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Binder free, Thin-Film Ceramic Coated Separators for Improved Safety of Lithium-Ion Batteries

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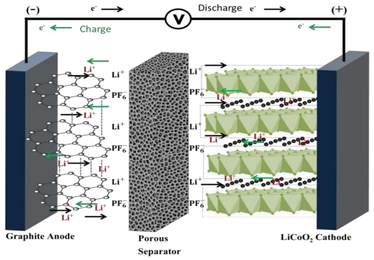
Project Objective: To Improve Safety of Lithium-Ion Batteries

❑ **Notable battery fire incident** [1]
- **Boeing 787: it was suggested that micro-dendrites may be responsible**
- **Samsung Galaxy Note 7: separator degradation observed**
- **Electric Vehicle: Tesla**

❑ **Separator Functions:**
- To prevent electric contact of electrodes
- Allows Li^+ ion conduction

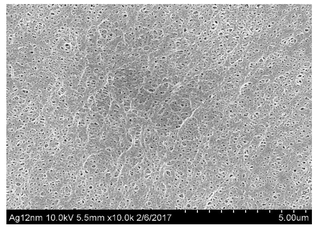
❑ **Structure:**
- Polyolefin based polyethylene/polypropylene (PE/PP)
- Interconnected pores (nm range)
- Thickness < 25 micron

❑ **Low Thermal Stability:**
- Melting Temperature: PE (130 °C), PP (165 °C)



Lithium-ion battery schematic [2]

Not Suitable for Abuse Conditions



Morphology of a Polyolefin Based Separator

[1] Federal Aviation Administration (FAA), ***Battery Incident Chart,*** **2021**
[2] Goodenough et al., ***Chem. Mater.,*** **2010**

Conclusion & Future work

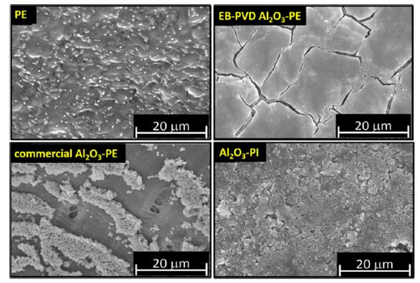
❑ **Unsafe for use at high temperatures (abuse conditions)**

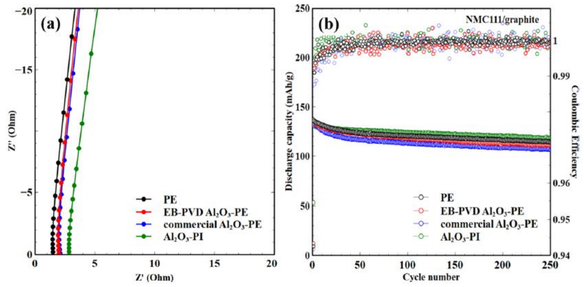
❑ **Develop Ceramic-coated separators**
- Ceramics have a high thermal stability,
- Ceramics are non-flammable,

❑ **Ceramic coated separator have**
- Improved thermal stability beyond (190 °C)
- Similar Electrochemical performance with higher safety

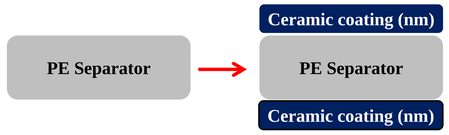
❑ **Compared with Other Commercially Available Separators**
- Stronger Ceramic-polymer Adhesion (No delamination)
- High thermal stability and precise control (nm to µm)
- Competitive electrochemical performance of full LIB cells

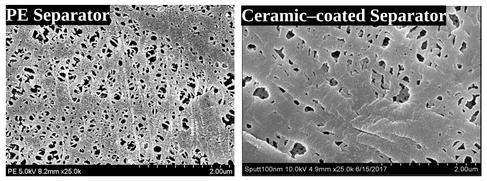
❑ **Future Work:**
- Testing the performance under high temperature abuse



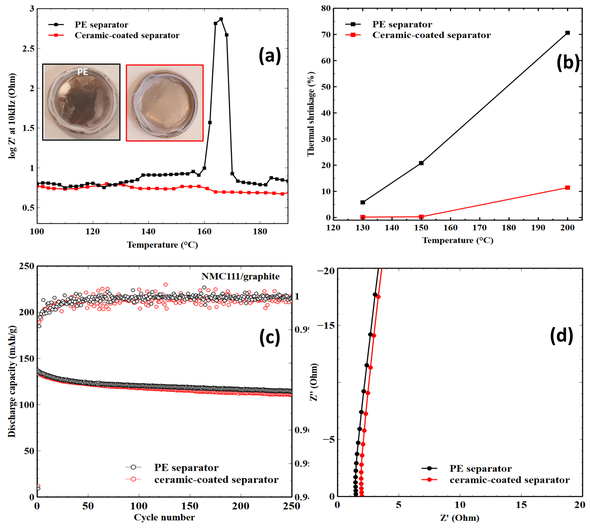


Contribution: Development of Ceramic-Coated Separator





Ceramic Coated Separators Advantages:
- ❑ Binder-free & Scalable
- ❑ High Thermal Stability (Improved Safety)
- ❑ Precise thickness control (nm to µm)
- ❑ Strong ceramic/polymer adhesion
- ❑ Negligible increase in weight



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