



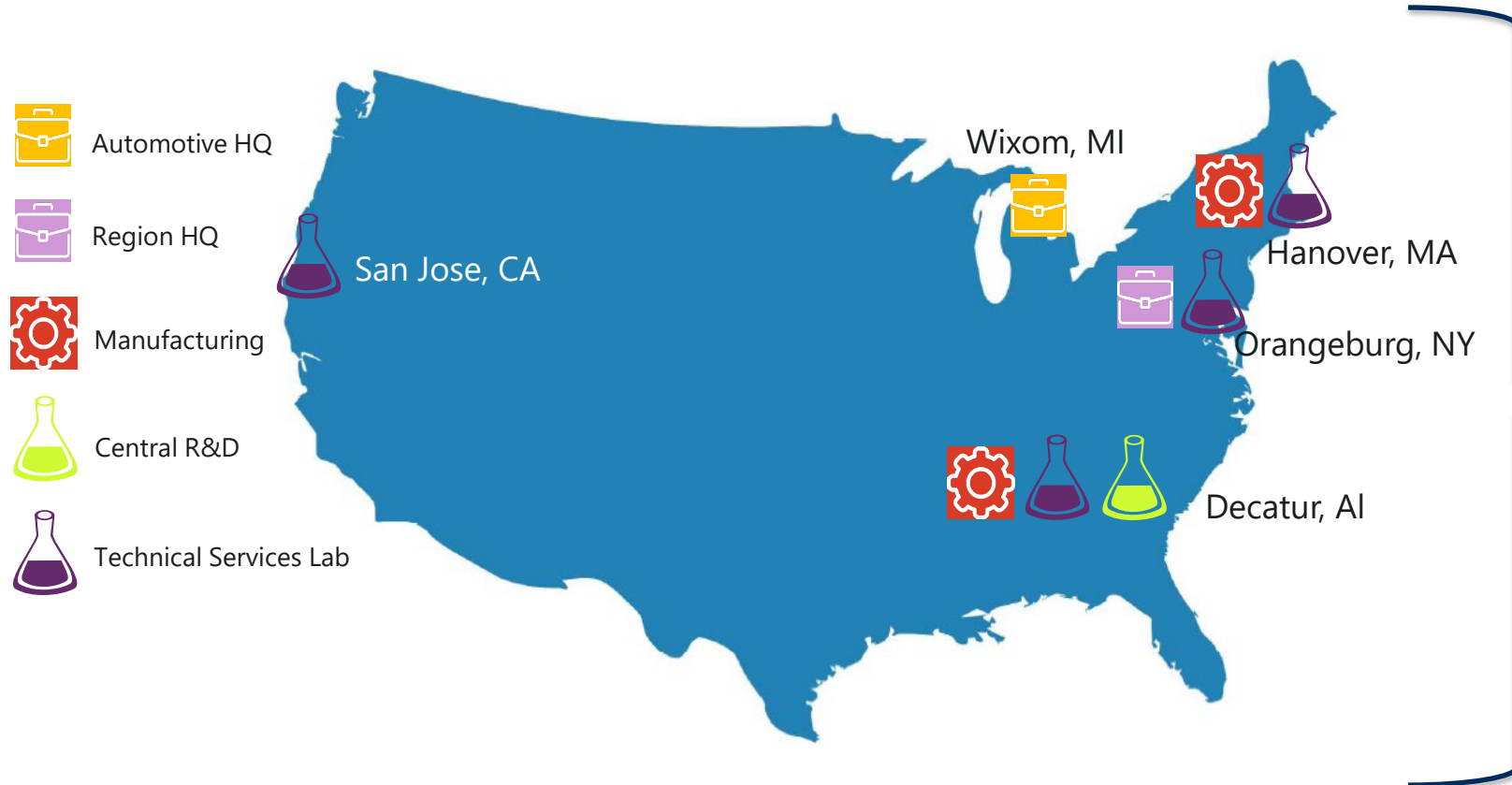
Feb 21
2023

Performance-Enhancing Materials for Lilon Batteries

NAATBatt Annual Meeting & Conference 2023

Ken Zemach, PhD -- Daikin Application Development

Daikin America's **critical mineral sourcing is entirely in NA/FTA regions**, and is **fully compliant with the current guidance of the Inflation Reduction Act!**



Daikin Industries, Ltd.

- Founded **1924**
- **\$17 Billion** revenue
- **88,698** employees
- **322** subsidiaries

Chemicals Division

- **\$1.5 Billion** revenue
- **4,000** employees

Technical battery program support covering the entire US
US-based production of Daikin products

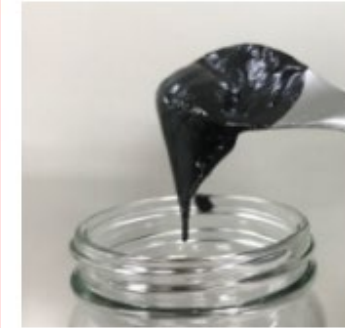
One Of The Largest Global
Manufacturers Of
Fluorochemical Products

Problem: Gelation of high-Ni cathode slurries

- Design for manufacturability not always part of R&D!

Solution: NEOFLON VT-475

- Greatly increase slurry stability -> reduce scrap
- Improve your manufacturing/production window



Homo or
Modified PVdF
Poor flow

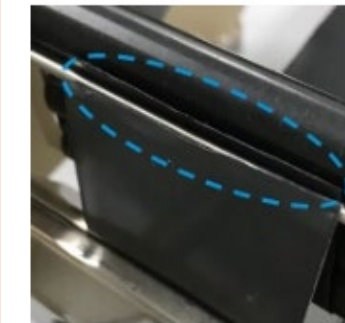


NEOFLON VT-475 with
homo PVdF
Optimal flow

Problem: Electrode cracking/inflexible

Solution: NEOFLON VT-475

- Increased electrode flexibility -> reduced scrap



Homo or
Modified PVdF
Cracked completely



NEOFLON VT-475 with
homo PVdF
Wounded w/o cracking

2mm mandrel bend test

Daikin's Binder Materials Solve Problems

Opportunity: SWCNTs enhance many cell properties

- Increased conductivity with minimal volume fraction
 - Increase charging speed
 - Increase cell capacity (less conductive agent required)
 - 98.5+% active material

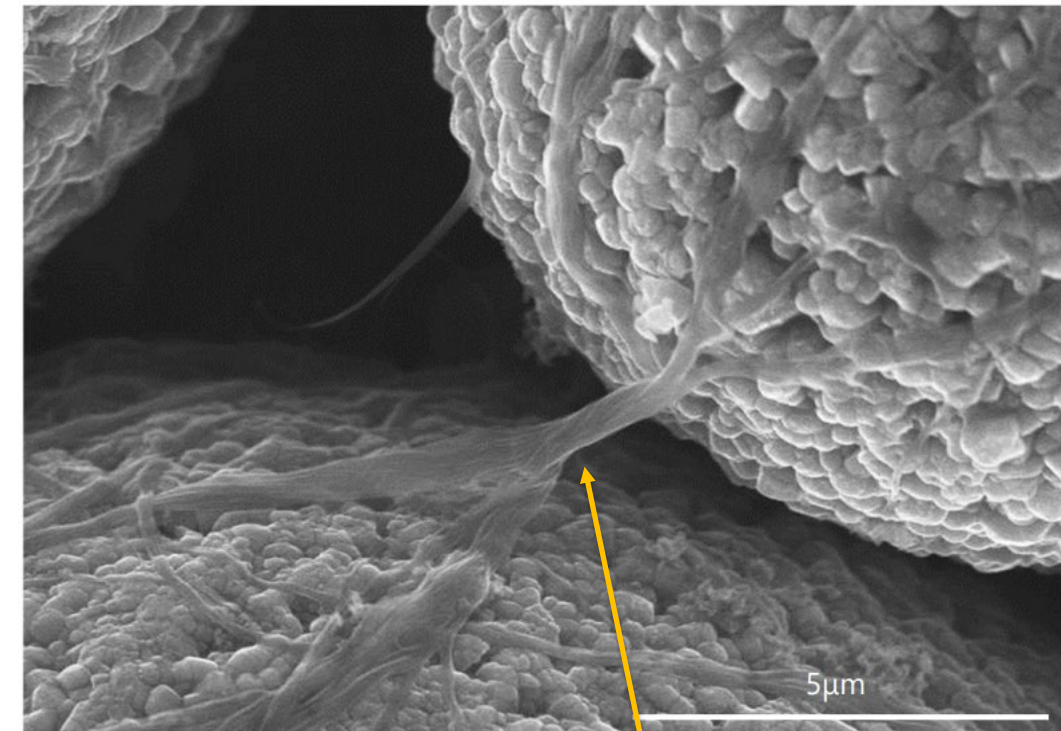
Problems: Handling and dispersion

- Handling of dry CNTs is restricted in many areas
- Even dispersion of CNTs in slurries can be difficult

Solution: NEOFILON VTD-475N

- OCSiAl SWCNTs pre-dispersed in VT-475 solution
- All the advantages of VT-475, plus...
- Easy, even dispersion
- No dry CNT handling
- Increased conductivity, increased cell capacity, increased adhesion

Cathode SEM image of NEOFILON VTD-475N
(VT-475 with TUBALL™)



SWCNT bundle

Daikin's Binder Materials Solve Problems

Opportunity: Dry battery electrode process can reduce OPEX/CAPEX

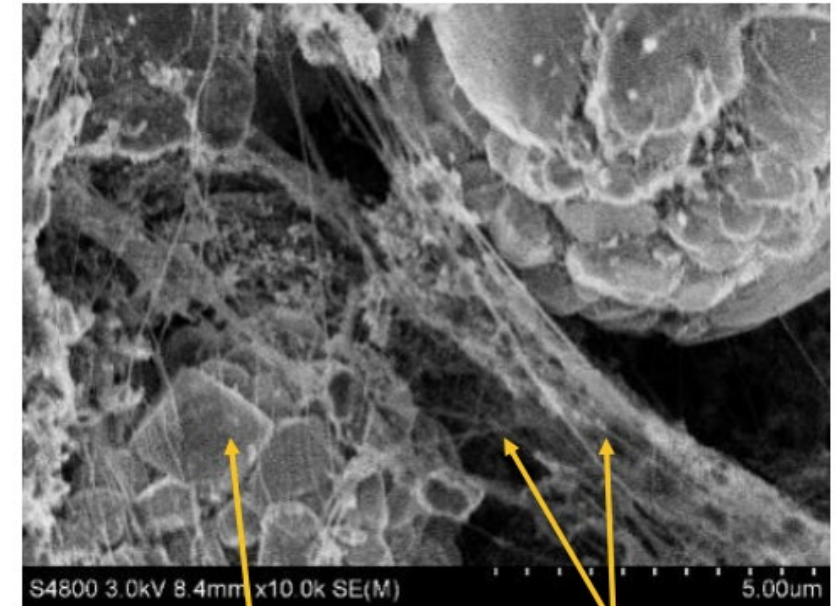
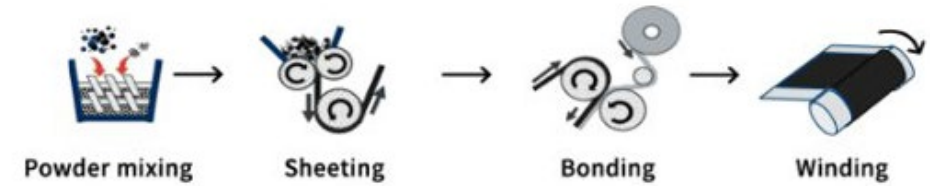
- Removes NMP from cathode electrode production

Problems: PTFE fibrillization is extremely process variable dependent

- Can be difficult to optimize process window
- Scale up can change process window due to shear and temperature differences

Solution: Daikin “family” of PTFE products

- Broad range of PTFE products, spanning both molecular weight and modifier chemistries
 - Results in different fibrillization “windows” (easier/harder, higher/lower temp, etc.)
 - Better match your particular process to the dry binder characteristics



Active materials

PTFE Fibrils

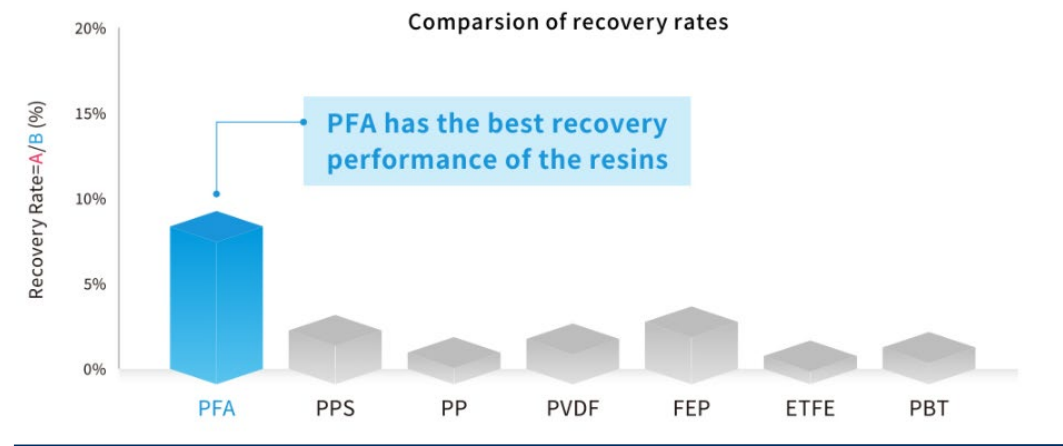
Daikin's Binder Materials Increase Processing Windows

Problem: Sealing larger cells, high heat conditions

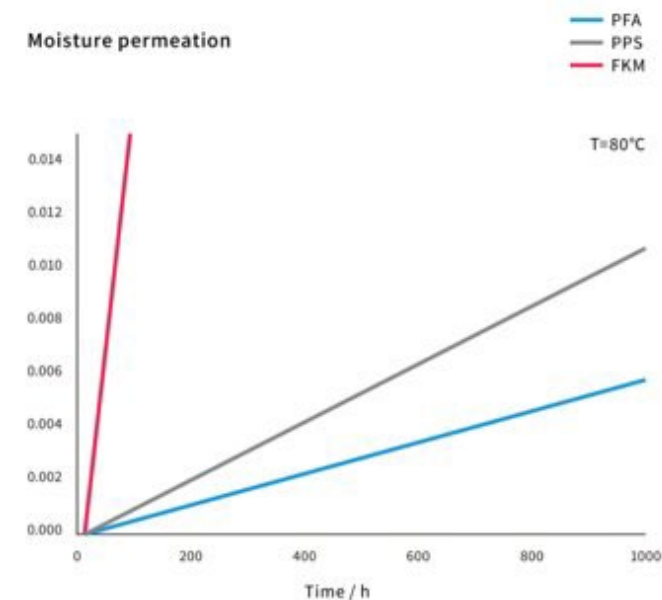
- “Dynamic sealing range” of most gaskets is limited after compression
- Heat deflection temperature can be insufficient near laser welding

Solution: NEOFLON PFA

- Excellent sealing performance: moisture and electrolyte
- Best dynamic range of sealing
- High temperature performance



Moisture permeation

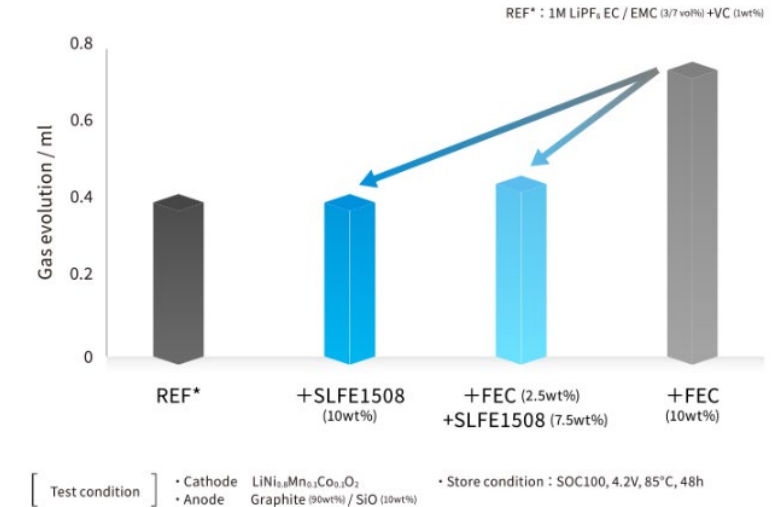


Daikin's Gasket Materials Provide Best-in-Class Performance

Problem: Gas generation in high Si-containing anodes

Solution: Daikin fluorinated electrolyte additives

- Suppression of gas generation in Si-containing anodes



Problem: Voltage stability of electrolytes, cathodes above 4.2V

Solution: Daikin fluorinated electrolyte additives

- Stable cycling demonstrated up to 4.6V
- Greatly increases specific & volumetric energy density

Problem: Flammability of electrolyte blends

Solution: Daikin fluorinated electrolyte additives directly address flammability issues

Daikin's Electrolyte Additives Enable Entirely New Cell Capabilities

*Let us help you solve problems.
Increase yield, capacity, manufacturability, and performance.*

Ken Zemach, PhD

Automotive Business Application Development

Daikin America, Inc

San Jose, CA / West Coast

775-219-0440

kzemach@daikin-america.com

Winfield Coachman

Automotive Business Development Executive

Daikin America, Inc

28345 Beck Rd, Suite 211, Wixom, MI 48393

248-494-6580

wcoachman@daikin-america.com

Kate Quick

Sr Automotive Director

Daikin America, Inc

28345 Beck Rd, Suite 211, Wixom, MI 48393

845-641-4352

kquick@daikin-america.com

<https://www.daikinchemicals.com/>

<https://daikin-america.com/automotive/>

Ready to Collaborate and Open for Visits in NA, Japan, and Germany



Positively Innovative