Johnson Battery Technologies

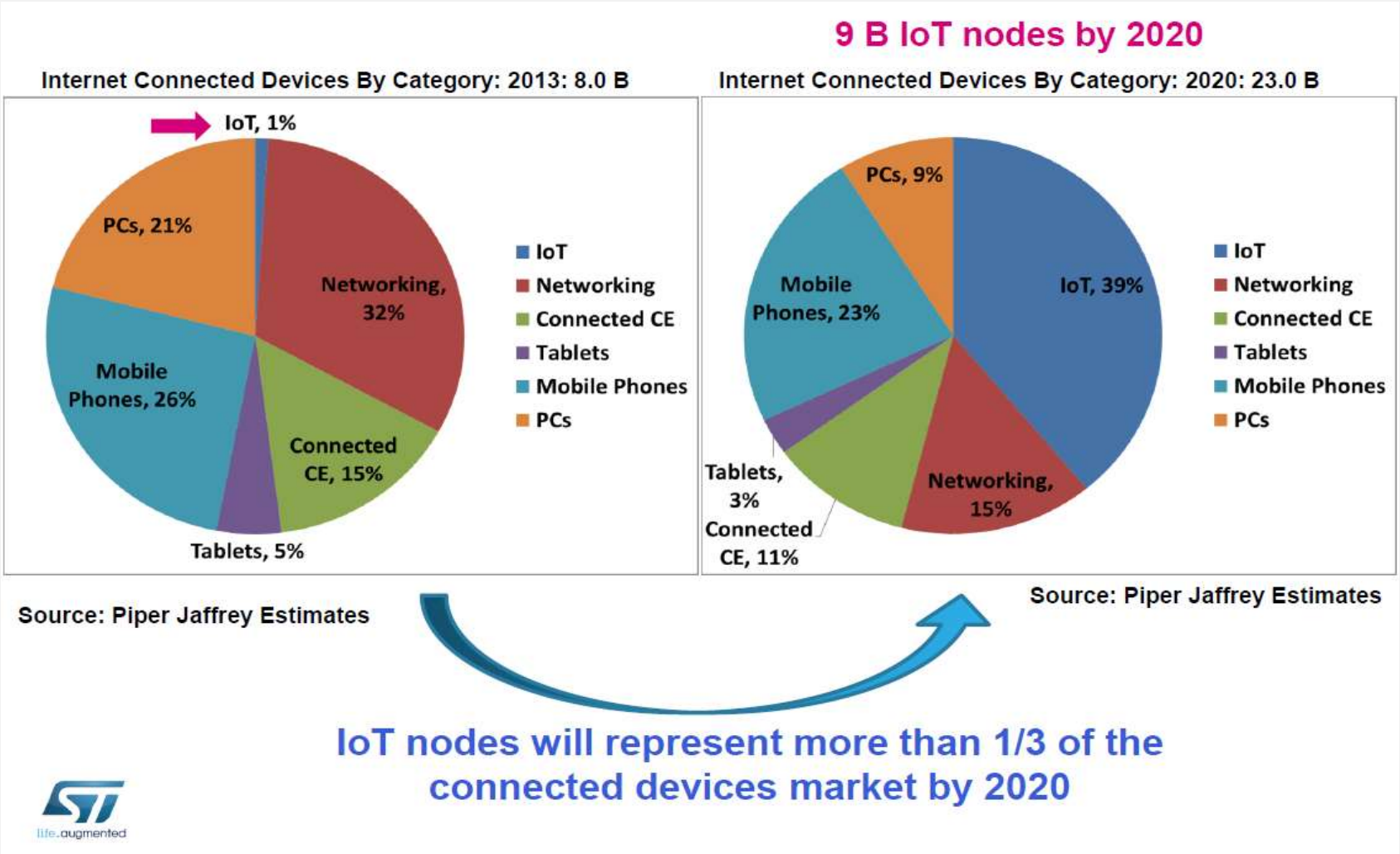
Johnson Battery Technology Inc. (JBT)

SOLID GLASS - CERAMIC ELECTROLYTE SEPARATOR FILM FOR SOLID STATE & LITHIUM ION BATTERIES

Dr. Lazbourne Allie

JBT MARKET OPPORTUNITY

Exponential Growth in IoT and IoT Nodes: Li- Ion Mkt $90Bn by 2027 (IDTechEx)

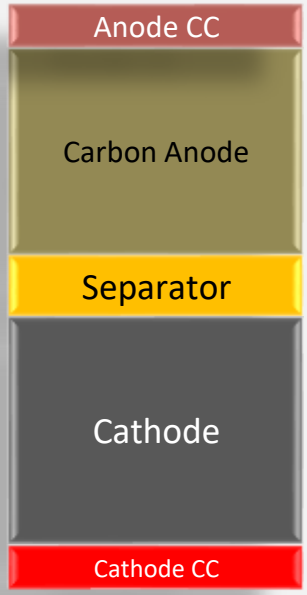


WHERE THE MARKET IS GOING

Higher Energy Density, Safer and Low Cost Production is Needed

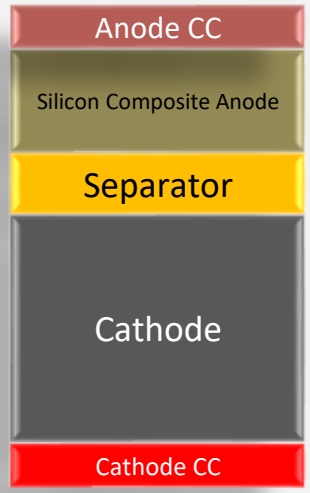
Lithium Metal
100-200 Wh/Kg
200-300 Wh/L

Dangerous



Lithium Ion
200-250 Wh/Kg
600 Wh/L

Safer

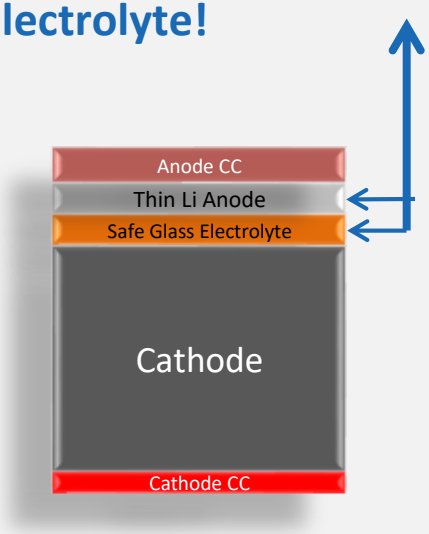


Lithium Ion
250-300 Wh/Kg
700 Wh/L

Safer

How to Achieve This:

- **Ultra Thin Lithium!**
- **Dendrite Suppressing Glass Electrolyte!**



Lithium Metal
400-500 Wh/Kg
1200 Wh/L

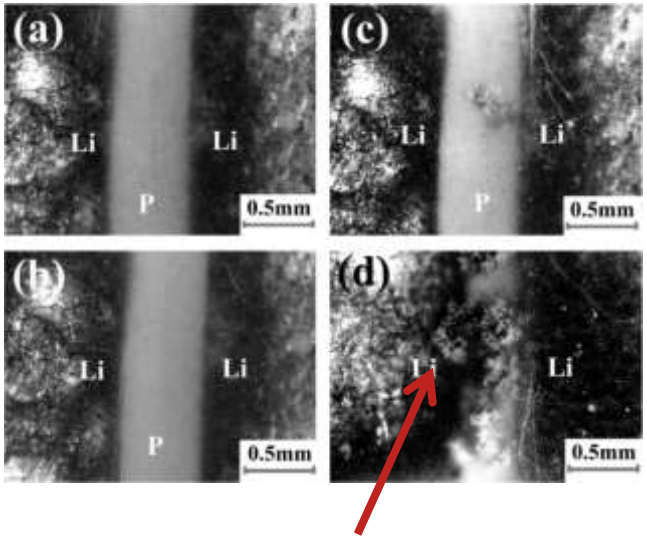
Safest

JBT's GROUND BREAKING SOLUTION

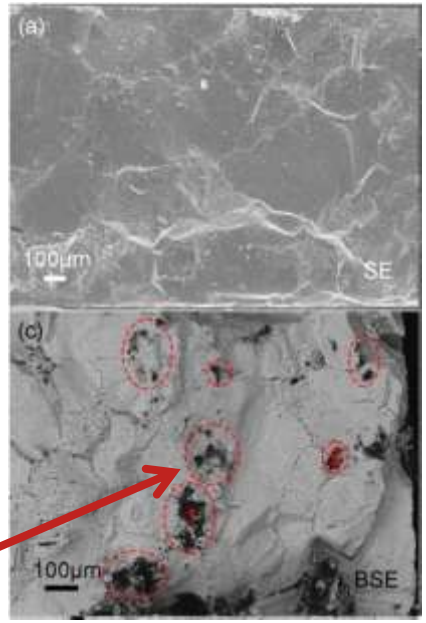
Addressing Battery Properties to Achieve Higher Density in a Safer Way!

Not Effective Barriers

Polymer Electrolyte



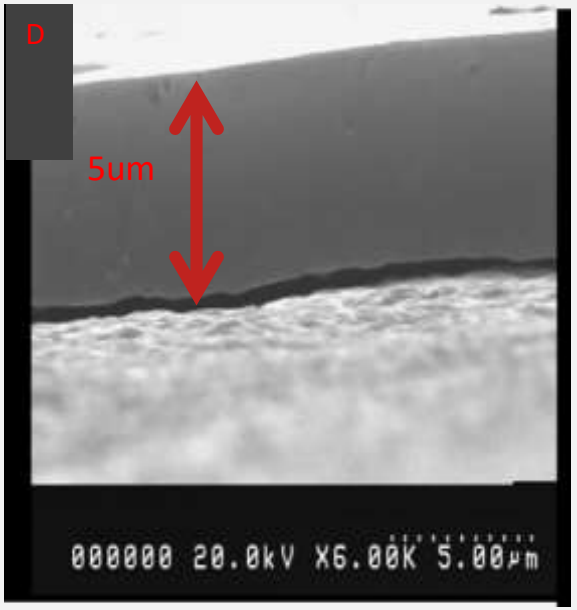
Garnet Type Solid Electrolyte



Does not suppress Li Dendrites
Is not an effective Barrier

Effective Barrier Solution Discovered by JBT

JBT's Glass-Ceramic Electrolyte



- ✓ **No grain boundaries**
- ✓ **Very dense**

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Source: Effect of nano-silica filler in polymer electrolyte on Li dendrite formation in Li/poly(ethylene oxide)–Li(CF3SO2)2N/Li,S. Liua,b, N. Imanishib, T. Zhangb, A. Hiranob, Y. Takedab, O. Yamamotob, J. Yanga

Source: Direct observation of lithium dendrites inside garnet-type lithium-ion solid electrolyte, Yaoyu Ren, Yang Shen, Yuanhua Lin, Ce-Wen Nan

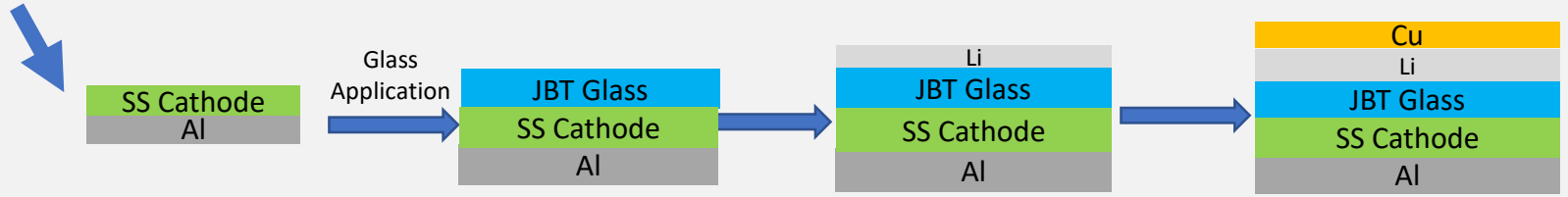
JBT's GLASS-CERAMIC ADVANTAGES

- **Proprietary Glass:**
  - Ceramic electrolyte can be used as a Lithium anode coating, a stand alone separator or as a catholyte
- **Broad Applications:**
  - Either as part of a SSB or in existing lithium ion constructs e.g. hybrid battery.
- **Industry Innovations:**
  - JBT solid electrolyte protects Li metal anode from forming dendrites enhancing safety, life and energy density
  - JBT technology eliminates need for excess lithium resulting in high energy density
  - Inexpensive cast manufacturing process which is scalable to transportation applications
- **Performance:**
  - Separator thickness <10um
  - Ionic and electronic Conductivity of $1X10^{-5}$ and $1X10^{-11}$ S/cm @ 23^{o}C, respectively.
  - High break down voltage > 6.5V allows increased voltage range and use of higher voltage cathode materials, e.g increased energy density
- **Wide Temperature Range Applications:**
  - Upto 150^{o}C or higher if anode is other than Li.

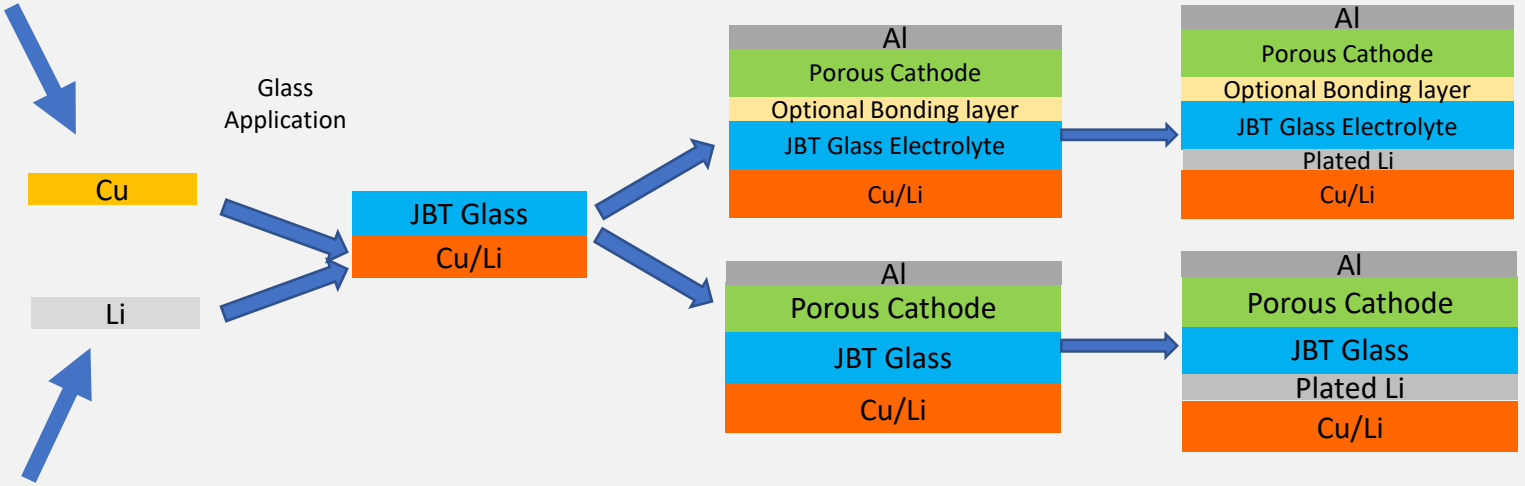
BROAD APPLICATIONS

Three Total Solutions: Solid State Battery and Hybrid

1. Solid State Battery: Glass separator deposited directly on SS Cathode



2. Hybrid Battery: Glass Separator deposited on current collector substrates



3. Hybrid Battery: Protective layer applied to Lithium Anode

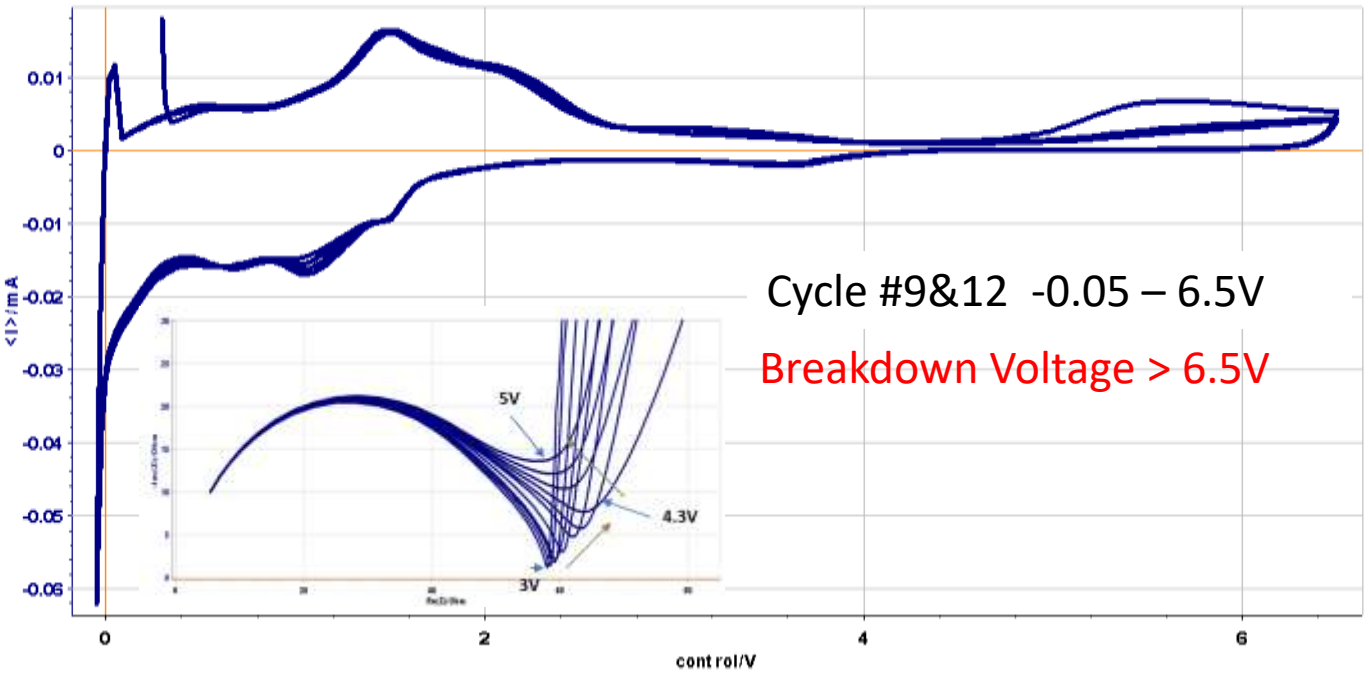
OUTSIDE BATTERY MANUFACTURER TESTS

Independent Third Party Tests Confirm Material Performance

SS – glass – Li; RT; CV 1mV/s

Minimal slope from CV is $71.2*10^{-6}$ mA/V. That corresponded to electronic conductivity, $\sigma = 1X\ 10^{-11}$S/cm.

Ionic conductivity is $1\ X\ 10^{-5}$ S/cm

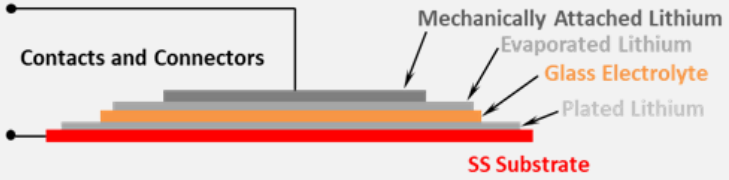


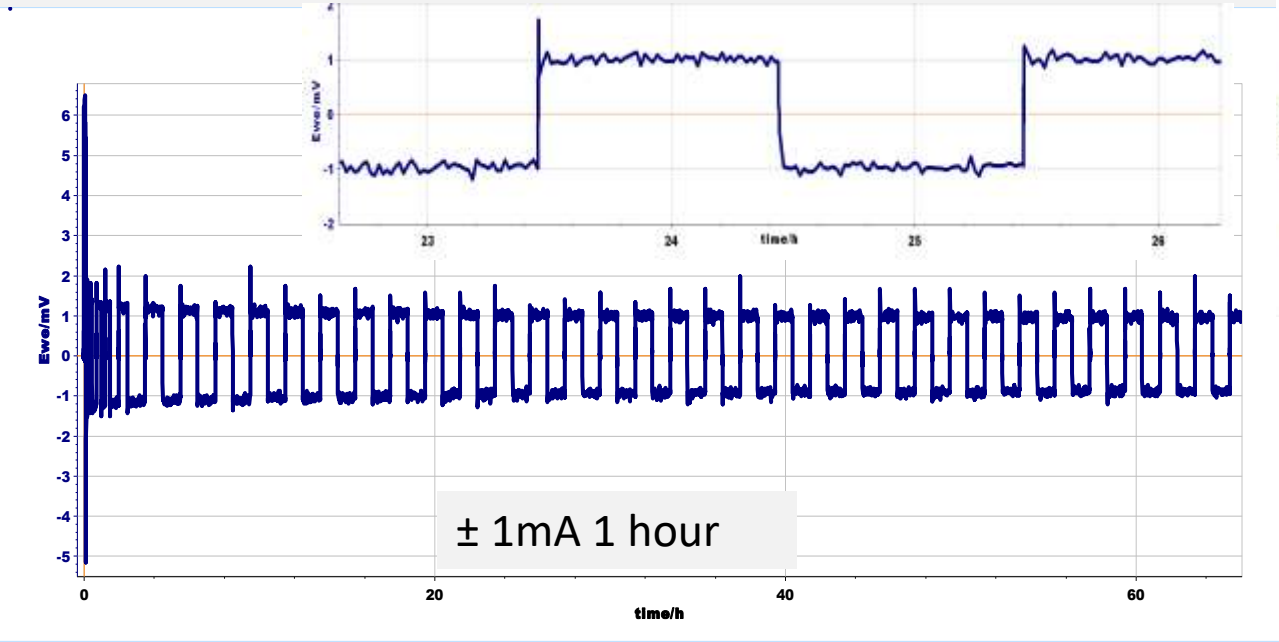
OUTSIDE BATTERY MANUFACTURER TESTS

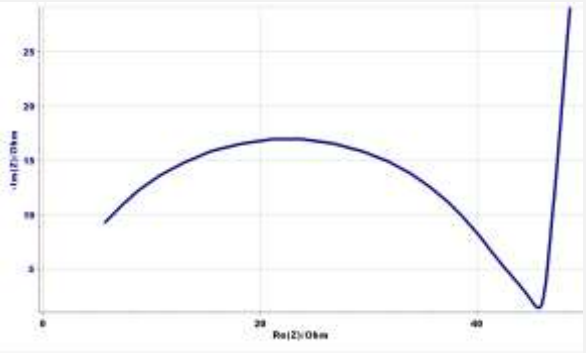
Independent Third Party Tests Confirm Material Performance

Lithium Deposition/stripping on SS (under glass)

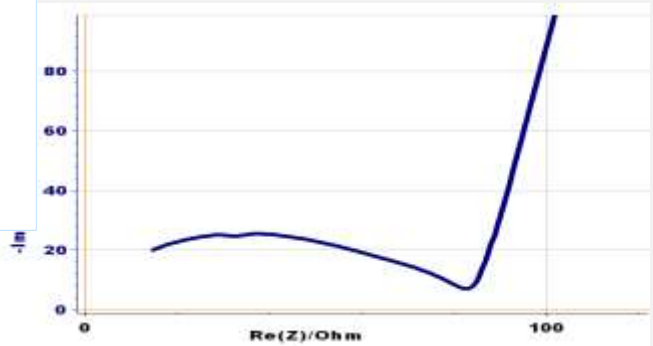
SS – glass – Li; RT; SPEIS







Before Stripping



After stripping all Li from C.C Substrate

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PROGRESS TO DATE

- ✓**Breakthrough** inorganic conductive lithium/coating/separator
- ✓**Cost Effective** - Inexpensive cast manufacturing process
- ✓**Broad Applications –** Part of SSB or readily integrated in existing lithium ion technology
  - Protects Li metal anode from forming dendrites
  - No need for excess lithium
- ✓**Outstanding performance**
  - Thin coating,<10um
  - High break down voltage, > 6.5V, Increase voltage range and allows higher voltage cathode materials
- ✓**Dendrite protection -** Electrolyte density and surface quality comparable to or better than LiPON,
- ✓**High cycle life** - Demonstrated stable Li cycling >500 cycles
- ✓**Good Conductivity -** Electrolyte has cycled Li at current densities up to 6 mA/cm2.
- ✓**Low resistance** - Samples with resistance under 30 Ω-cm2
- ✓The challenge JBT has is not a material one but an engineering one that we believe can be solved given the right tools and engineers

ASK AND EXPECTED OUTCOMES

Seeking Strategic Partners and Investors to Commercialize Our glass Electrolyte Separator

- **Marketing, licensing and sampling distribution by 2021.**
- **Deliver to the total global market a safer, higher density battery that can be applied to the internet of things.**
- **Enter the market at a competitive price point as a result of low cost manufacturing needs.**

Johnson Battery Technology Inc. (JBT)

Thank You!

Please contact us for more information:

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