



Battery pack manufacturing - a redefinition of requirements for joining technologies

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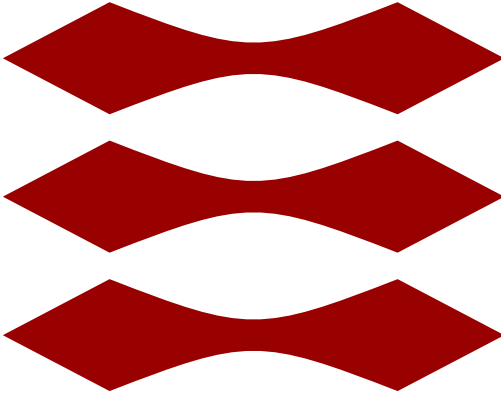
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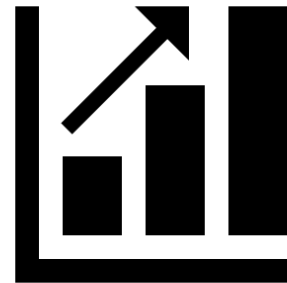


MFR Zwicker, M Moghadam, W Zhang, CV Nielsen

Battery pack manufacturing - a redefinition of requirements for joining technologies

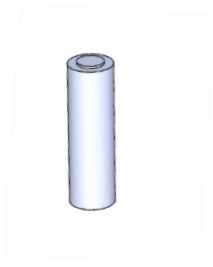
Current Trends

- Global trend towards electromobility
- Largest automotive market aims for banning fossil fuel cars
- Electromobility one of the most mature technology to satisfy demand



Battery Pack Design

Cylindrical cell



Tesla inc.

e.g. Tesla Model S

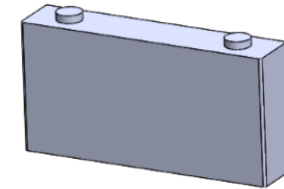
Pouch cell



Nissan

e.g. Nissan LEAF

Prismatic cell

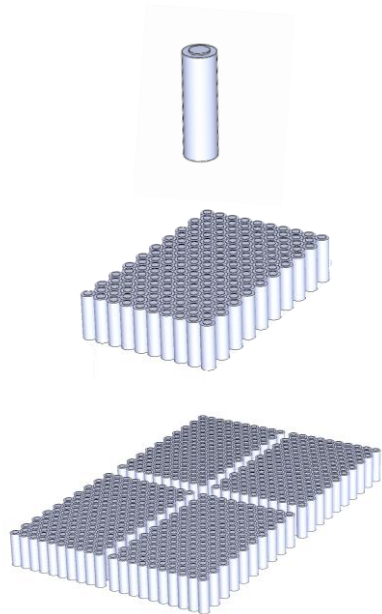


BMW AG

e.g. BMW i3

Battery Pack Design

Cell – Module – Pack



e.g. Tesla Model S

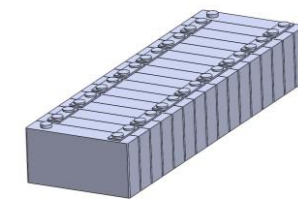
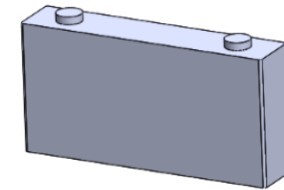
Cell – (Module) – Pack



Mixed types possible

e.g. Nissan LEAF

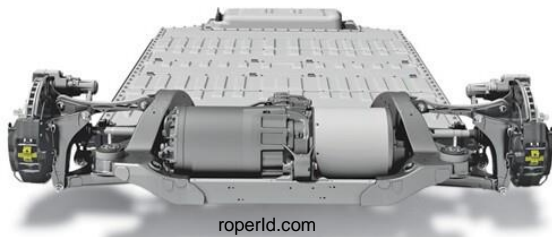
Cell – Pack



e.g. BMW i3

Battery Pack Design

Cell – Module – Pack



roperld.com

e.g. Tesla Model S

Cell – (Module) – Pack



Cleantech.com

e.g. Nissan LEAF

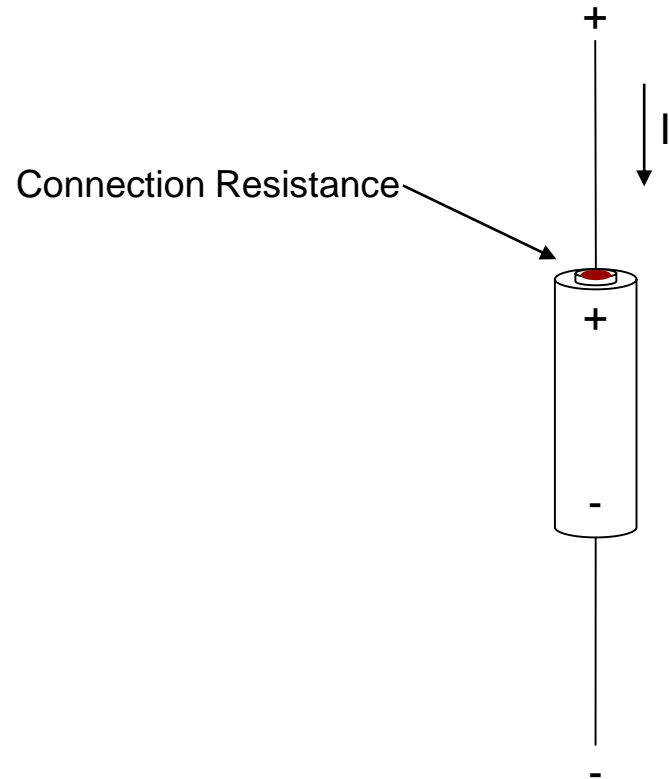
Cell – Pack



BMW AG

e.g. BMW i3

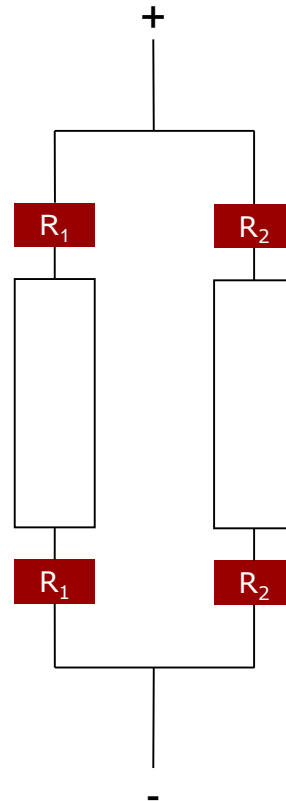
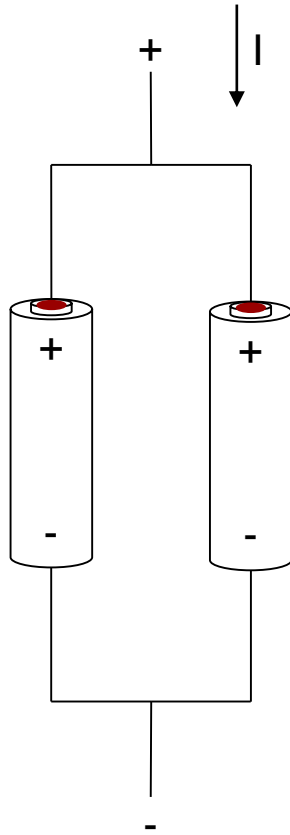
Battery Connections



Direct Implications:

- Loss of electrical energy
→ Loss of capacity
- Generation of thermal energy
→ Faster ageing

Parallel Connections



Connection Resistance (charging)

Connection Resistance (discharging)

Kirchhoff's Current Law $I_1 = I_2(R_2 / R_1)$

Joining Technology Requirements

Mechanical Requirements

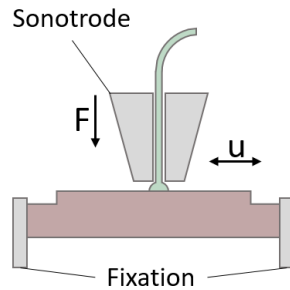
Material and Metallurgical
Requirements

Economic Requirements

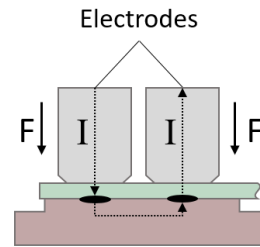
**Electrical and Thermal
Requirements**

Commonly applied joining technologies

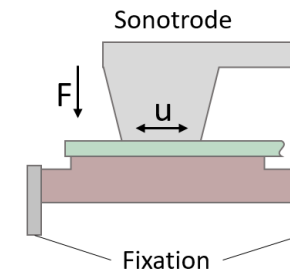
Wire Bonding



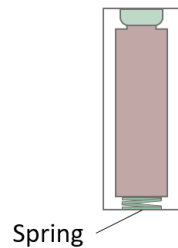
Resistance Welding



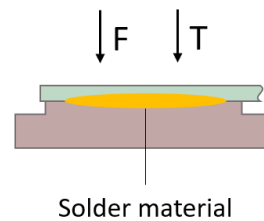
Ultrasonic Welding



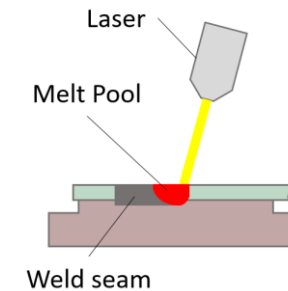
Force Fitting



Soldering

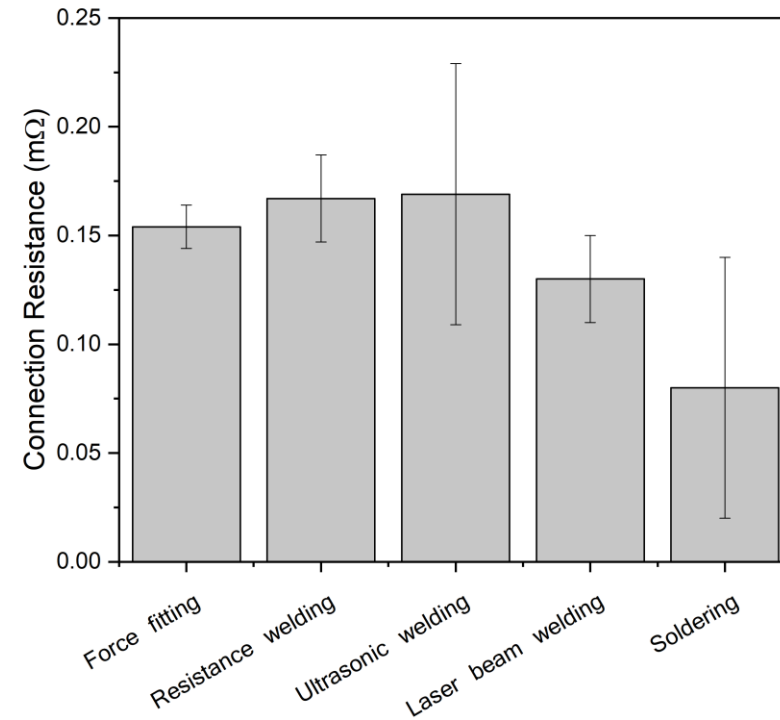


Laser Beam Welding



Tool
 Interconnector
 Battery cell/terminal
 Weld

Comparison of Joining technologies



Brand, M. J., Kolp, E. I., Berg, P., Bach, T., Schmidt, P., & Jossen, A. (2017).
Electrical resistances of soldered battery cell connections. *Journal of Energy Storage*, 12, 45-54.

Brand, M. J., Schmidt, P. A., Zaeh, M. F., & Jossen, A. (2015).
Welding techniques for battery cells and resulting electrical contact resistances. *Journal of Energy Storage*, 1, 7-14.

Conclusion

- Connection resistance plays important role in battery packs
- Scientific literature in the field of joining technology lacks interdisciplinary approach
- Electrical engineering approaches battery joining
- Missing of general measurement methodology for connection resistance

Thank you for your attention.