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Debonding methods for electric vehicles battery packs

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1. Introduction

As electric vehicles (EVs) drive the transition toward sustainable transportation, addressing the end-of-life (EoL) challenges of lithium-ion battery packs is essential. Current battery designs often rely on permanent adhesive joints, hindering efficient disassembly and recycling [1]. This study explores two innovative adhesive debonding strategies for battery pack dismantling: a heat-activated primer enabling reversible bonding of lid sealants; a stretch & release pressure sensitive adhesive (PSA) for prismatic cell separation. These approaches aim to enable low-energy, non-destructive disassembly, improving serviceability and EoL management. Figure 1 illustrates the application of these adhesives, along with a thermally conductive adhesive, representing the three most common bonding types used across the battery sector.

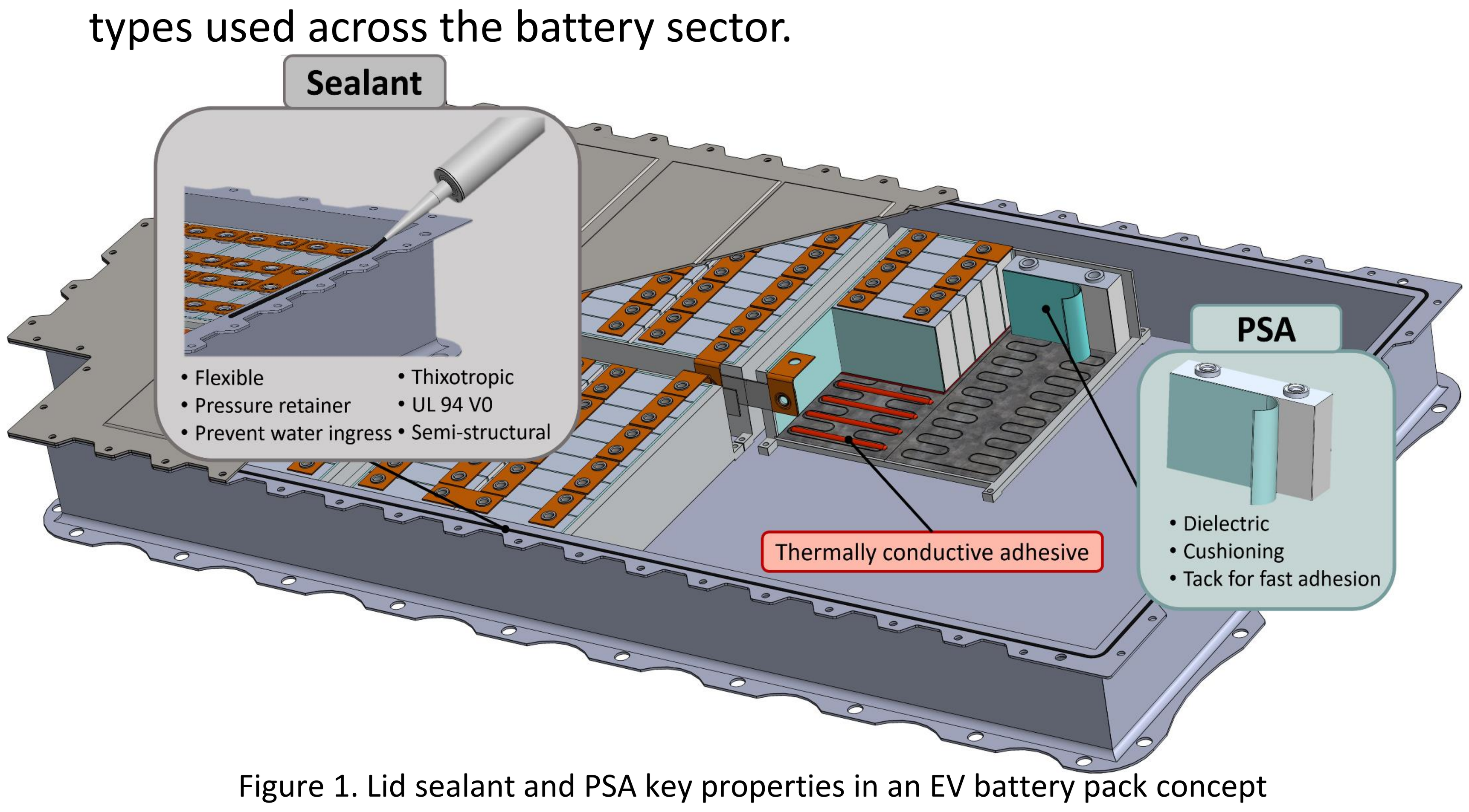


Figure 1. Lid sealant and PSA key properties in an EV battery pack concept

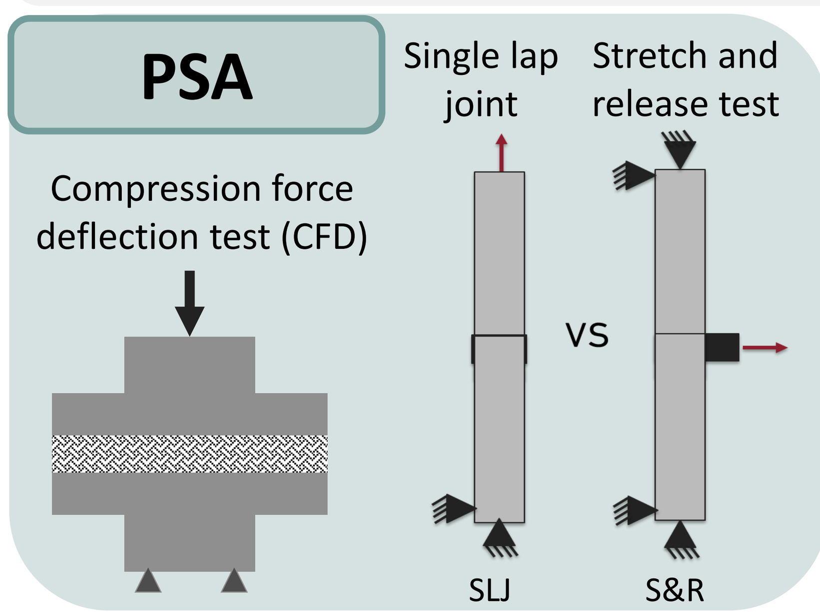
2. Materials

Sealant — 1k polyurethane *Sikaflex 252* + Heat trigger debondable primer (150ºC)

PSA

Already in use	VS	Trial S&R
3M 300LSE		*tesa* 76565
PSA Pad from *Gotion*		*tesa* 64911

3. Testing methods



Testing conditions

Test	Rate (mm/min)	Specifications
CFD	0.2	ø62mm, 1 adhesive layer
SLJ	1	Al substrates, 12.5mm of overlap (ASTM D1002)
S&R	200	Al substrate, 12.5, 25 and 50mm of overlap

4. Validation

A one-component polyurethane (1K PU) sealant was tested in single lap joints with and without the heat-activated primer. The primer increased the lap shear strength (LSS), changing the failure mode from adhesive to cohesive failure (Figure 2). Moreover, heating the joint for a few seconds at 150°C enabled clean interface debonding between the adhesive and primer layers.

For PSAs between prismatic cells, the debondable tesa adhesives show superior LSS compared to the benchmarked tapes. In CFD tests, tesa 64911 enables greater cell expansion, outperforming the Gotion PSA pad, while tesa 76565 offers higher stiffness with limited expansion (Figure 3) [2]. Upon debonding, the force to stretch and release is estimated to be up to 10 times lower than the LSS, allowing for ease disassembly (Figure 4).

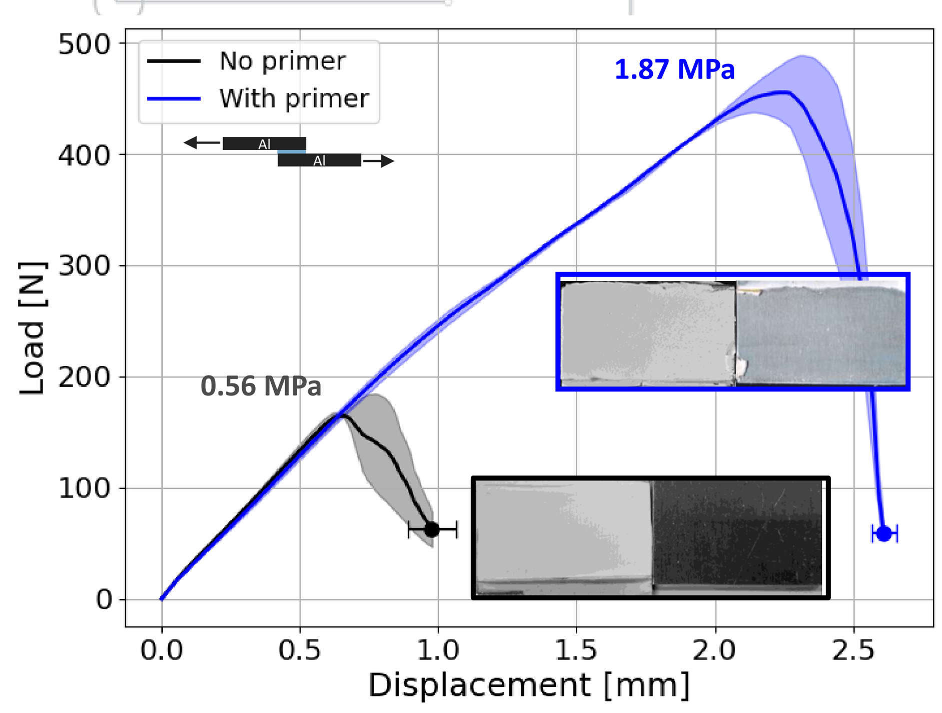


Figure 2. SLJ Performance of the 1k PU with and without the debondable primer

PSA	LSS [kPa]		PSA	LSS [kPa]
3M 300LSE	448 ± 23	VS	tesa 76565	477 ± 31
Gotion	375 ± 31		tesa 64911	484 ± 21

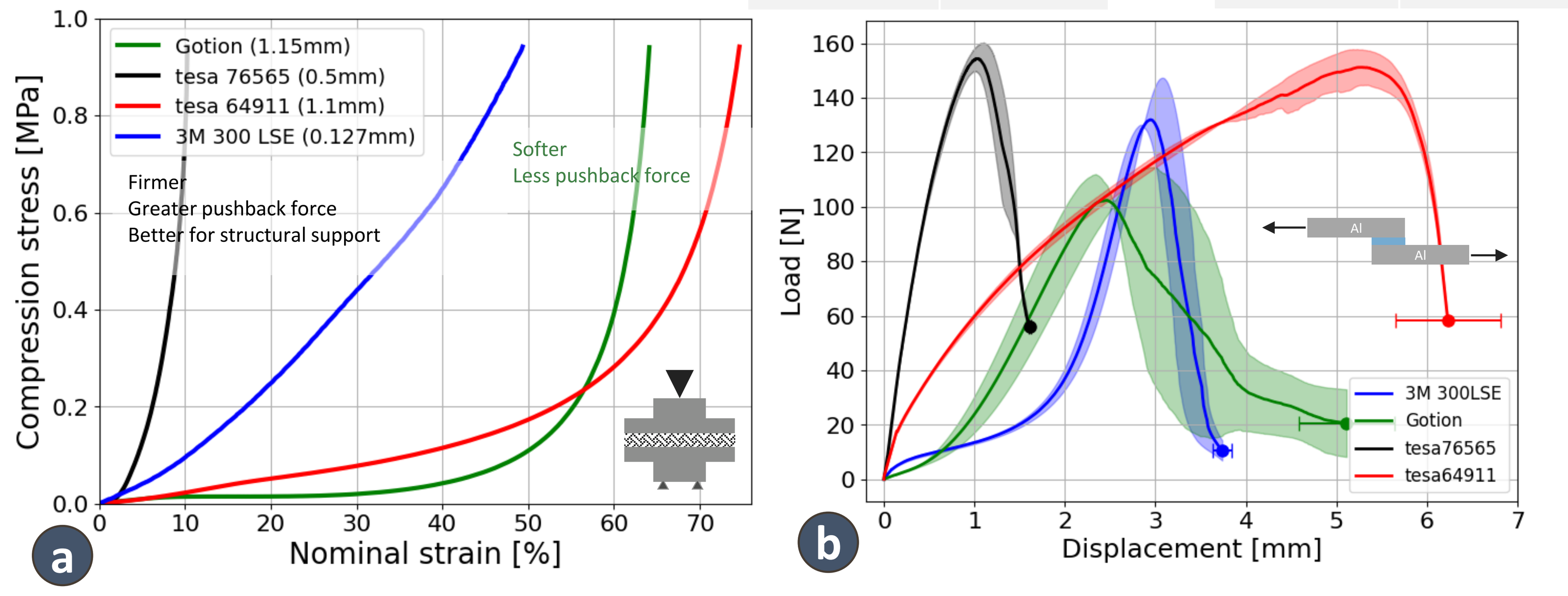


Figure 3. a) CFD test; b) Single lap joint and lap shear strength

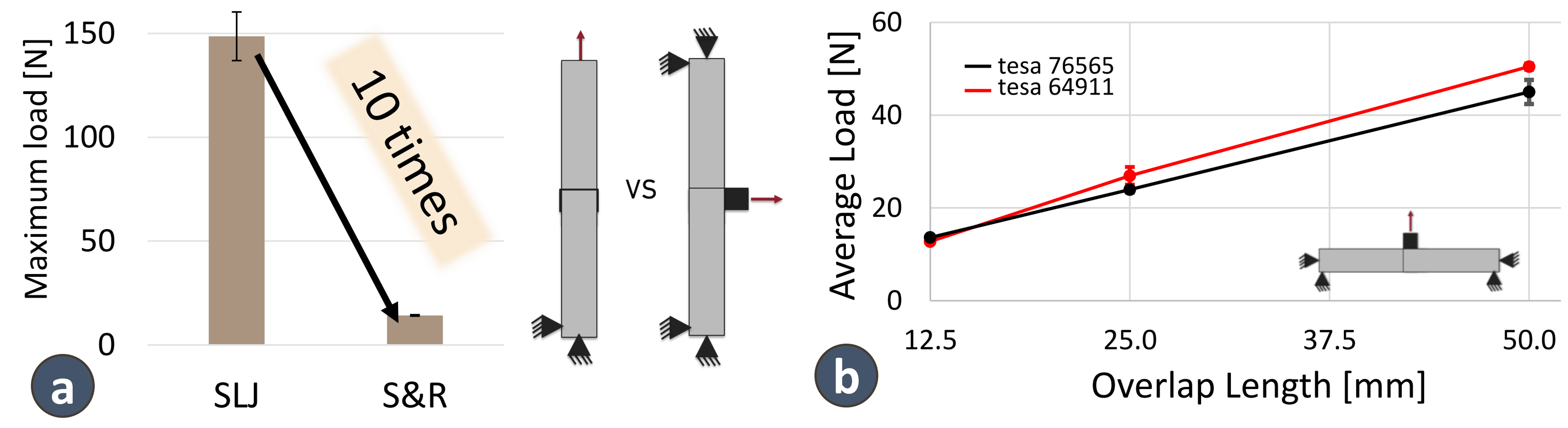


Figure 4. a) S&R vs SLJ peak load; b) required S&R load envelope

5. Conclusions

- Heat-triggered debondable primer enables fast and easy battery lid removal through conduction heating, while also significantly improving adhesion to aluminium surfaces. Additional testing is required to evaluate the primer's compatibility with other adhesive formulations and to assess its durability under real-world conditions.
- For cell-to-cell bonding, tesa stretch & release tapes performed equal to or better than commercial PSAs regarding the performed mechanical tests, with the added benefit of significantly lower debonding forces, unlike commercial PSAs which require excessive force for cell separation.

Acknowledgements

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References

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[2] Mei, Wenxin, et al. "An investigation on expansion behavior of lithium ion battery based on the thermal-mechanical coupling model." Journal of cleaner production 274 (2020): 122643

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