Investigating Barrier Properties of Laminate Packaging Materials for Flexible Batteries

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Introduction

Flexible batteries are used in wearables such as health monitoring devices, skin sensors, and flexible electronics.

These batteries are made with sealed flexible packaging material which undergo constant bending.

https://www.powerstream.com/thin-lithium-ion.htm

Research Questions

What is the effect of grain orientation of the seal strength?
What is the effect of the adhesive, tab, electrolyte exposure, relative humidity (RH) and temperature on the seal strength?
How does the seal strength change after bending?

Analyzed Material

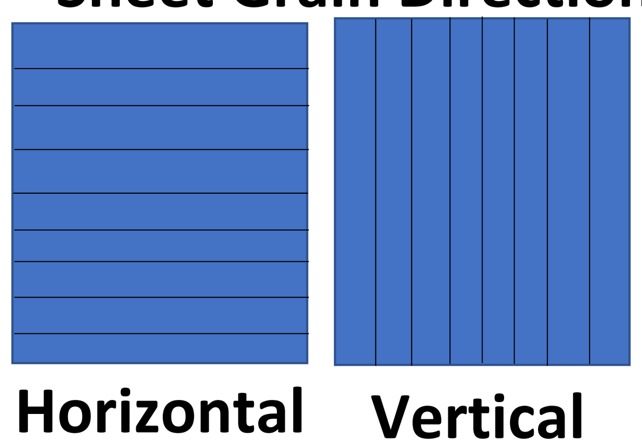
Name: A
Thickness: 0.148 mm

Name: B
Thickness: 0.087 mm

Methods

1. Cut the samples into the desired dimensions

Sheet Grain Direction



Sheet Grain Seal Orientation:
HH: Both horizontal
VV: Both vertical
VH: 1 vertical & 1 horizontal

Methods

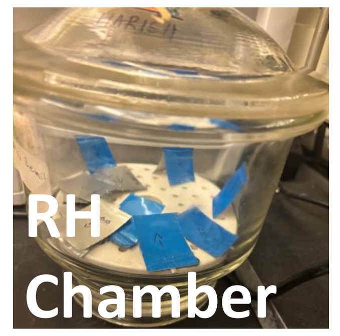
2. Prepared two adhesive tapes and the tab

Adhesives were added between the sealing area to secure the tab used for electrical connections to the battery electrodes.

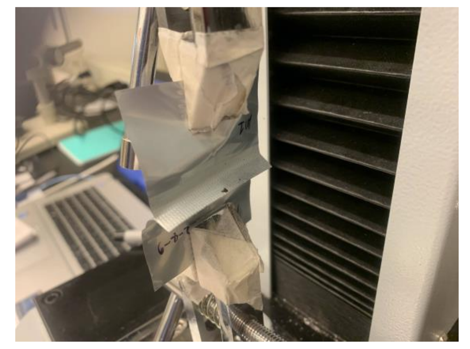
3. Sealed samples

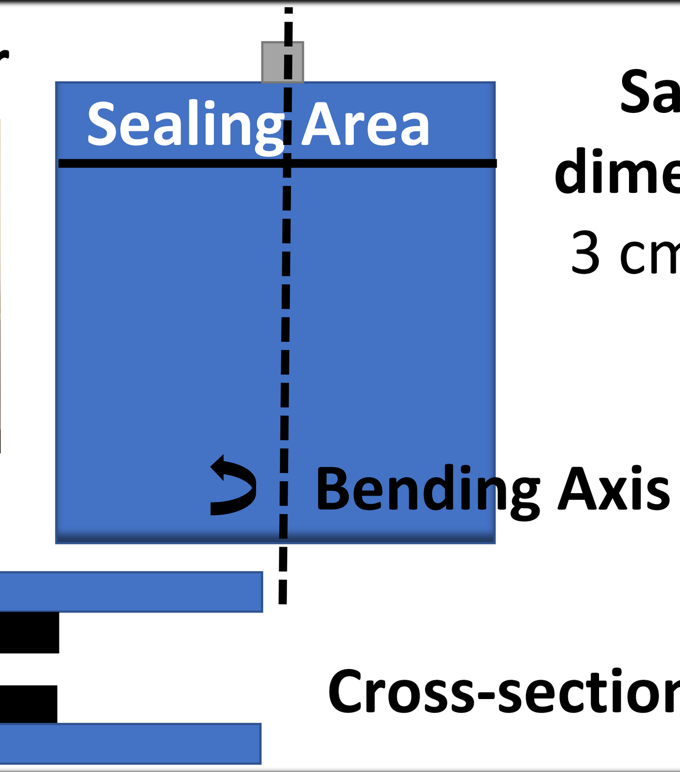
4. Bending, electrolyte addition, RH or temperature change

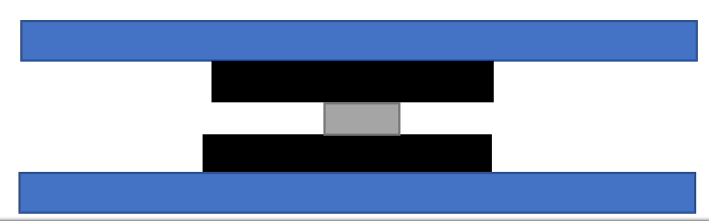
Testing	Value
Temperature	65˚ C
RH Percentage	65 %
Bending Angle	60˚ at 3k Cycles



5. Tensile tester







Sample dimensions: 3 cm x 4 cm

Results

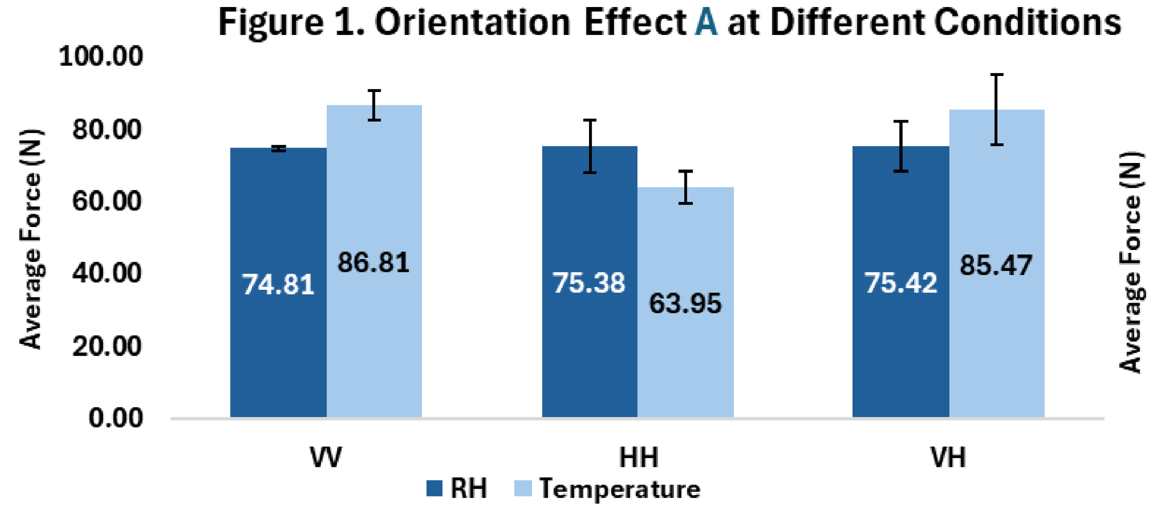


Figure 1. Orientation Effect A at Different Conditions

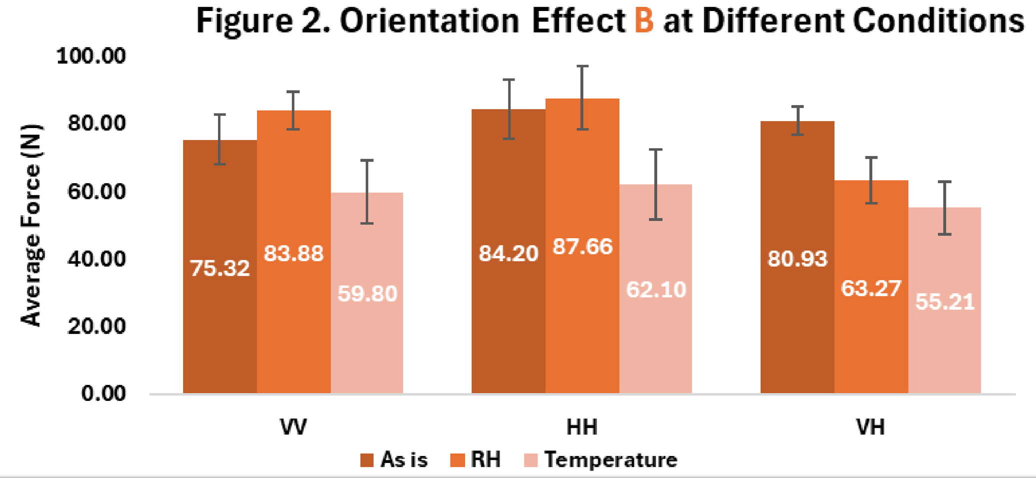


Figure 2. Orientation Effect B at Different Conditions

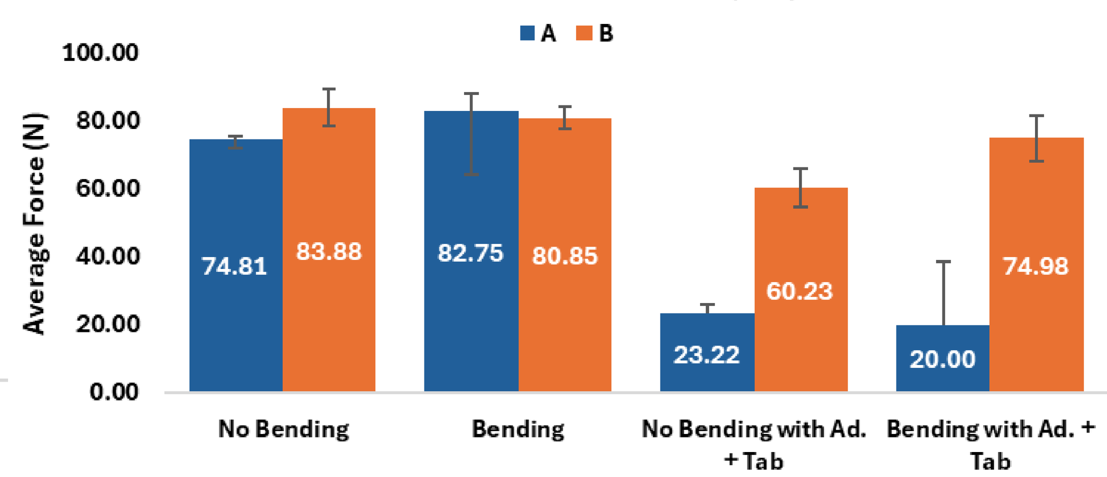


Figure 3. A Vs B with RH (VV)

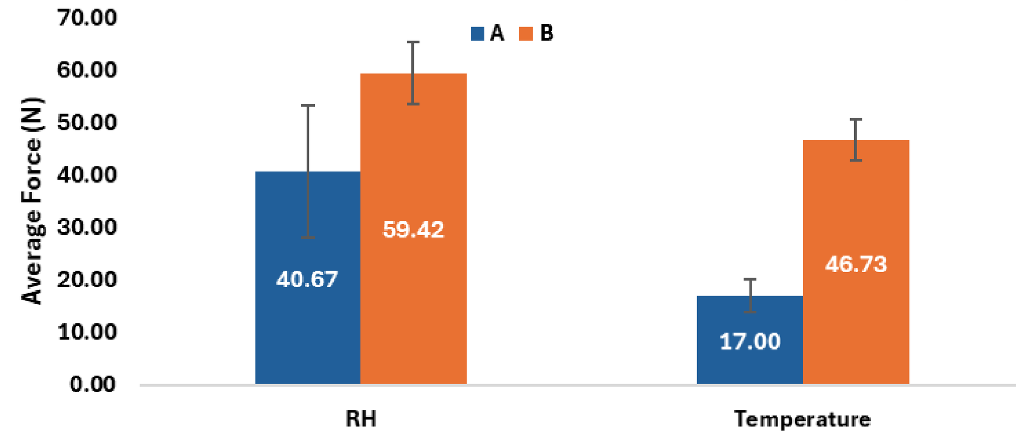


Figure 4. A vs B with Electrolyte Addition (HH)

Figure 1 & 2: Average max force of different orientations are shown for materials A and B with comparison of RH and temperature effect. Material B also shows as is (no condition).

Figure 3: Average Max force of different conditions are displayed for RH with comparison of materials A and B.

Figure 4: Average Max force of different conditions is displayed for electrolyte addition with comparison of materials A and B.

Conclusion

For material A, with RH , all orientations' seal strength had minimal change with all close to 75 N. Temperature testing (VV & VH) had similar force while HH had the lowest strength. In material B HH did the best overall but showed that temperature reduced the seal strength the most. With RH, material B had better seal strength except on bending. Adding adhesive + tab showed to decrease the seal strength for both materials. In electrolyte addition material B had higher seal strength and temperature showed lowered strength compared to RH effect.

Acknowledgements

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