

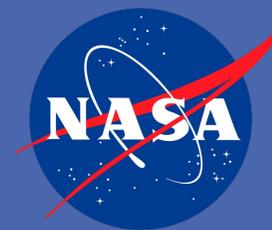
Discerning Cell Surface Defects with 3D Optical Profilometry

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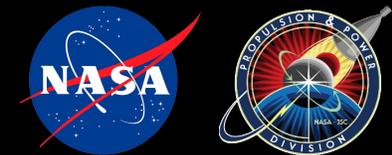
Cell Strategic Reserve

NASA Johnson Space Center



What is the Cell Strategic Reserve?

- NASA's supply of Crewed-Flight Qualified Li-Ion Battery Cells
- Reserve is housed at JSC



What does the Reserve do?

- Assess cells from across industry for applicability to Crewed Flight
- Identify cells that meet the highest performance and safety criteria
- Procure cell lots direct from the manufacturer
- Vet the lots to validate our expectations and establish a baseline
- Screen every cell for electrical performance and visual defects
- Remove all outliers and package cells for long term storage
- Upgrade the cells to Class I and deliver them



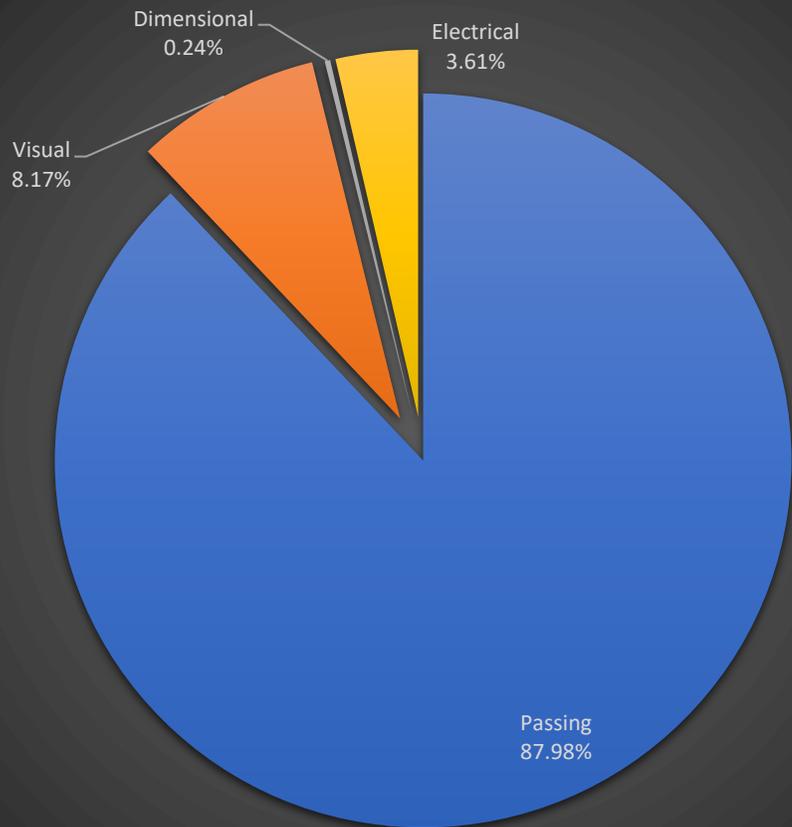
Why does it matter?

- Working with multiple cells from multiple vendors, we've learned
- Developed and Released Work Instructions:
 - Receiving Inspection; EP-WI-035
 - Ensure Cells were shipped properly & with correct documentation
 - Initial Lot Assessment; EP-WI-036
 - Visual, Dimensional, Electrical Testing, CT Scanning
 - Destructive Physical Analysis; EP-WI-034
 - Side Wall Rupture Characterization; EP-WI-038
 - Lot Acceptance Testing; EP-WI-033
 - Large array of abuse testing & destructive testing
 - Individual Cell Screening; EP-WI-037
 - Verifying that each individual cell conforms electrically and physically to the lot
- By following a standardized process, we deliver repeatably reliable cells

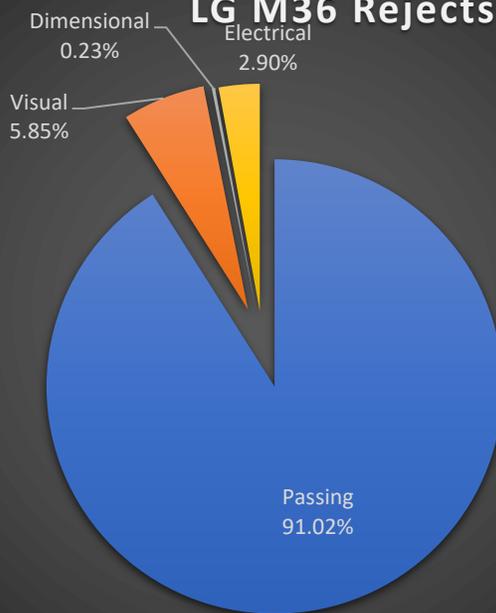


Defects

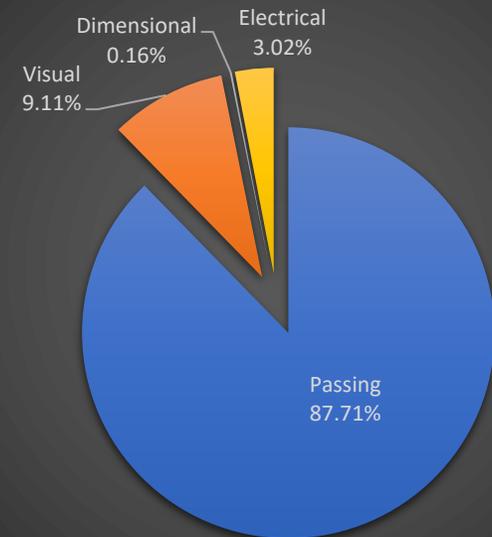
68,000 Screened Cells



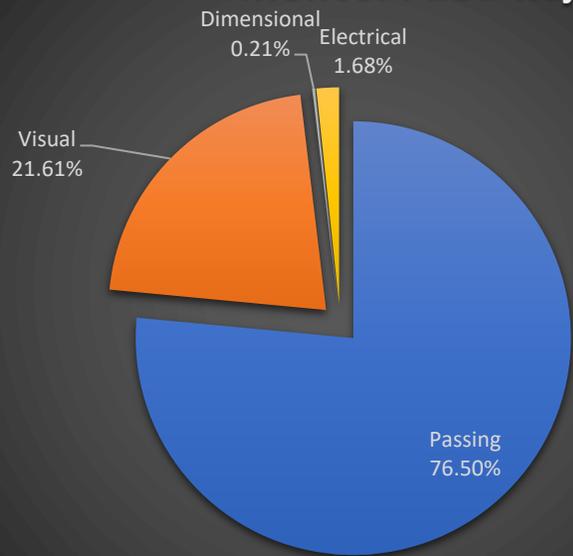
LG M36 Rejects



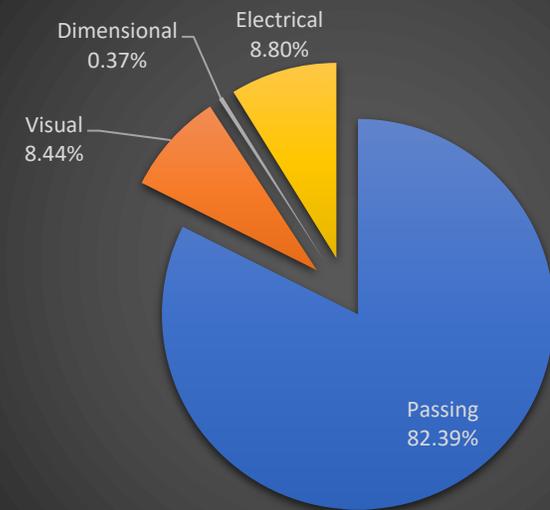
Samsung 30Q Rejects



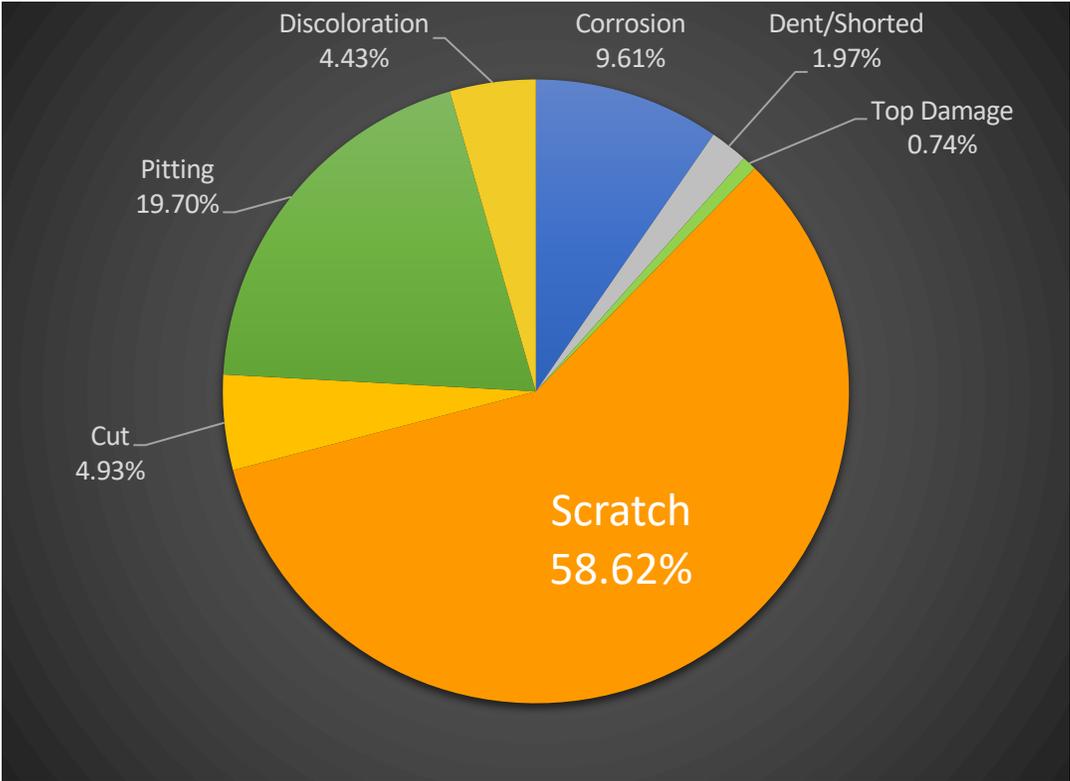
Molicel P28B Rejects



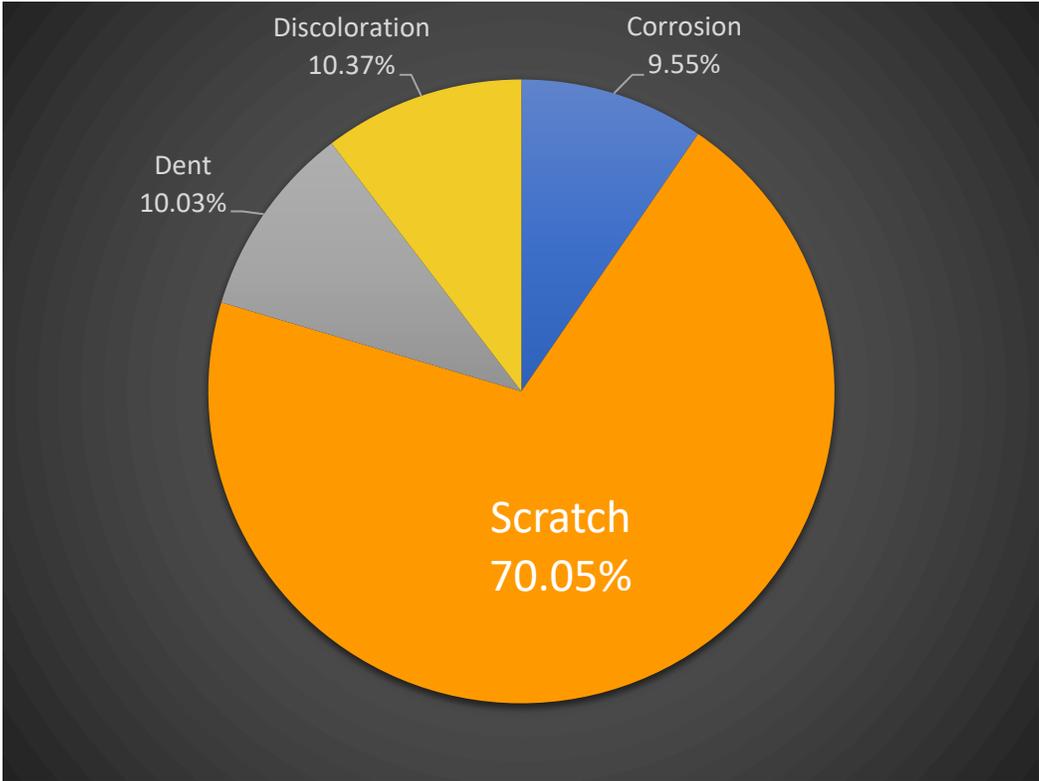
Molicel M35A Rejects



Visual Rejects



M36 Visual Rejects



P28B Visual Rejects



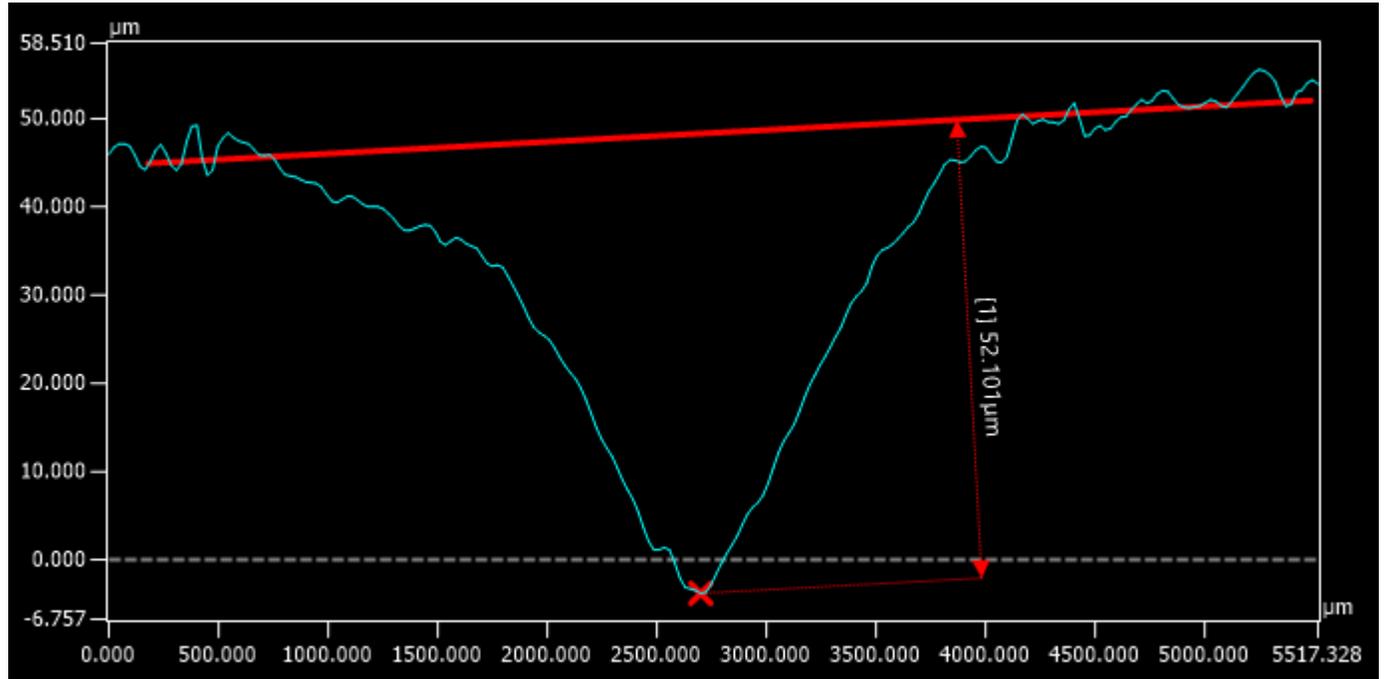
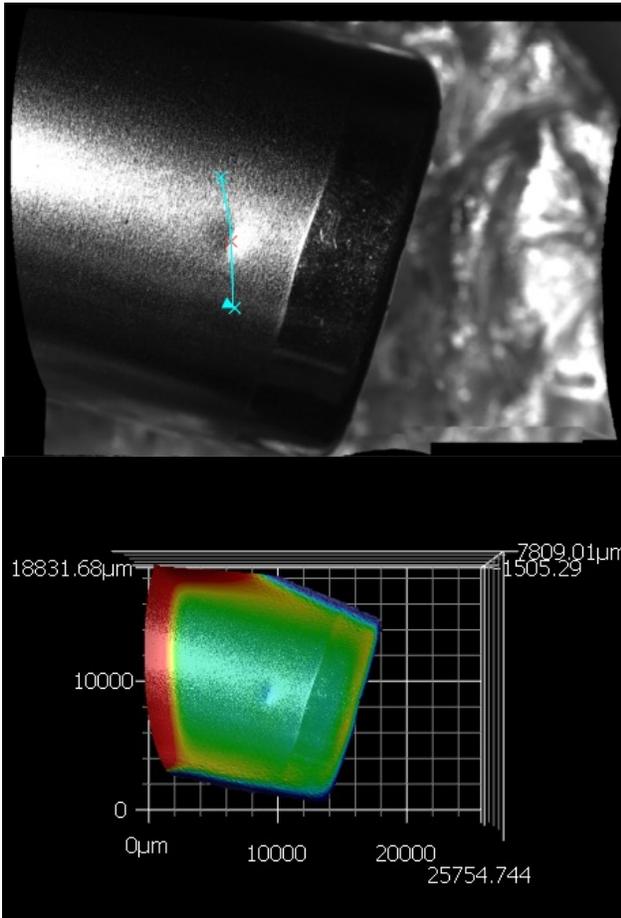
3D Optical Profilometer



- Shape and profile measurement
- Measures variations in height, providing a detailed profile of the surface topography
- Takes average of surface of cell button or cell wall to compare to scratch depth or crease
- 0.1 micron level resolution



Dent on Can Wall - Significant



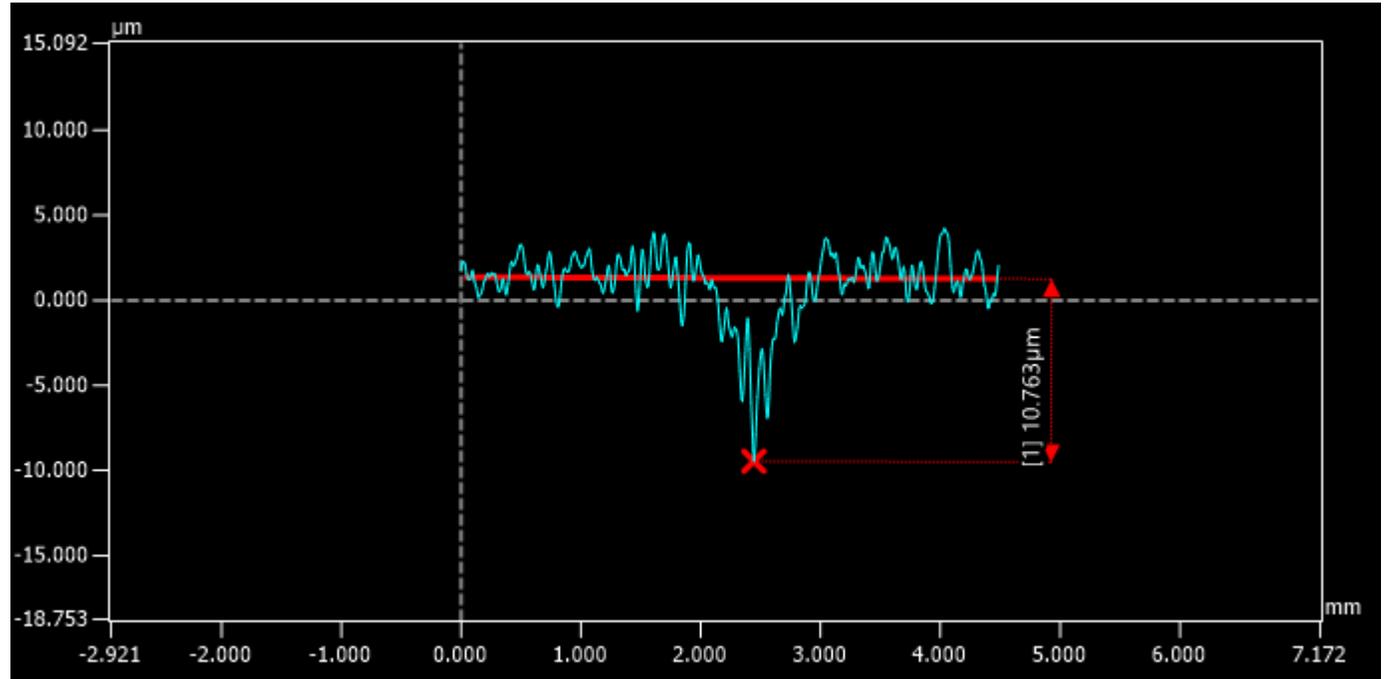
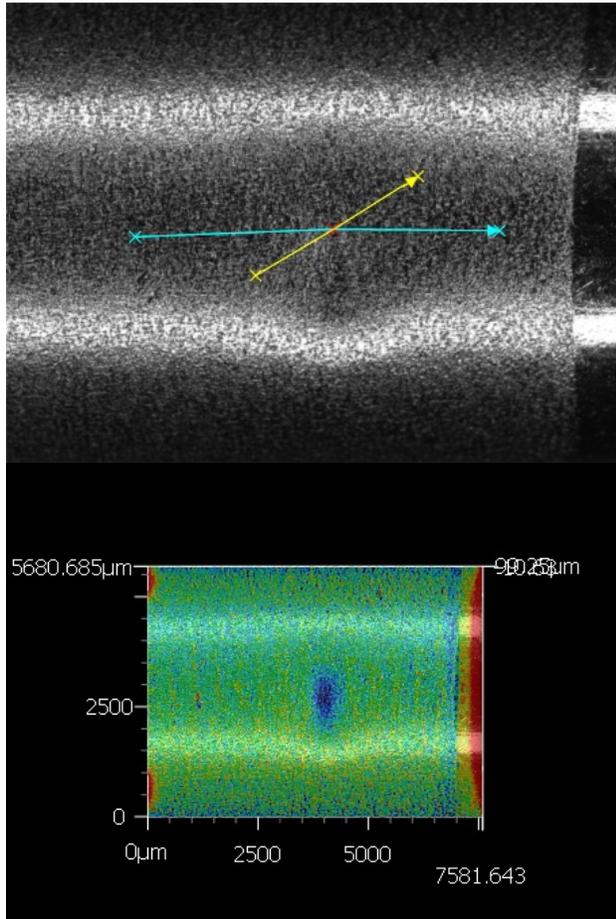
No.	Measurement name	Measured value	Unit
1	Line - Point1	52.101	μm

Molicel M35A

- Dent depth is larger than 5% of cell can wall thickness



Dent on Can Wall – Subtle



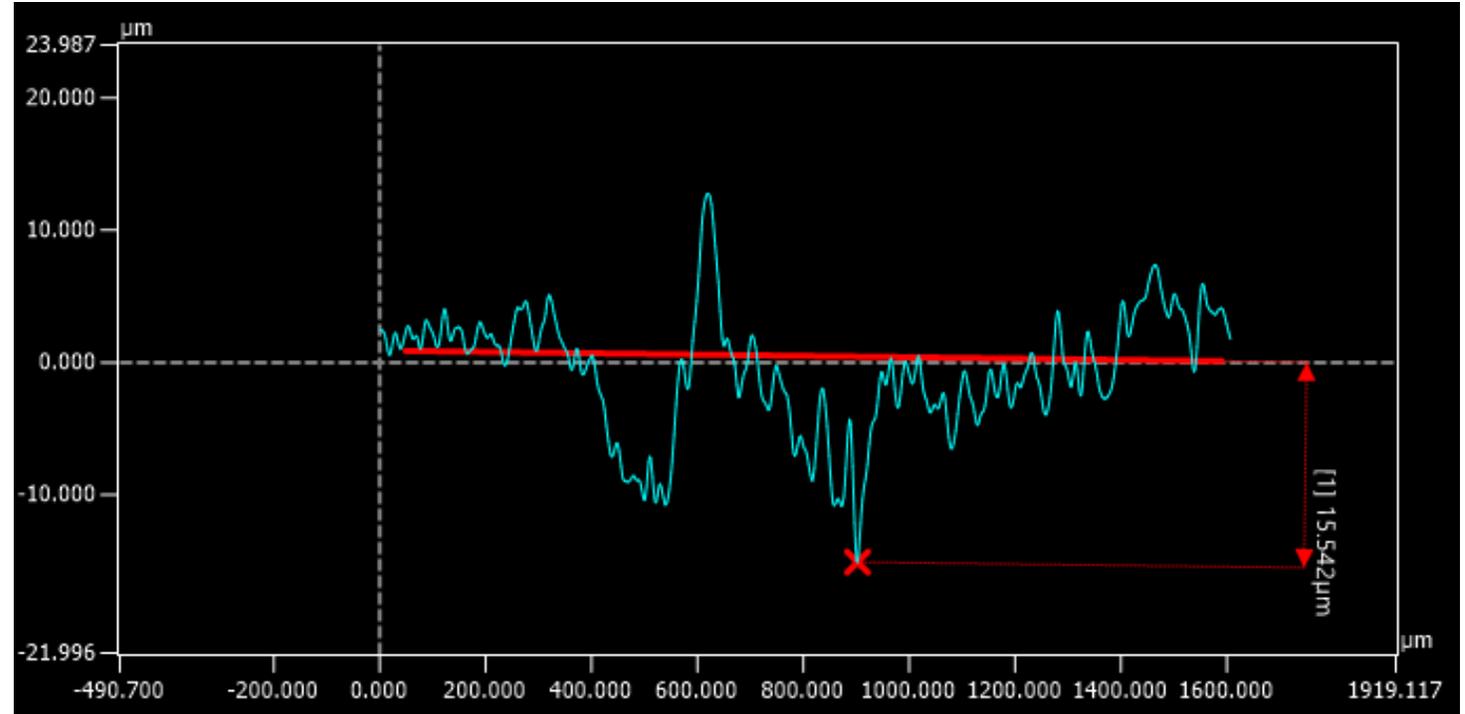
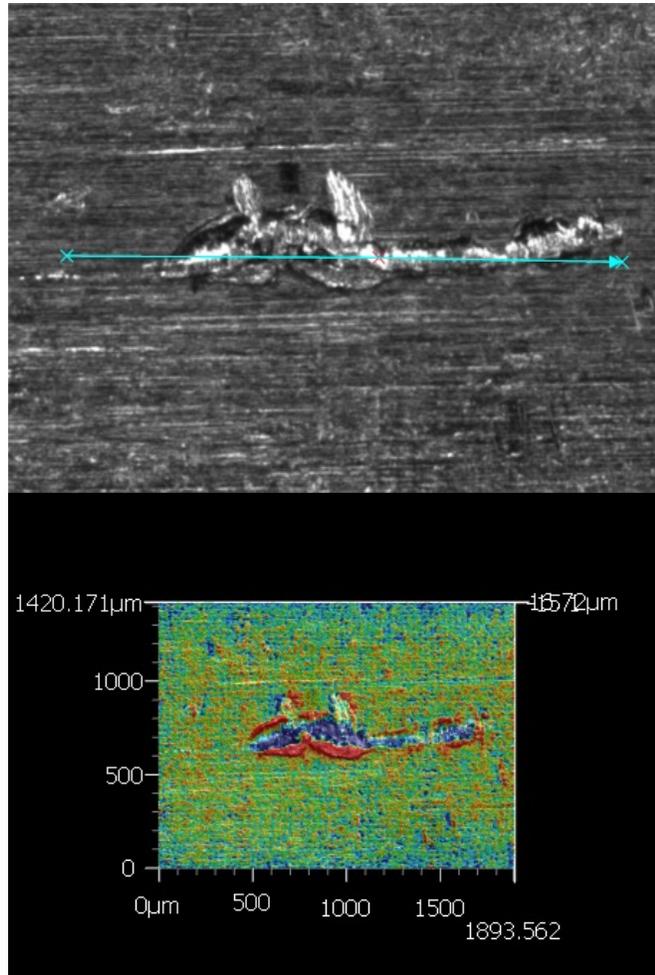
No.	Measurement name	Measured value	Unit
1	Line - Point1	10.763	μm

Molicel M35A

- Dent depth is smaller than 5% of cell can wall thickness



Scratch on Can Wall



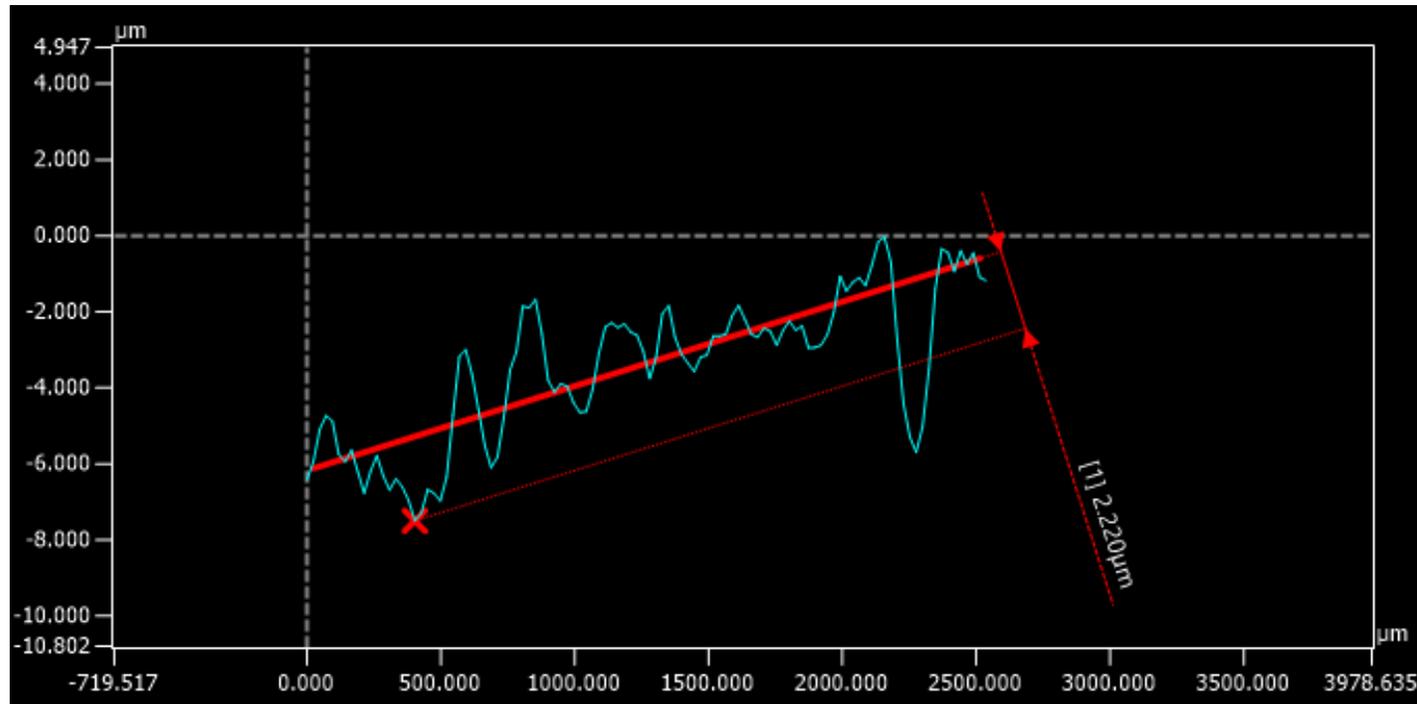
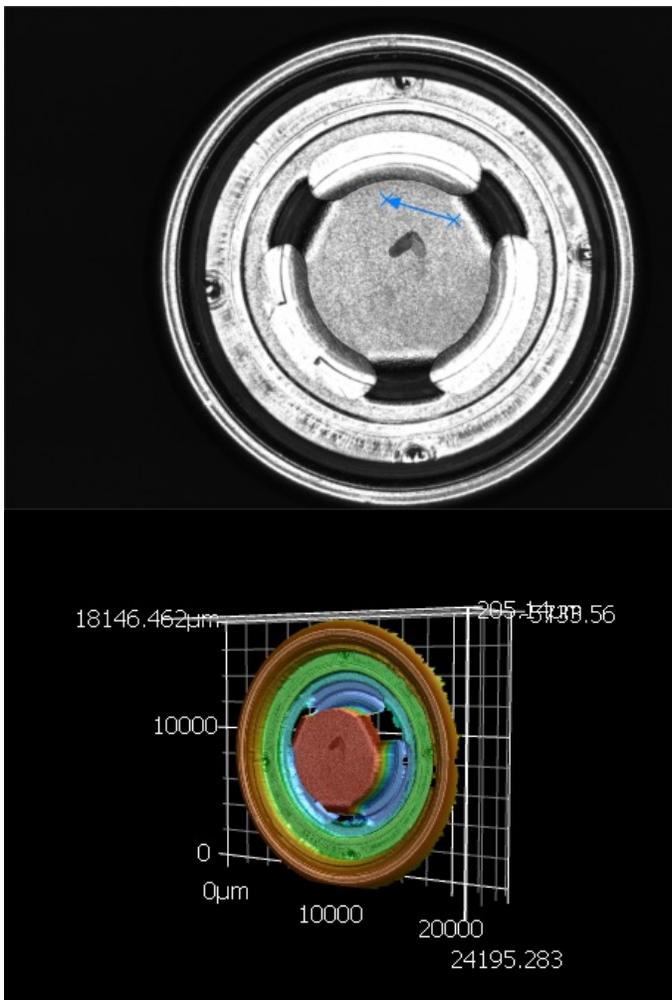
No.	Measurement name	Measured value	Unit
1	Line - Point1	15.542	μm

LG M36

- Scratch depth larger than 5% of cell can wall thickness
- Can lead to insulation fail (cell wrapper)



Scratch on Button – False Positive



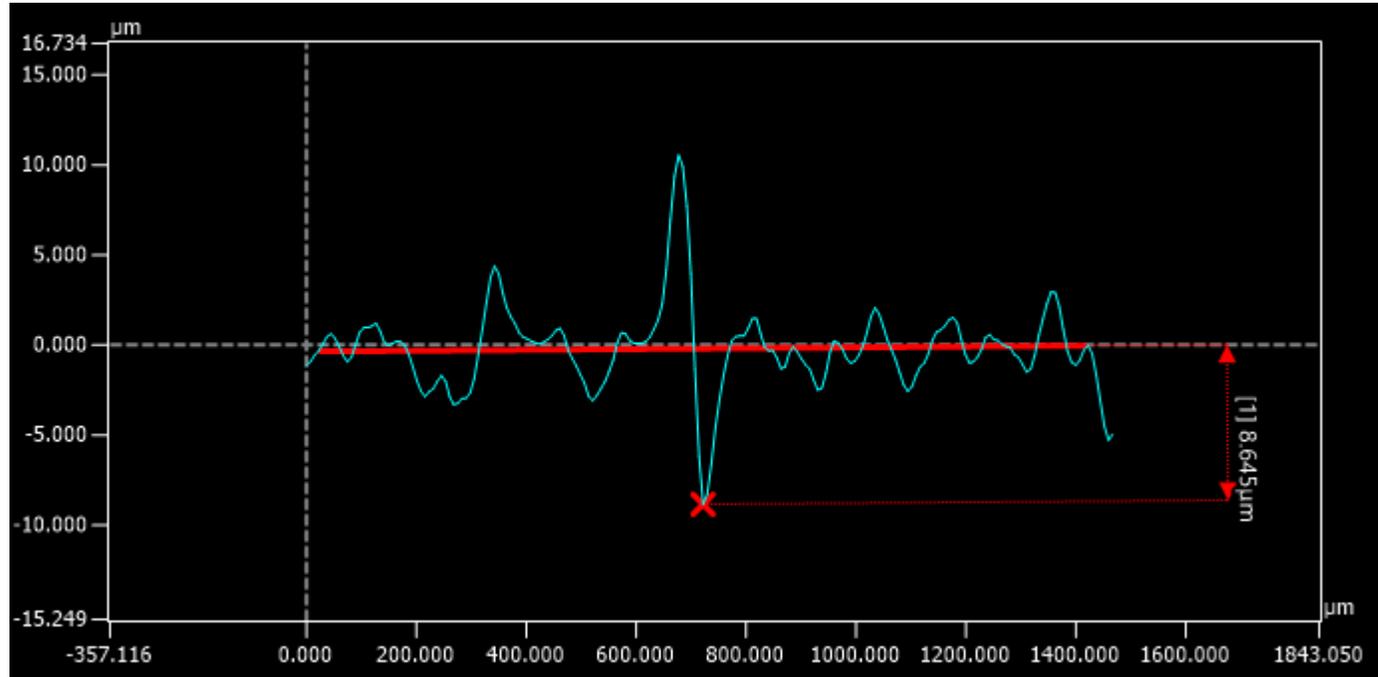
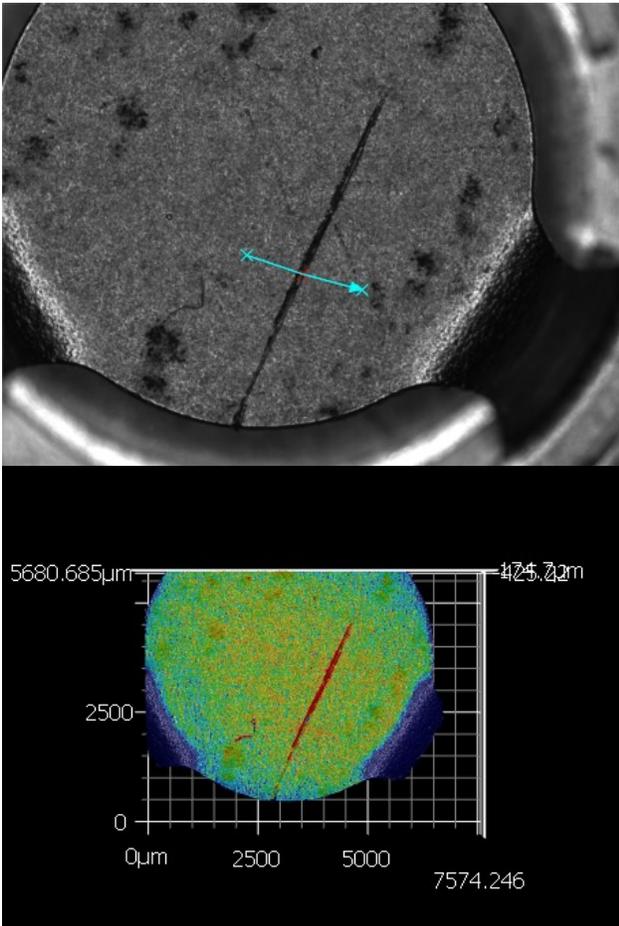
No.	Measurement name	Measured value	Unit
1	Line - Point1	2.220	μm

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- Cannot see/feel a scratch



Intentional Scratch on Cell Button



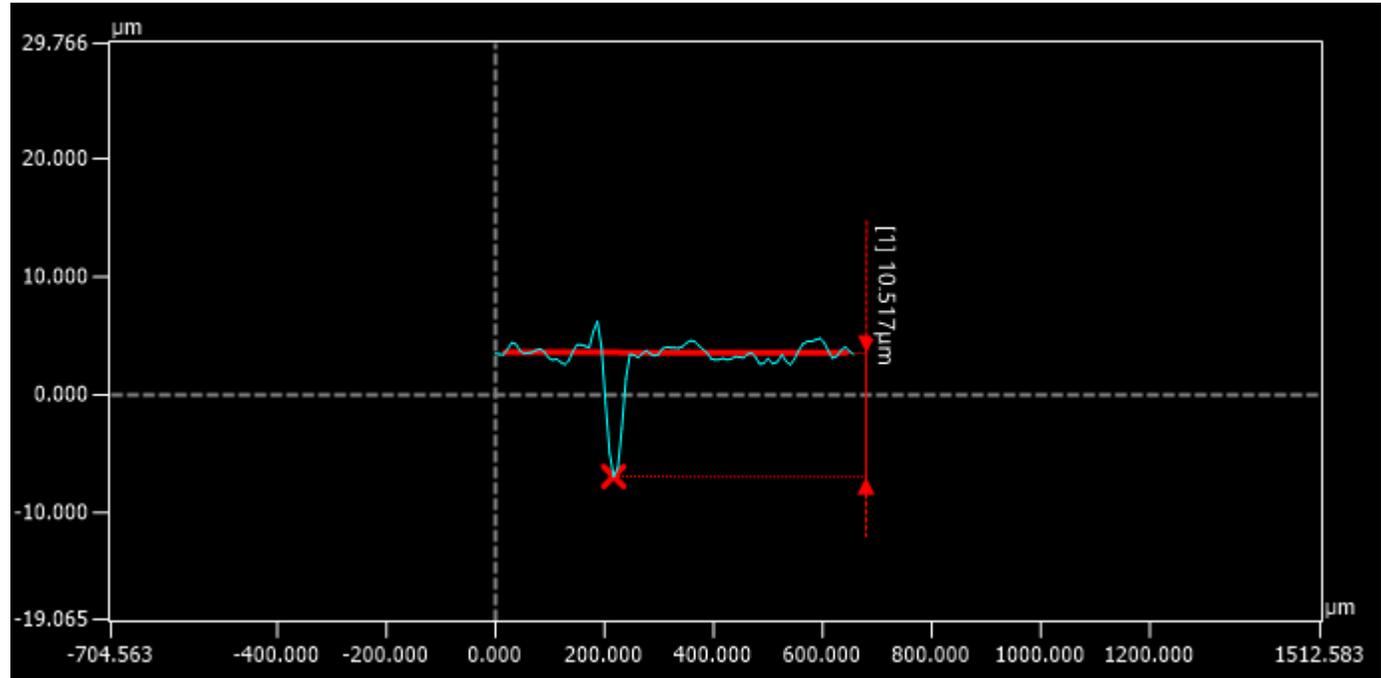
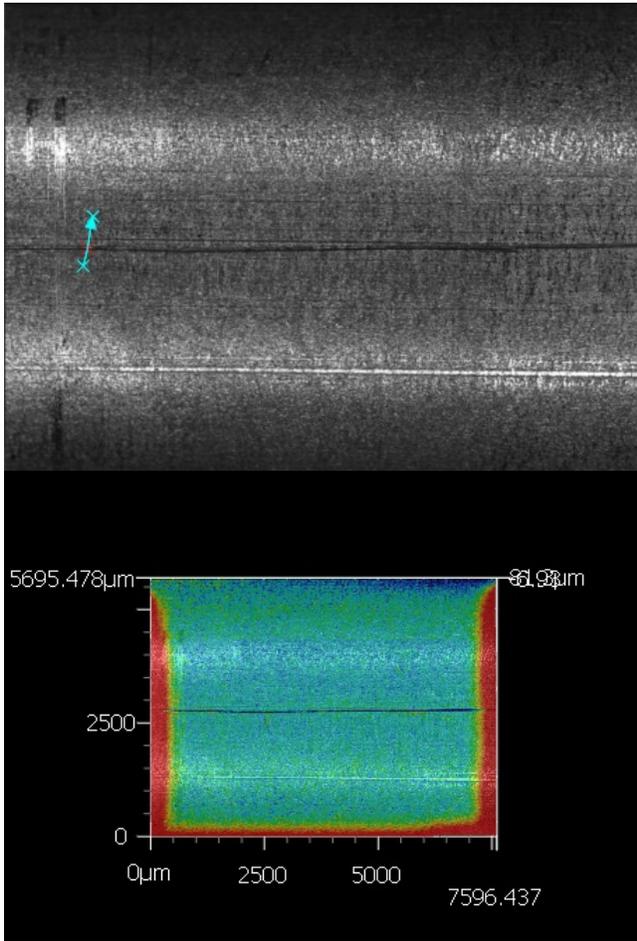
No.	Measurement name	Measured value	Unit
1	Line - Point1	8.645	μm

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- Cannot see/feel a scratch



Intentional Scratch on Cell Can Wall – To Cut Wrapper



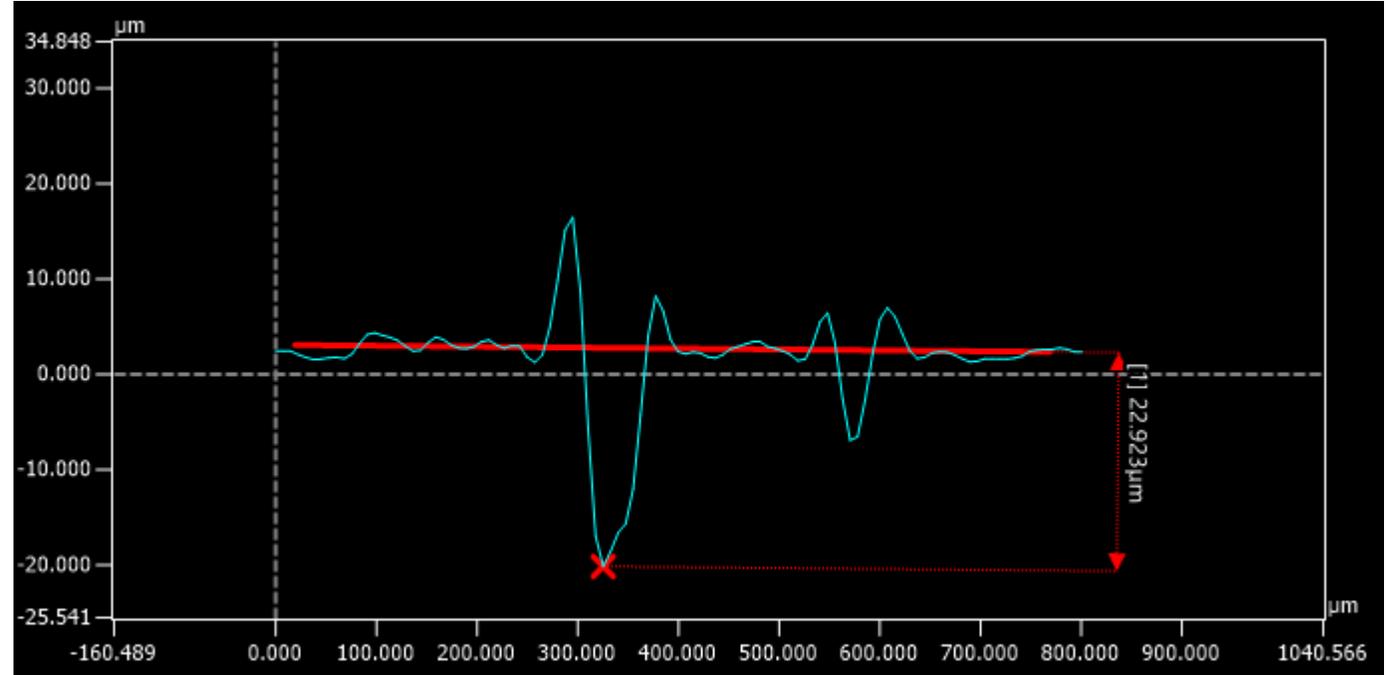
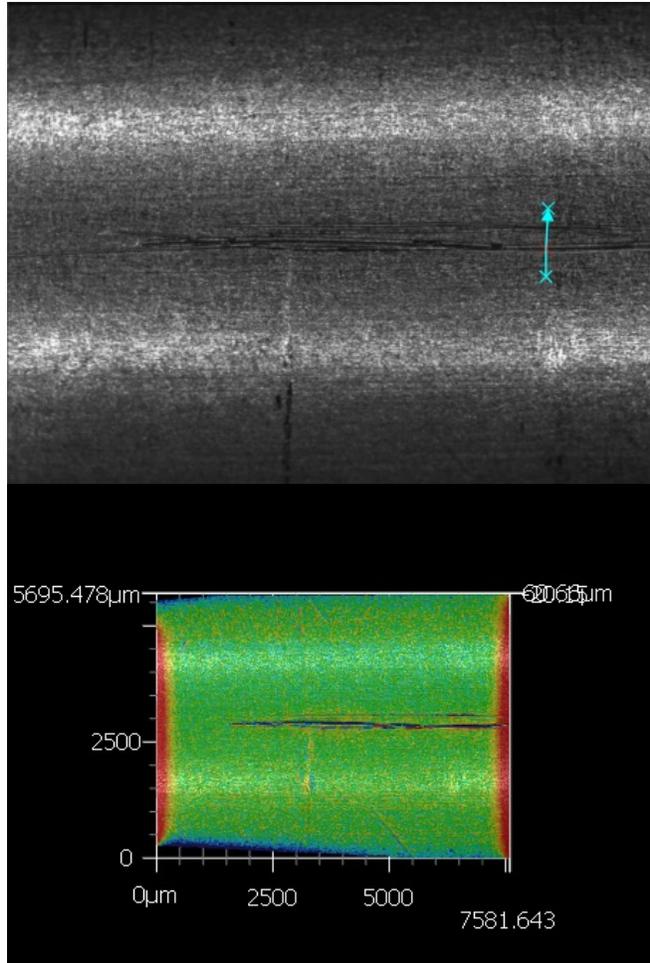
No.	Measurement name	Measured value	Unit
1	Line - Point1	10.517	μm

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- Depth almost 5% of cell can wall thickness



Intentional Scratch on Can Wall



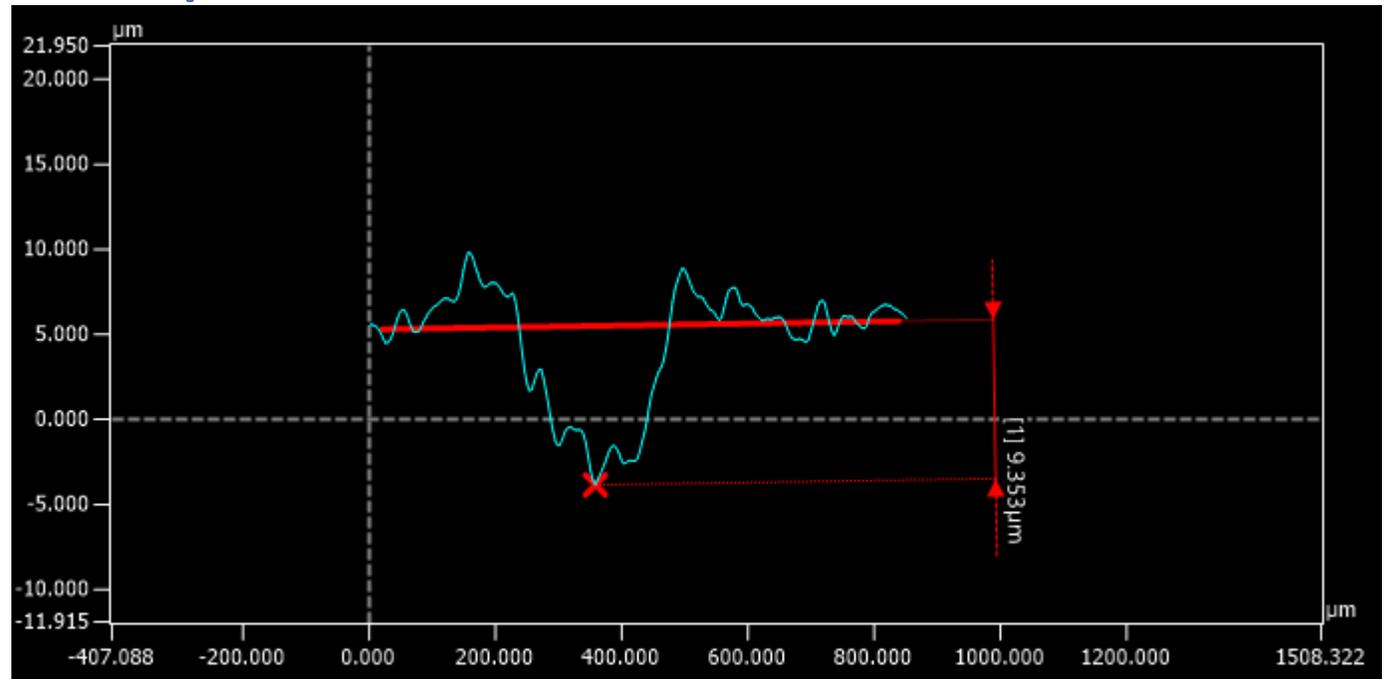
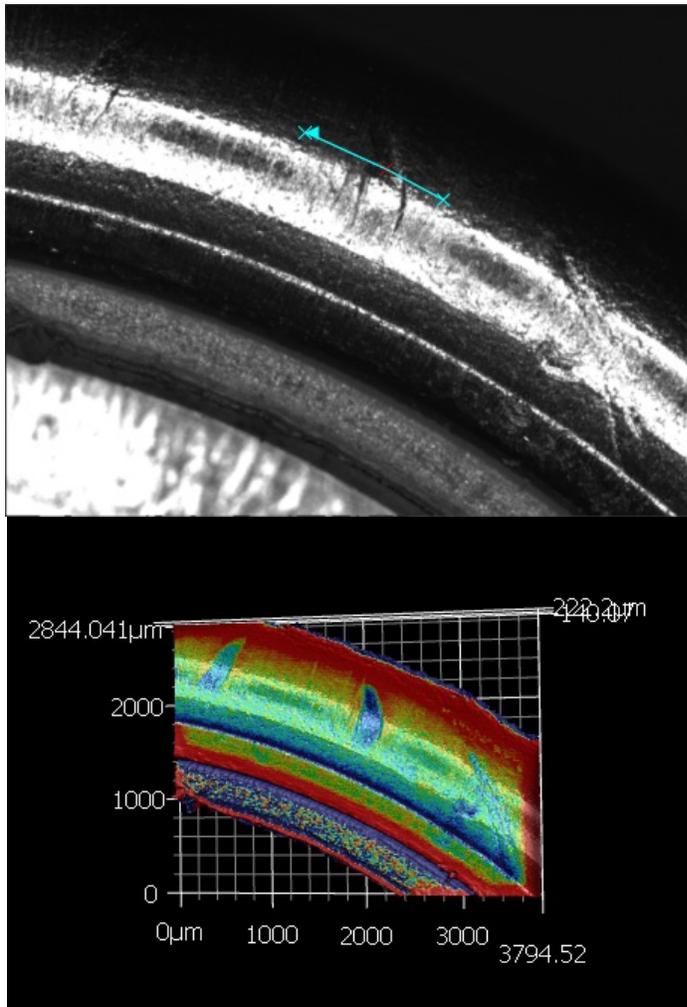
No.	Measurement name	Measured value	Unit
1	Line - Point1	22.923	μm

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- Depth of scratch > 5% of cell can wall thickness



Scratch on Can Crimp Shoulder



No.	Measurement name	Measured value	Unit
1	Line - Point1	9.353	μm

LG M36

- Several scratches on can crimp shoulder
- Crimp is vulnerable area for side wall rupture



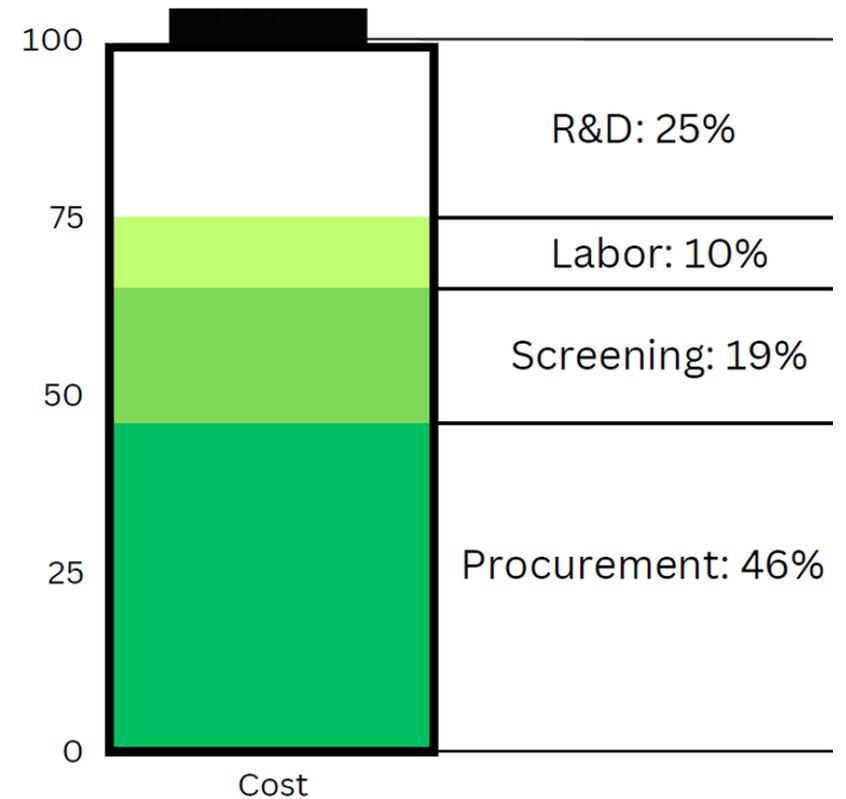
Examples of side wall rupture fails:



Why do I care?

- Safety
 - All our Work Instructions comply with: JSC-20793 – Crewed Space Vehicle Battery Safety Requirements.
 - NASA Engineering and Safety Council (NESC) Approved
- Lower Schedule
 - Screening is complete and the cells are ready to ship
- Lower Cost
 - R&D Cost is shared with Navy and other partners

➤ Lower Risk



What's included?

- Class I Cells with Lot Traceability
- C of Cs from Manufacturer, all Testing Suppliers, and JSC
- All documentation
 - History
 - Manufacturer Provided Lot Traceability
 - Lot Testing Results
 - Individual Cell Screening Results
 - Annual Calendar Life Test Data – With updates!



How do I buy them?

- Three contract types:
 - Program Directives
 - Lowest Risk
 - Space Act Agreements (SAA)
 - Limitations apply
 - General Terms Agreements (GTAs)
 - Program specific, limitations apply
- Pricing is available upon request
- Contact:
 - Eric Darcy - Eric.C.Darcy@NASA.gov
 - Chris Blackwell – Christopher.B.Blackwell@NASA.gov

Stock:

- High Power - 18650
 - Molicel P28B
 - Samsung 30Q
- High Energy - 18650
 - Molicel M35A
 - LG M36 (Low Stock)

