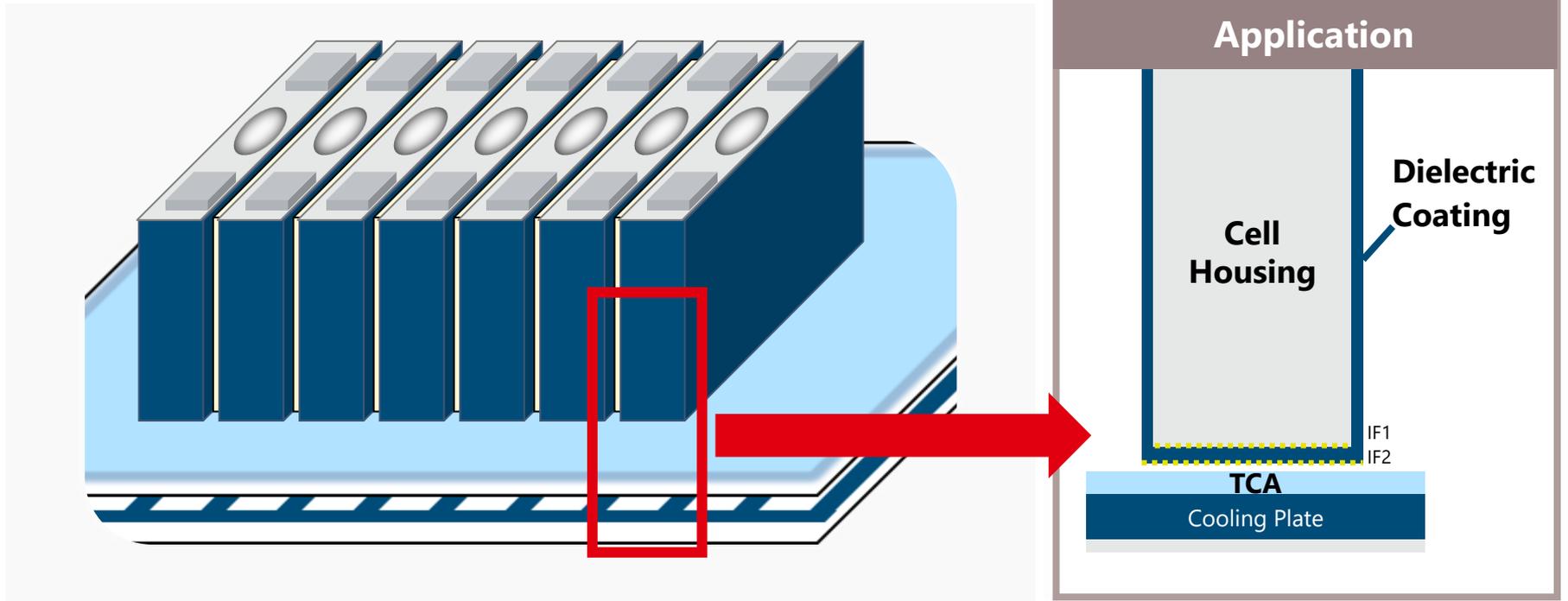
Dielectric Coating



Automated application process, **high resistance** of delamination, **uniform and thin spraying** layer with an **enhanced structural integrity**



HIGH LEVEL OF ADHESION TO DIFFERENT INTERFACES



HENKEL DIELECTRIC COATINGS

Technology Introduction

Dielectric coatings for battery cell housings to replace conventional PET-foil

Application and Cure Time

Spray Coating + UV Curing
within seconds

Chemistry

Acrylate

Material Thickness

<100µm

Dielectrical Strength

>80 kV/mm

Shear Strength

>15 MPa



Features & Benefits

- Fast UV light curing within seconds at room temperature
- Compatibility with Henkel structural and thermal adhesives
- Excellent interfacial adhesion avoiding shock-induced delamination
- Cost efficiencies due to automated spray coating process suitable for mass production

ENABLING STRUCTURAL INTEGRITY

STRUCTURAL ADHESIVES

3

**High structural joint strength
with stress distribution along
the bonded area**

**Ability to join dissimilar
substrates**



STRUCTURAL ADHESIVES

BENEFITS OF STRUCTURAL ADHESIVES

Join Dissimilar Substrates

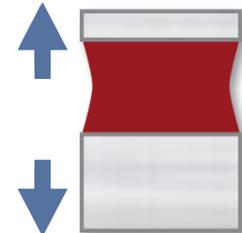
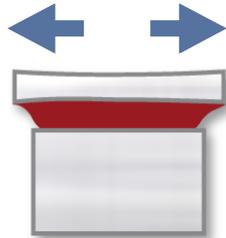
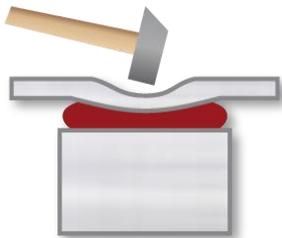
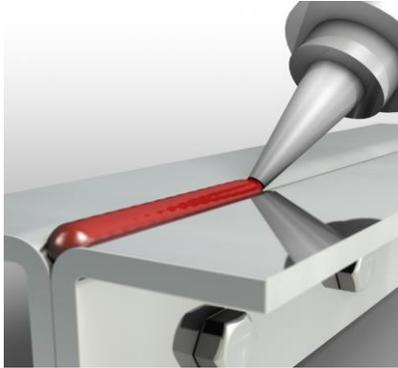
Distribute Stresses Evenly

Fastener Reduction

Design Flexibility

Corrosion Improvement

Cost Reduction



STRUCTURAL ADHESIVES

CHEMISTRY TYPES

Two Part Acrylic

Advantages



High cure through depth
High peel and impact strength
Good environmental resistance

Considerations



Fixture times (5 to 30 minutes)
Static mix process
Odor

Epoxies

Advantages



High adhesion
Good toughness
Superior environmental resistance

Considerations



Two-part systems require mixing
One-part system requires heat cure
Cure v. fixture times

Polyurethanes

Advantages

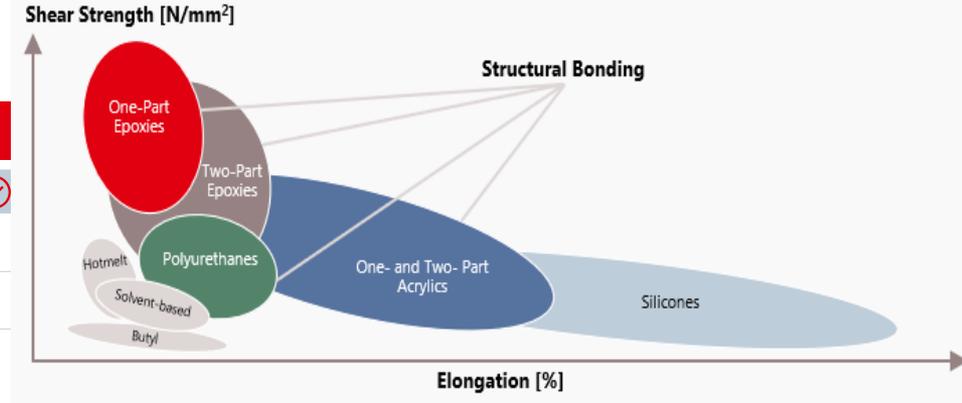


Extremely tough with high cohesive strength
Good resistance to solvents
Good impact and abrasion resistance

Considerations



Two-part systems require mixing
One part has limited depth of cure
Primer may be required



FUTURE CONSIDERATIONS

4

Debondable adhesives are essential in ensuring a circular economy

Repair, Reuse, Repurpose, Recycle



TRIGGERS FOR DEBONDING

TRIGGER IN SCOPE OF HENKEL AUTOMOTIVE



Henkel Thermal Debonding Layer (H-TDL)

Softening, decomposition or expansion of the adhesives' polymers, triggered by heat



Henkel Electrical Delamination Layer (H-EDL)

Obtaining a weak boundary layer that leads to accumulation of the adhesives at interfaces, triggered by electrical current

IMPORTANCE OF WORKING ON DIFFERENT TRIGGERS

Depending on the design, debonding solution needs to be adapted based on customer requirements:

Battery configuration

- Module to pack
- Cell to pack
- Cell to chassis

Thermal system

- Central cooling plate
- Modular cooling plates
- Cooling ribbons

Cell type

- Cylindrical
- Prismatic
- Pouch

Debonding objective

- Repair
- Repurpose (e.g., 2nd life)
- Recycling

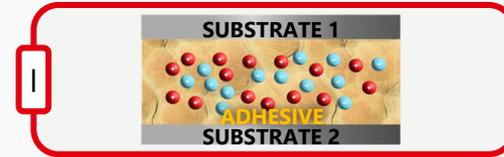
HENKEL ELECTRICAL DELAMINATION LAYER FUNCTIONALITY



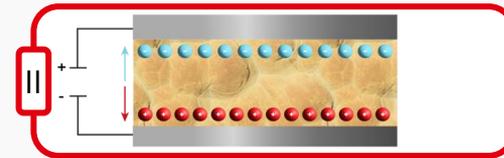
PRINCIPLE: FORMATION OF A WEAK BOUNDARY LAYER WITHIN THE DEBONDABLE LAYER BY ION DIFFUSION TO ELECTRODES WHEN VOLTAGE IS APPLIED

- High automation capability and process reliability by applying an electrical voltage to designated points on the battery pack (electrically conductive substrates)
- Debonding is carried out at room temperature
- Debonding progress easily readable by current intensity (voltage converges towards 0 A)
→ Creation of clean surfaces for rebonding

Dispensing of **electrically debondable adhesive**



Diffusion of **ions** in **electrical** field



Adhesive failure by creation of weak boundary layer



MEET WITH US



DALTON CONLON

Business Development Manager, eMobility
Henkel Adhesive Technologies, North America
dalton.conlon@henkel.com
[linkedin.com/in/daltonconlon](https://www.linkedin.com/in/daltonconlon)

THANK YOU.