ENGINEERED MATERIAL SOLUTIONS FOR THE PROTECTION OF E-MOBILITY APPLICATIONS

WEVO-CHEMIE GmbH, October 6, 2022

WEVO-CHEMIE GMBH

AN INDEPENDENT FAMILY-OWNED COMPANY WITH AN INTERNATIONAL PRESENCE

WEVO IN FIGURES

1st

ISO/TS 16949 certified
(since 2017: IATF 16949)
supplier in our sector

53

export countries served
by Wevo

> 75

years of experience in
product development
and application technology

> 400

Wevo resin formulations
available worldwide

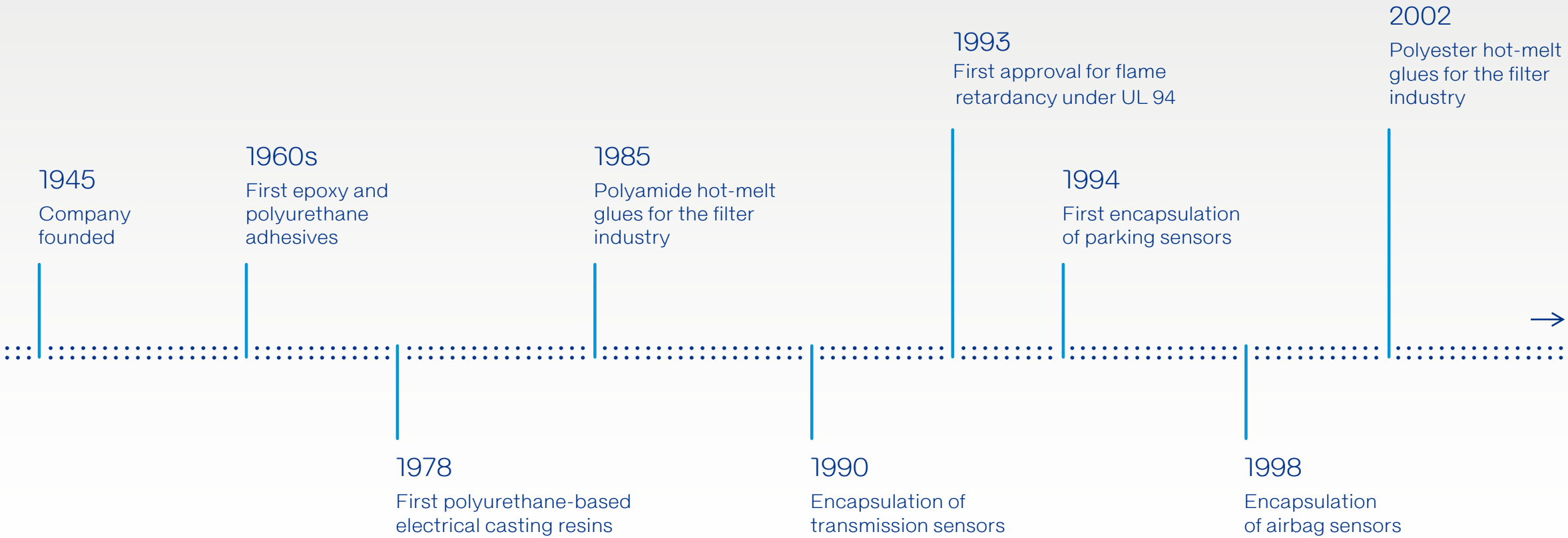
> 1200

customers use our systems

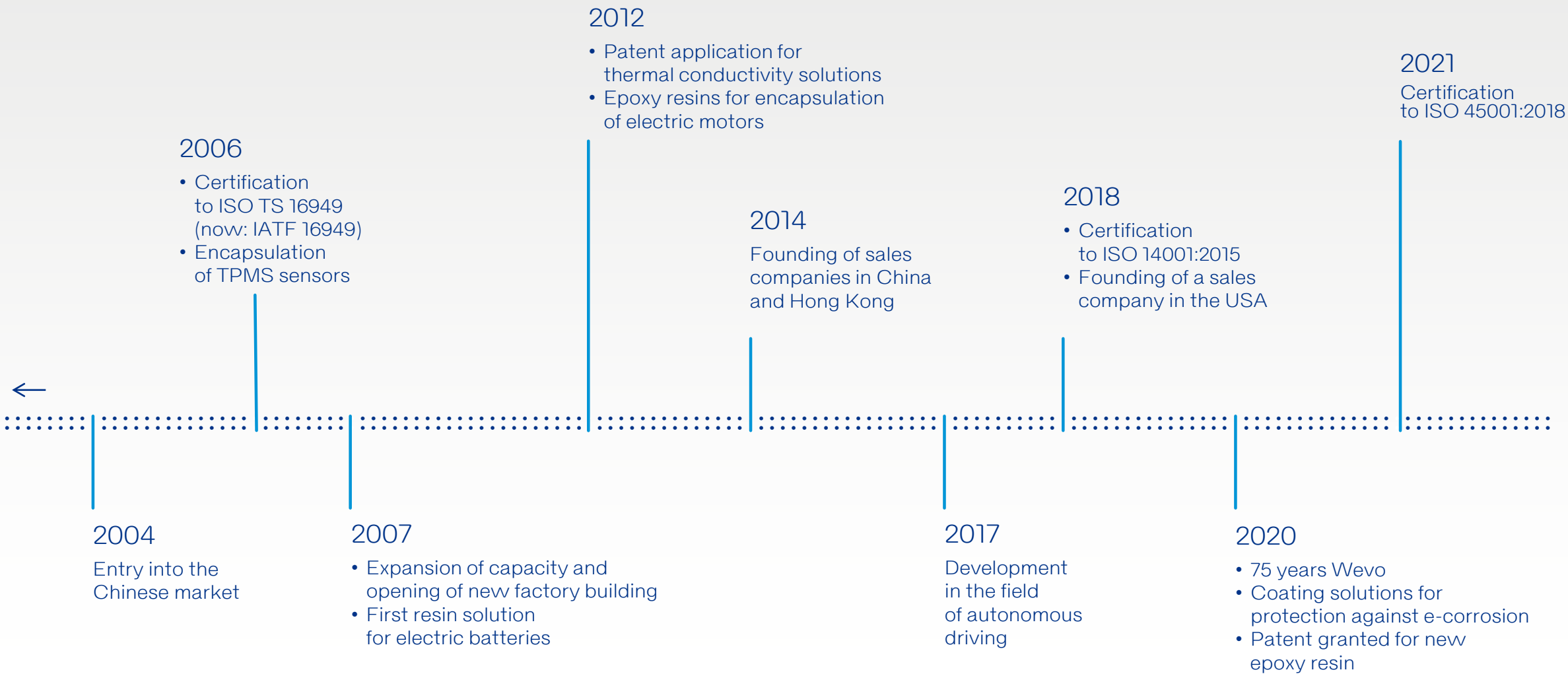
> 2 bn

components casted,
bonded or sealed with
Wevo products every year

MILESTONES


1945
Company founded
1960s
First epoxy and polyurethane adhesives
1978
First polyurethane-based electrical casting resins
1985
Polyamide hot-melt glues for the filter industry
1990
Encapsulation of transmission sensors
1993
First approval for flame retardancy under UL 94
1994
First encapsulation of parking sensors
1998
Encapsulation of airbag sensors
2002
Polyester hot-melt glues for the filter industry

MILESTONES



PRODUCT PORTFOLIO

THREE PRODUCT CHEMISTRIES FOR CUSTOMISED SOLUTIONS – FOR YOUR REQUIREMENTS

WEVOPUR

OUR VERSATILE
POLYURETHANE SYSTEMS

Balanced systems with
highly configurable profile.

WEVOPOX

OUR CUSTOMISABLE
EPOXY SYSTEMS

High-strength systems with
high thermal stability.

WEVOSIL

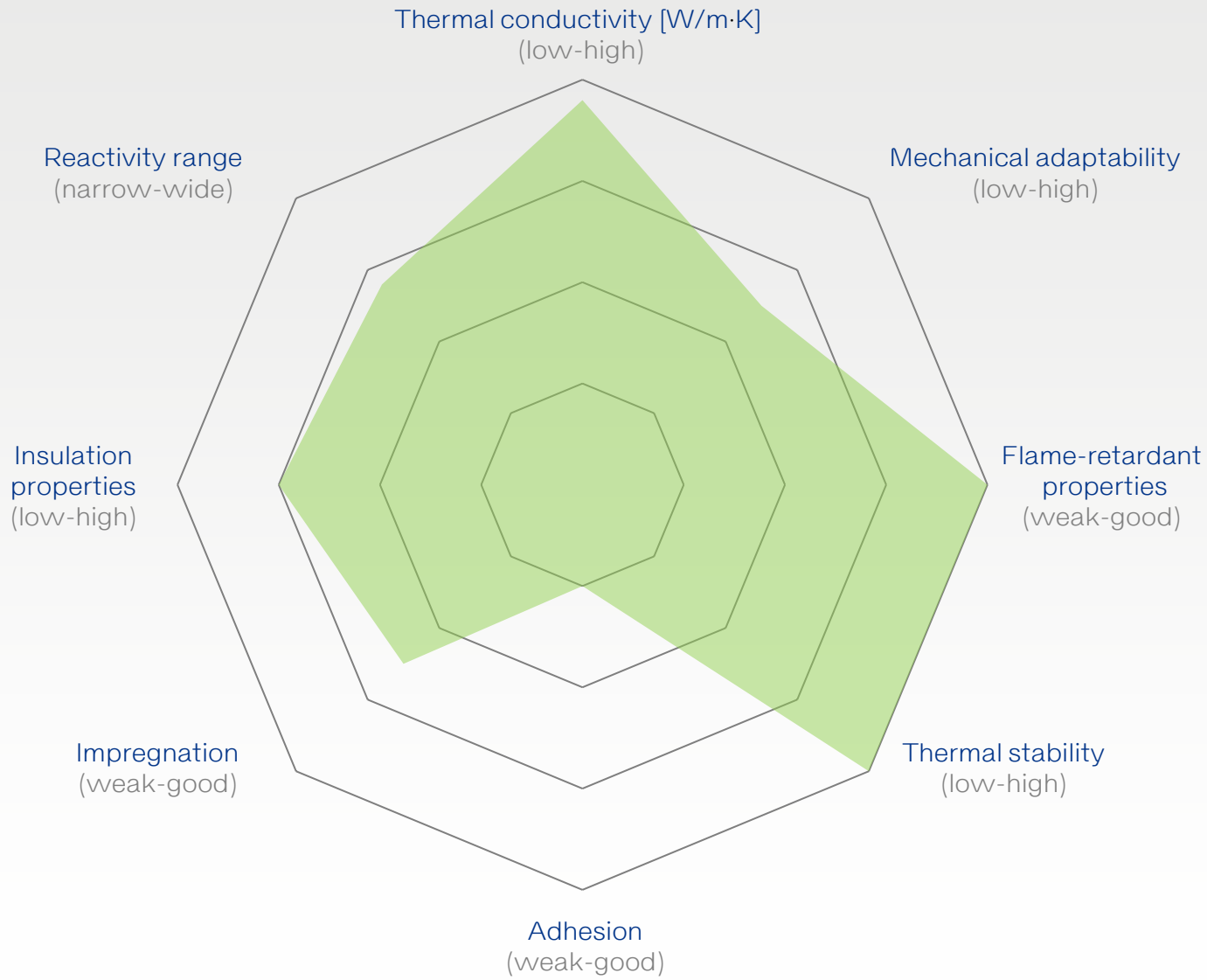
OUR HIGH-PERFORMANCE
SILICONE SYSTEMS

High-elasticity systems with
high thermal stability.

- ANTI-CORROSION
- CHEMICAL RESISTANCE
- CONDENSATION PROTECTION
- EX-PROOF
- HERMETIC SEALING
- MECHANICAL STABILITY
- MOISTURE PROTECTION
- MULTI-SUBSTRATE
- RTI
- THERMAL CONDUCTIVITY
- TRANSPARENT
- FLAME RETARDANT

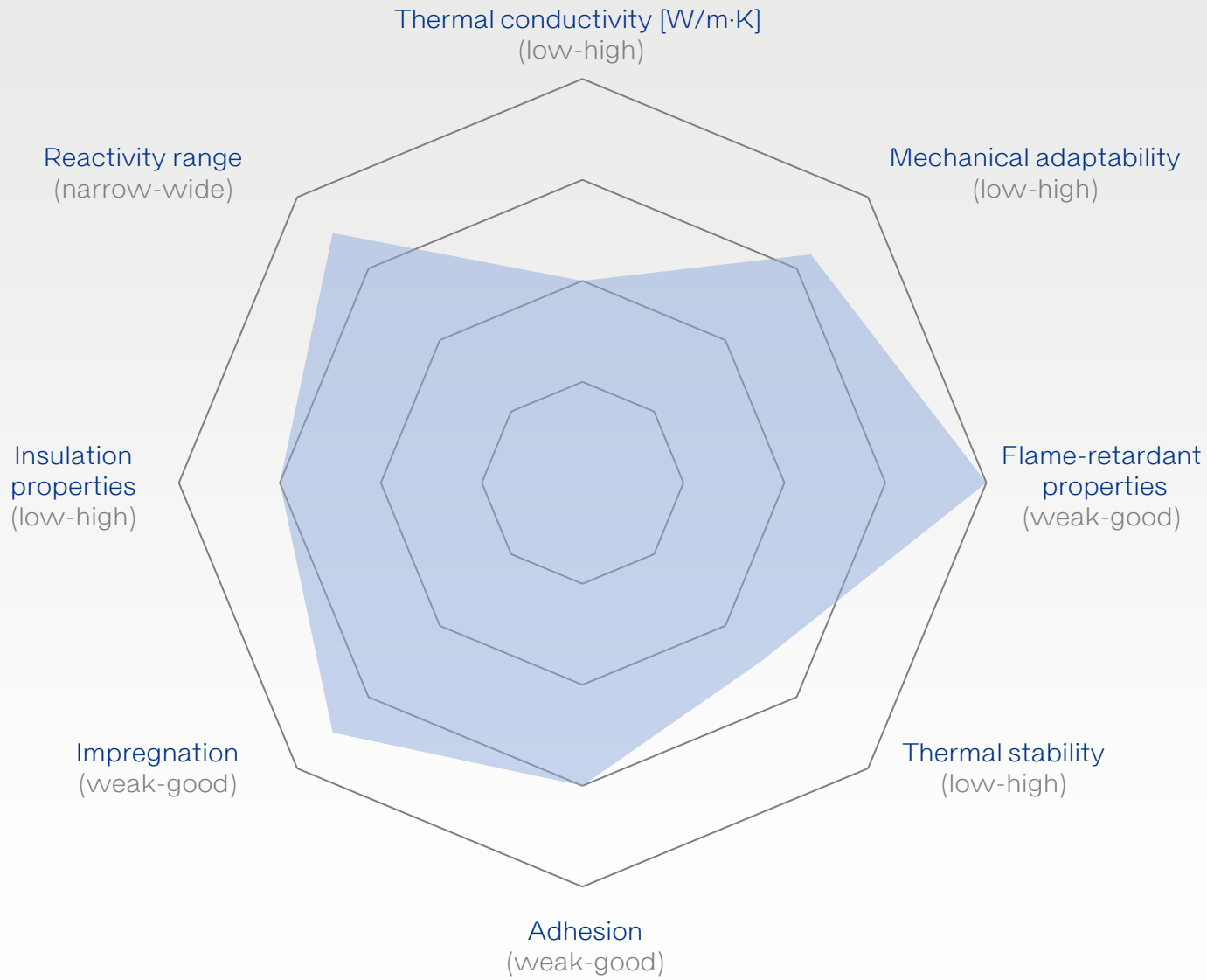
SILICONE

- Excellent temperature stability
- User friendly processability
- Low shrinkage
- Higher thermal conductivity
- Excellent elastomeric properties
- Good dielectric strength
- Re-workable
- Flame retardancy



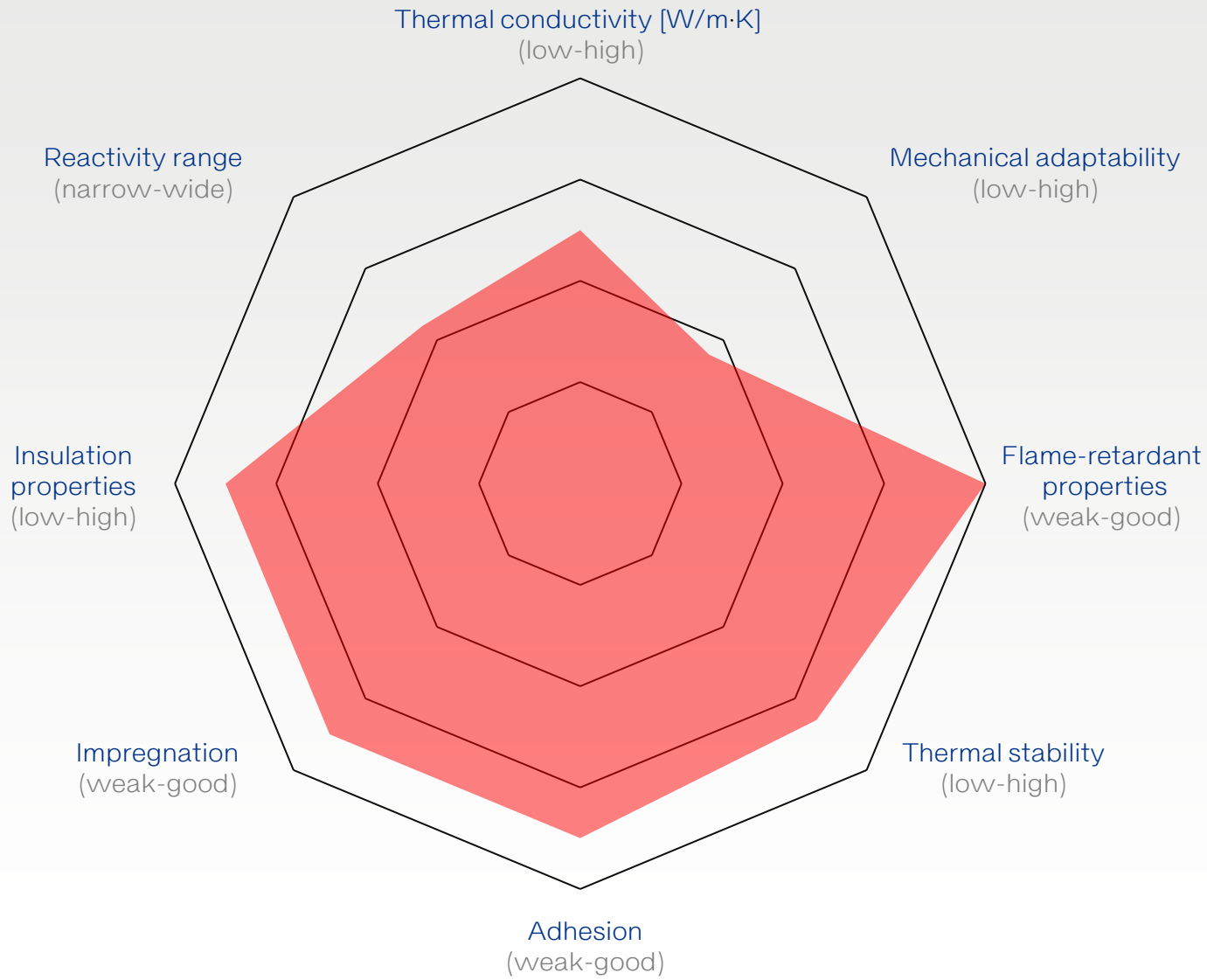
POLYURETHANE

- Design flexibility
- Excellent flowability
- Mechanical integrity
- Moderate thermal conductivity
- Excellent elastomeric properties
- Excellent barrier
- Good dielectric strength
- Flame retardancy



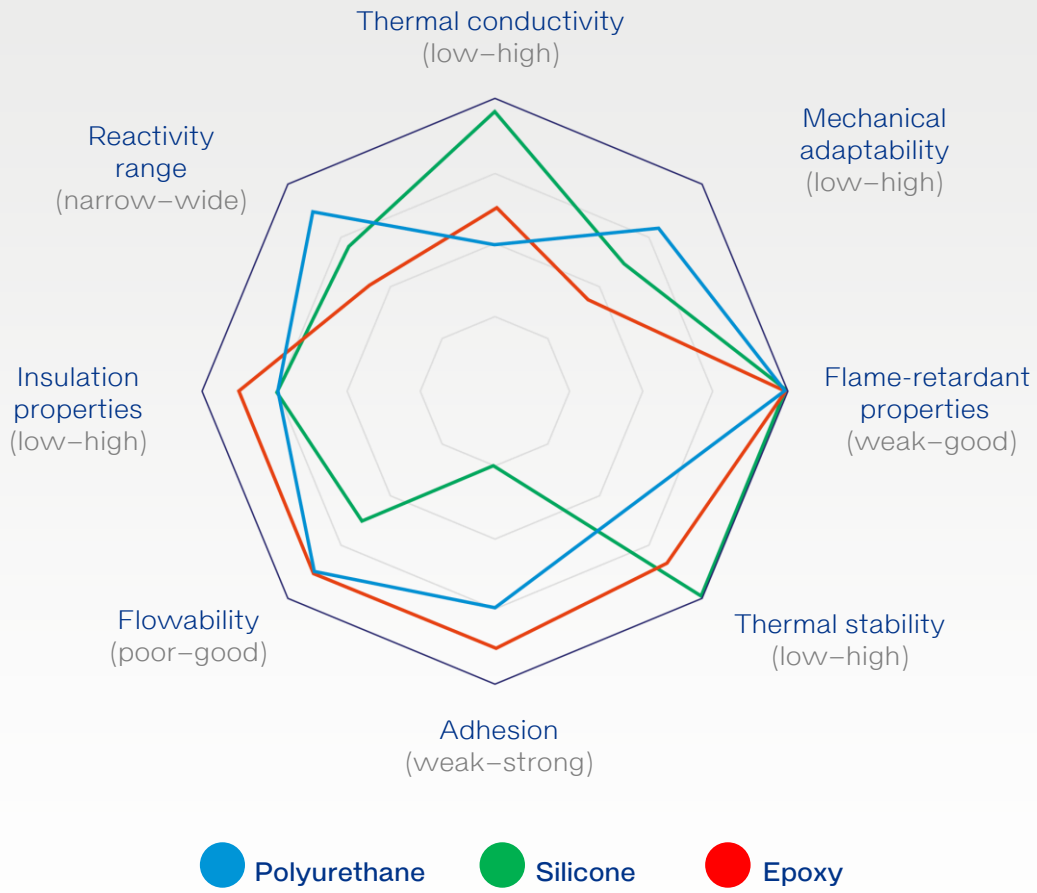
EPOXY

- Good temperature stability
- Excellent flowability
- Excellent impregnation
- Mechanical integrity
- Moderate thermal conductivity
- Security
- Good dielectric strength
- Flame retardancy



THE RIGHT CHOICE

PARAMETER	EPOXY	POLYURETHANE	SILICONE
Adhesion	Excellent	Excellent	low/moderate
Chemical resistance	Good	Good	low/moderate
Design flexibility	Good	Excellent	Moderate
Dielectric strength	Excellent	Excellent	Excellent
Elastomeric properties	Rigid	Moderate	Soft
Flame retardancy	Yes	Yes	Yes
Flowability	Excellent	Excellent	Excellent
Mechanical adaptability	Good	Excellent	Moderate
Mechanical integrity	Excellent	Excellent	Low/moderate
Re-workable	Low/impossible	Difficult	Good
Temperature stability	Moderate/low	Low/moderate	Very high
Thermal conductivity	Moderate	Moderate	High
User friendly	Good	Moderate	Excellent

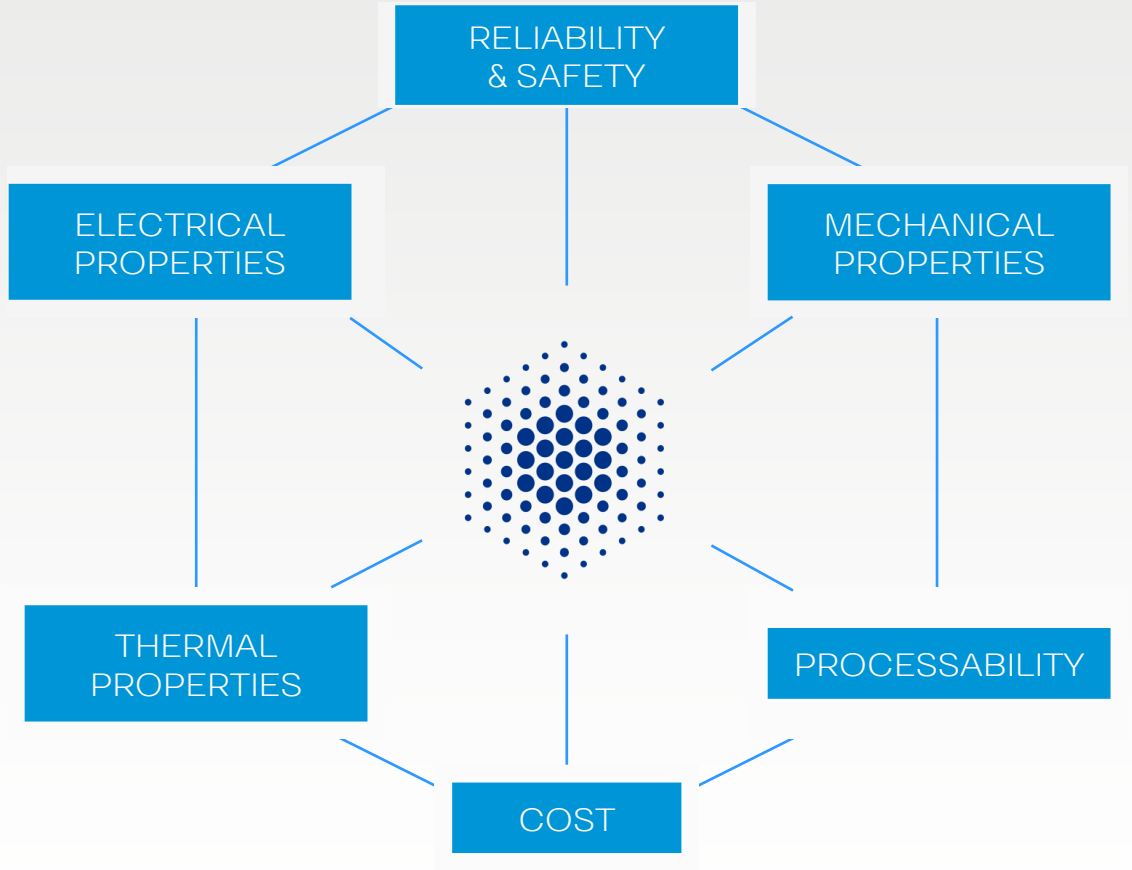


THE SYMMETRY

ENGINEERING SOLUTIONS FOR ELECTRONIC MATERIAL NEEDS

Wevo's diversity and expertise offers engineering solutions that address and recognises the customer's needs.

Whatever the application, Wevo's practical approach converts the customer needs into specific disciplines. Each discipline can combine chemistry, application, mechanical and electrical engineering consideration and importantly safety and reliability. These considerations may involve working with or co-collaboration with the customer supply partners.



FORMULATION

PROCESSABILITY

Flowability · Mixing ratio · Reactivity Range

Thermal Conductivity · Viscosity Ratio

Achieving the desired technical properties without compromising processability.

HEAT DISSIPATION

Thermal Conductivity · Density · Wettability · Compressibility

Layer Thickness

In the field of battery technology, the reliable dissipation of heat and excess heat is essential for the stability and longevity of the system.

WEIGHT

Thermal Conductivity · Density

Flowability · Design of Battery Pack

E-mobility vehicle development strives to increase range while reducing total weight. The system weight is therefore of critical importance in battery development.

COST

Thermal Conductivity · Heat Dissipation · Processability · Weight

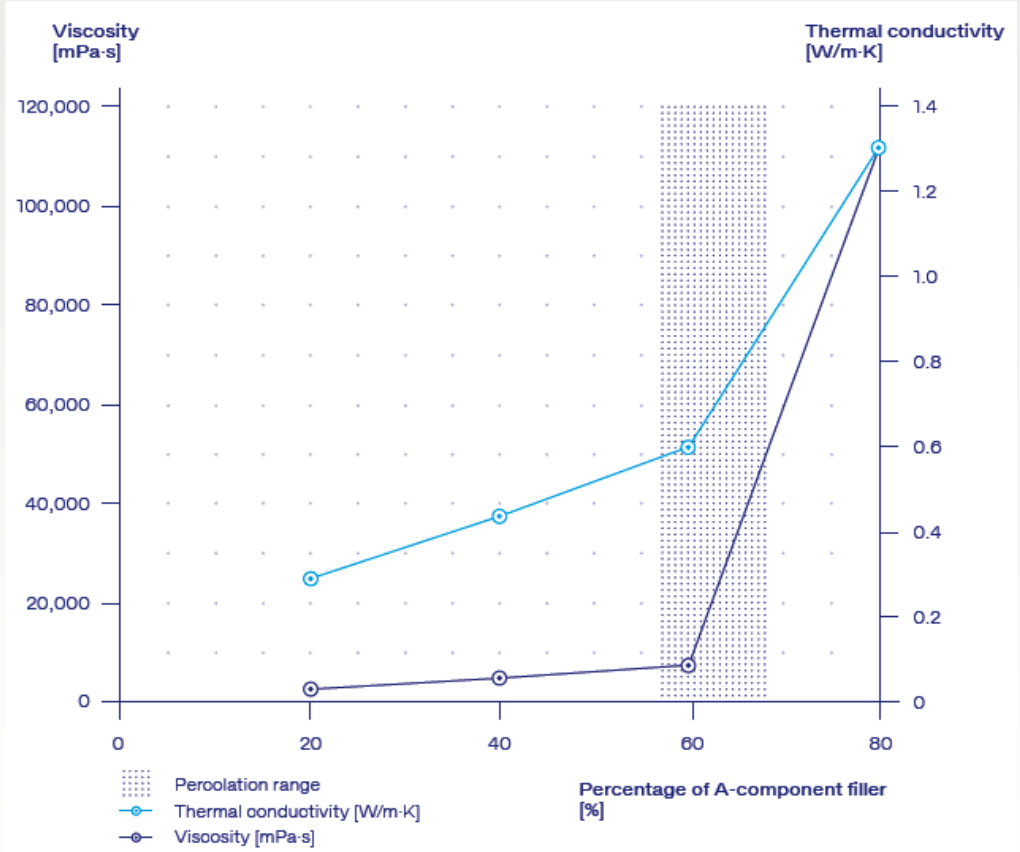
Design of Battery Pack Unit

Achieving development and technology goals and profile while minimising its impact on the costs of the resin systems.

THERMAL INTERFACE MATERIALS

These materials require fillers with thermal conductive properties.

- Complex mix ratios
- Complex material handling
- Increased viscosity
- Increased density
- Decreased flowability



Research data established via a German government funded project

HOT TOPICS

- Thermal conductivity
- Thermal runaway
- Thermal propagation

HOT TOPICS

- Thermal conductivity
- Thermal runaway
- Thermal propagation
- Thermal insulation
- Flame suppression
- Smoke toxicity and density

HEAT DISSIPATION DECIPHERED

- Thermal conductivity (W/m·k)
  Higher thermal conductivity = quicker/more energy removed
- Thermal resistance (Rth)
  Low thermal resistance = lower temperature difference + higher thermal flow
- Thermal diffusivity (DT)
  Homogeneous temperature distribution + thermal conductivity = rapid heat dispersed
- Heat capacity (Specific)
  High heat capacity = more heat energy absorb before per 1 kelvin increase

GAP FILLERS

- Paste-like materials employed to fill spaces between heat source and cooling element
- Applied to a surface and then assembled
- Elastomeric properties offering dampening properties
- Highly filled, high density, more weight per litre

Bulk thermal conductivity ≋

Higher thermal resistance ≋ solid contents and/or crosslinking

POTTING

- Lower viscous material employed to create a void-free environment
- Improves mechanical integrity and stress relief
- Functional as an adhesion, sealant and gap fill
- Elastomeric properties from paste to medium hard to very hard

S I L I C O N E S > P O L Y U R E T H A N E S > E P O X I E S

Void-free + high surface contact pathway ≈

Lower thermal resistance

Higher Thermal diffusivity

TiM's– CURRENT TRENDS

GAP FILLERS

- Reduced bondline / gap fill distance
- Compressible to compensate for engineering tolerances
- Mechanical stability (higher adhesion)
- Reduced thermal impedance

POTTING

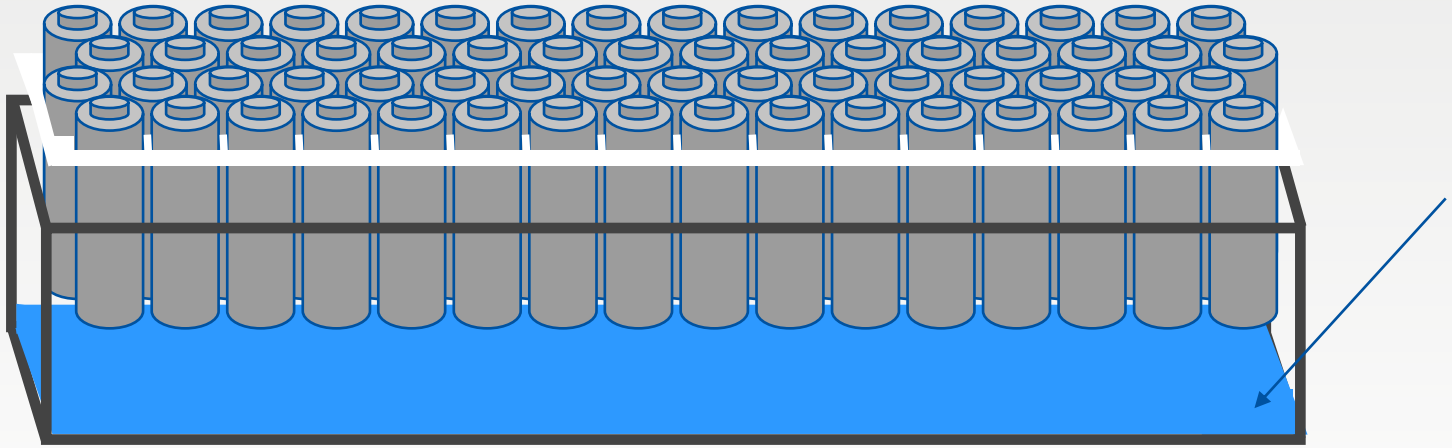
- Replace gap fills
- Multi-functional
- Reduce cost, weight and complexity

WATT NEEDED

≤ 1 W/m·K		>3 W/m·K
Polyurethane	≅	Silicone
Adhesive		Adhesive
Gap Fill		Gap Fill
Potting		Potting

When comparing interface materials in live applications, some customer trials have indicated that a ≤1W/m·k polyurethane system can deliver the same energy/heat dissipation as a >3W/m·k silicone system.

POTTING

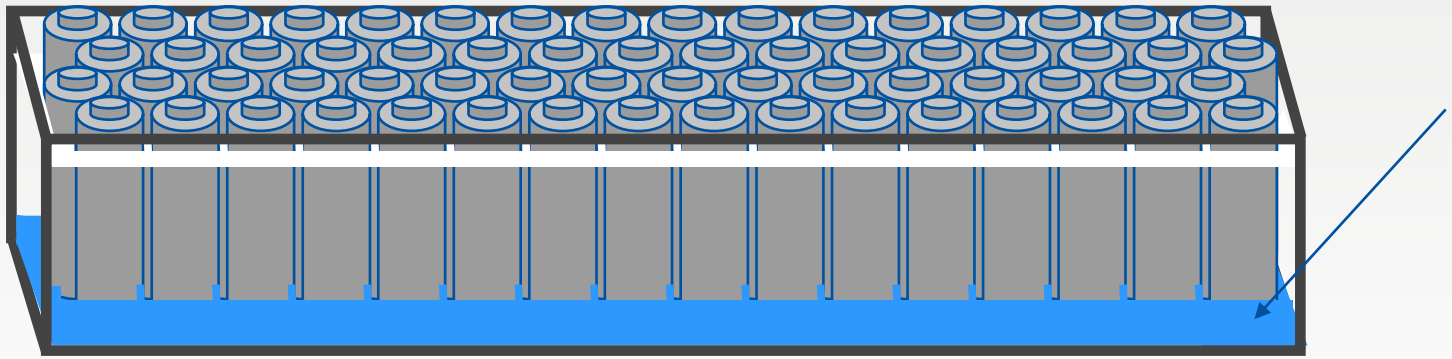


The potting solution can either:

a) First applied into the housing and then the cells are presented into the potting solution.

b) The cell are placed and the potting solution is dispensed and will flow between the cells, filling all voids.

POTTING



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ISO DIN vrs ASTM

System	Method	Thermal conductivity [W/m·K]	Pressure [psi / bar / MPa]
Shore 00: 60–70	DIN (Hot disc)	2.50	– / – / –
Shore 00: 60–70	ASTM D5470-2017	2.60	14.5 / 1.0 / 0.1
Shore 00: 60–70	ASTM D5470-2017	3.00	43.5 / 3.0 / 0.3

System	Method	Thermal conductivity [W/m·K]	Pressure [psi / bar / MPa]
Shore A: 55–65	DIN (Hot disc)	1.50	– / – / –
Shore A: 55–65	ASTM D5470-2017	1.48	14.5 / 1.0 / 0.1
Shore A: 55–65	ASTM D5470-2017	1.51	43.5 / 3.0 / 0.3

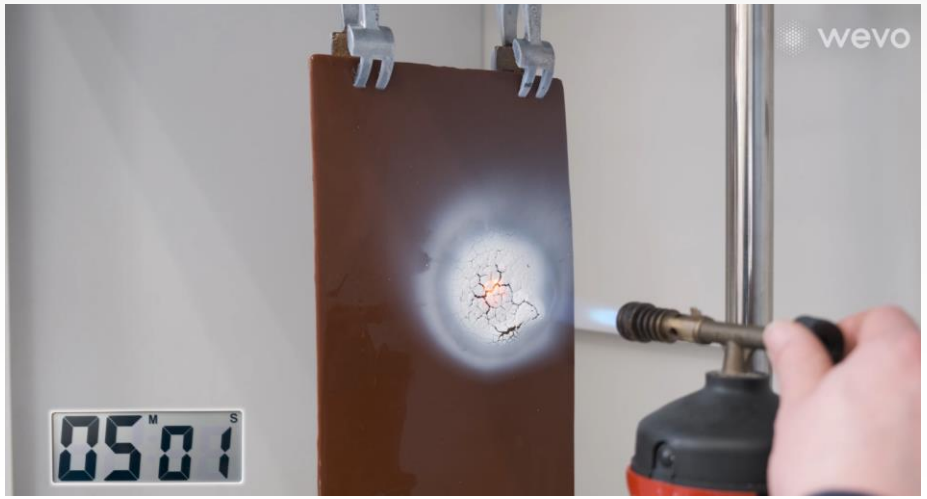
SYSTEM MANAGEMENT

- Heat Dissipation
- Thermal management (mitigation)
- Condensation (moisture ingression)
- Electrical discharge or arcing
- Carbon (organics - after thermal incident)

THERMAL MITIGATION

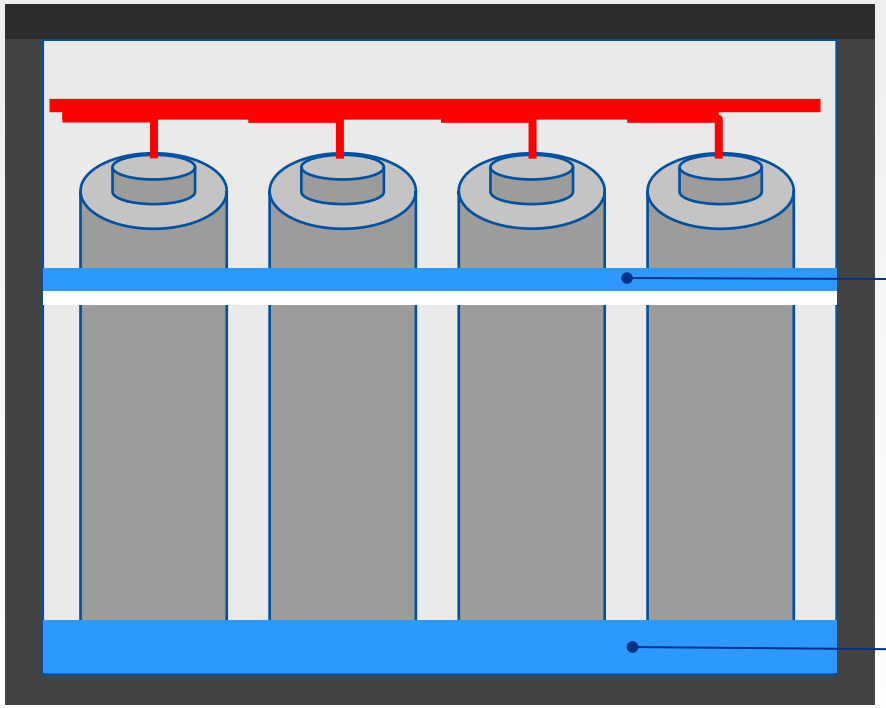
Silicone Solution

- Reducing potential ignition by possible means of flame suppression
- Inorganic with no carbon build-up after thermal incident
- Controlled exhaust of venting cells



>1000 °C flame on a 1mm silicone coated steel plate

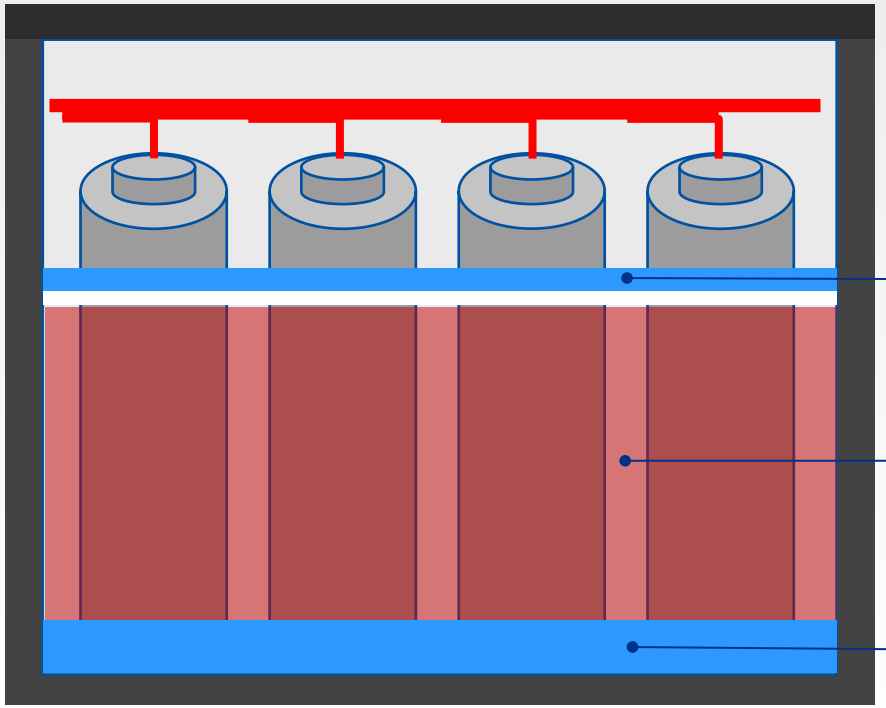
THERMAL MITIGATION



Thermal interface material adhesive or sealant,
also employed for immersion or pressurised systems

Thermal interface material,
gap filler of potting solution

THERMAL MITIGATION



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Thermal mitigation material,
engineered silicone solution

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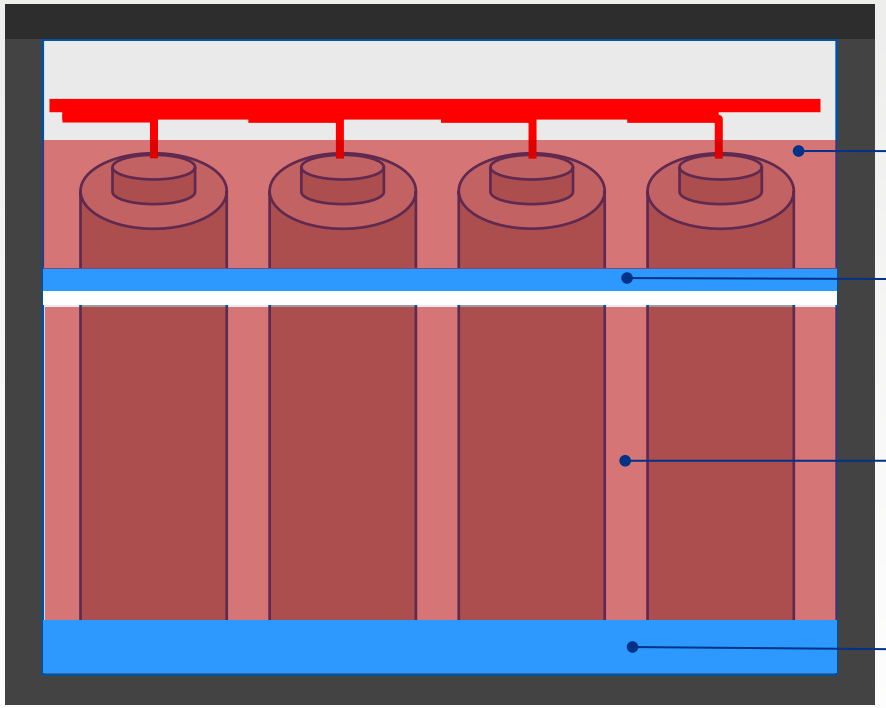

Thermal mitigation material,
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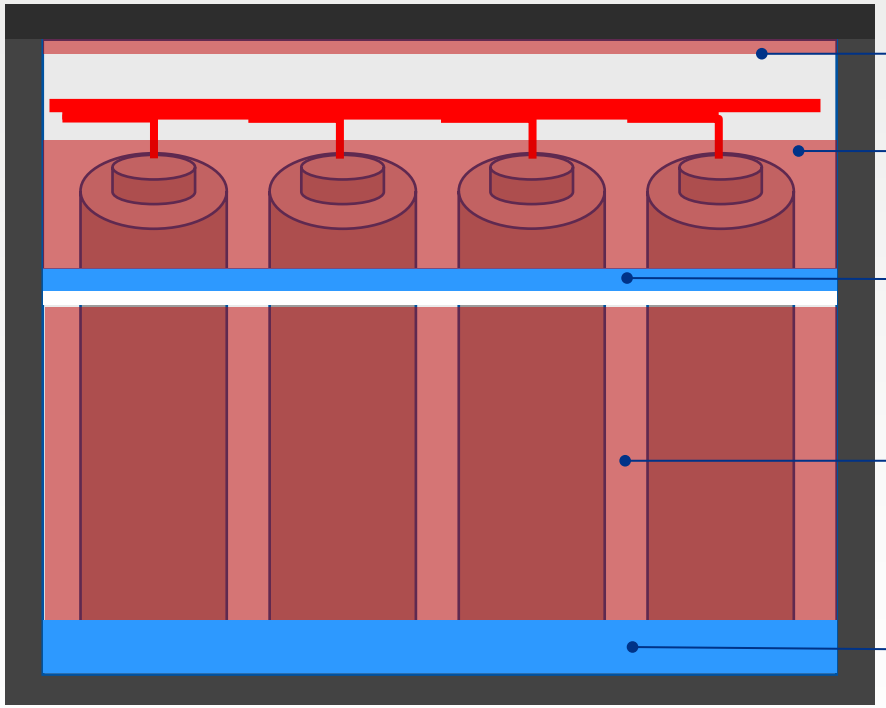
THERMAL MITIGATION



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RAILWAY FIRE STANDARD EN 45545-2

The test-standard evaluates the fire risk of components and materials used for operating rolling stock in railway transportation systems. The standard and certification includes 3 tests:

1. Smoke density
2. Oxygen index
3. Smoke toxicity

Trains and wagons are categorized via a matrix according to operation categories 1–4 and design categories N, A, D, S and a hazardous level HL 1–3 is determined dependent on the operation and design category:

OPERATION CATEGORY	DESIGN CATEGORY			
	N (normal/standard)	A (automatic operation)	D (double check)	S (sleeping car)
1. Surface operation	HL1	HL1	HL1	HL2
2. Tunnel < 5 km	HL2	HL2	HL2	HL2
3. Tunnel > 5 km	HL2	HL2	HL2	HL3
4. No side evacuation possible	HL3	HL3	HL3	HL3

EN 45545-2: HAZARDOUS LEVELS AND ALLOWED LIMITS

For electrical and electronic components like chokes, transformers, circuit breakers and isolators there are different requirements phrases applicable dependent on their position for interior use (R 22) and exterior use (R 23):

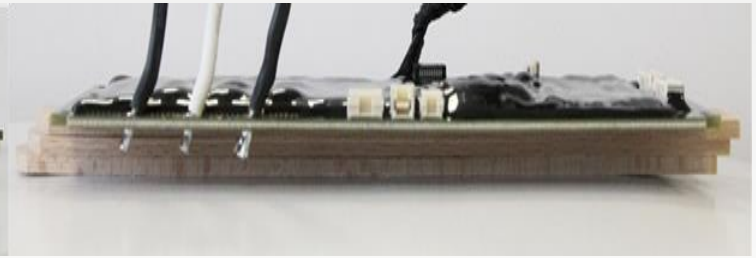
The following matrix shows the allowed thresholds for the different hazardous levels in the applied tests: Oxygen Index, Smoke Density D_S max. and Smoke Toxicity CIT_{NLP}

				HL 1	HL 2	HL 3
R22 (interior use) (IN16, EL2, EL6A, EL7A, M2)	T01 / EN ISO 4589-2: OI	Oxygen content %	Minimum	28	28	32
	T10.03 / EN ISO 5659-2: 25 kWm^{-2}	D_s max. dimensionless	Maximum	600	300	150
	T12 / NF X70-100-1 and -2, 600 °C	CIT_{NLP} dimensionless	Maximum	1.2	0.9	0.77
R23 (exterior use) (EX12, EL2, EL5 EL6B, EL7B, M3)	T01 / EN ISO 4589-2: OI	Oxygen content %	Minimum	28	28	32
	T10.03 / EN ISO 5659-2: 25 kWm^{2}	D_s max. dimensionless	Maximum	–	600	300
	T12 / NF X70-100-1 and -2, 600 °C	CIT_{NLP} dimensionless	Maximum	–	1.8	1.5

COATING & CELCORR

Wevo's pursuit to initiate and innovate leads to develop materials to improve corrosion reliability of electronic devices. Led by the Centre for Electronic Corrosion, Department of Mechanical Engineering, Technical University of Denmark, as a research group focusing on "Climatic Reliability of Electronic Devices".

We help electronic industries on various issues to develop products with a "Design for Reliability (DFR)" concept.



WEVOPUR COMPREHENSIVE COATING SOLUTIONS FOR MECHANICAL, THERMAL AND CORROSION PROTECTION

Photos curtesy of Cleantron BV and Bdtronic

High performance conformal coating for PCBA protection from humidity

Rajan Ambat and Ioannis Mantis
Center for Electronic Corrosion, DTU

Terence Kearns
WEVO, Germany

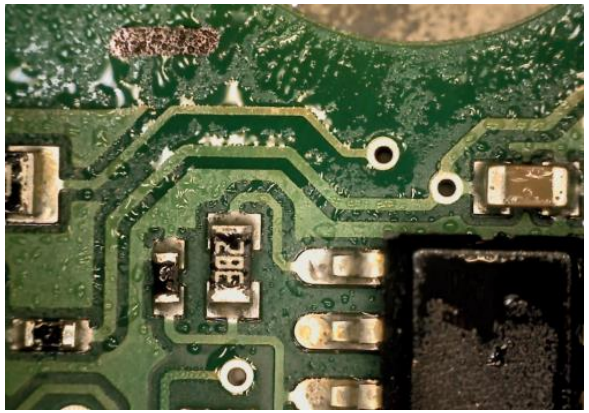
Mitigating environmental effects on electronics

Extrinsic

Adding a humidity barrier directly on PCBA/component or enclosing

Example: **Conformal coating, potting, enclosure design & materials, and other humidity lowering methods**

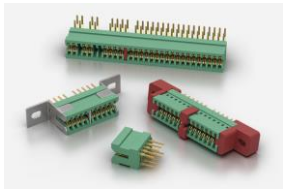
Moisture transport through polymer wall



Intrinsic

Enhancing inherent robustness

Example: **PCBA design & materials, component design & materials, PCBA cleanliness etc.**



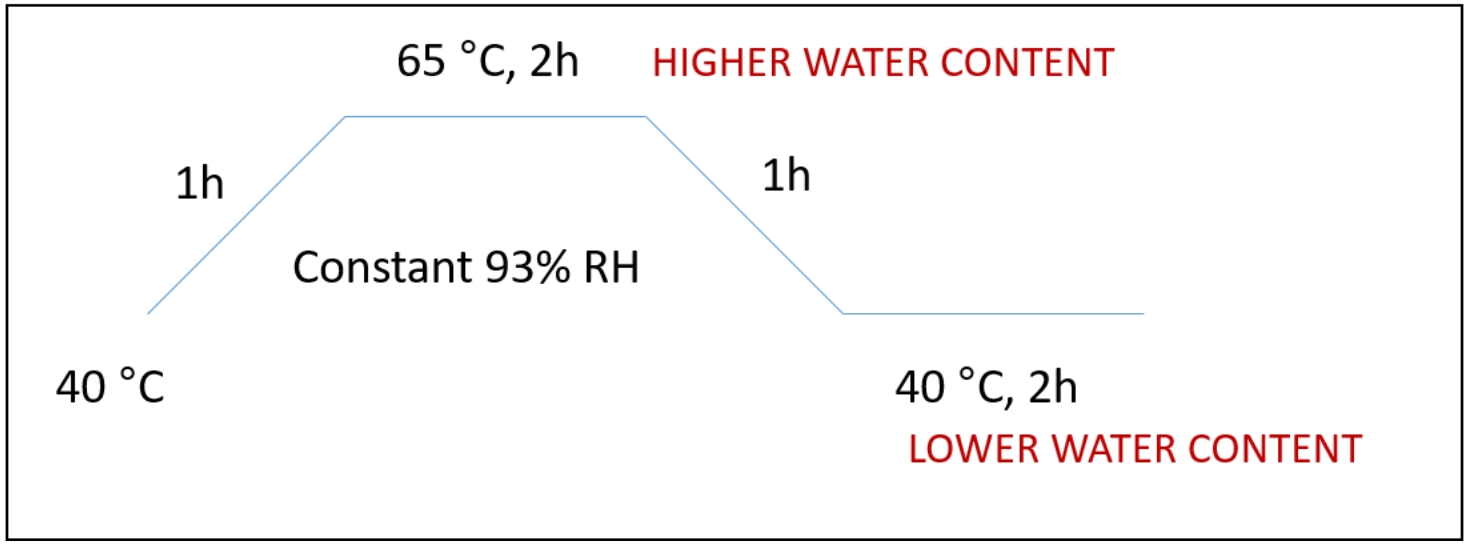
Moisture/gas transport through opening

Climatic exposure & electrochemical testing

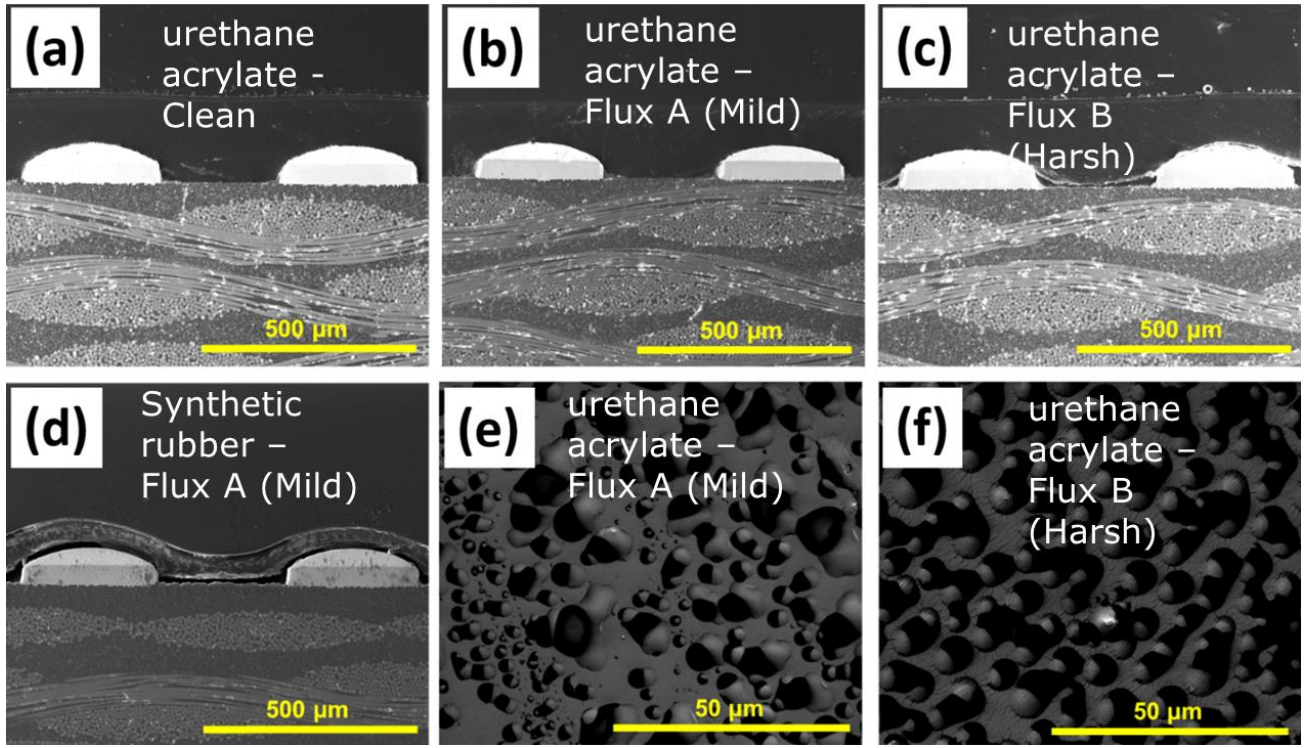
5 days electrochemical impedance spectroscopy
- 25 mV AC
- scan range 100 kHz to 100 mHz

7 days leakage current test
- 5V DC

48 CYCLES OF 6 HOURS:



PCBA-Coating interface delamination and failure summary

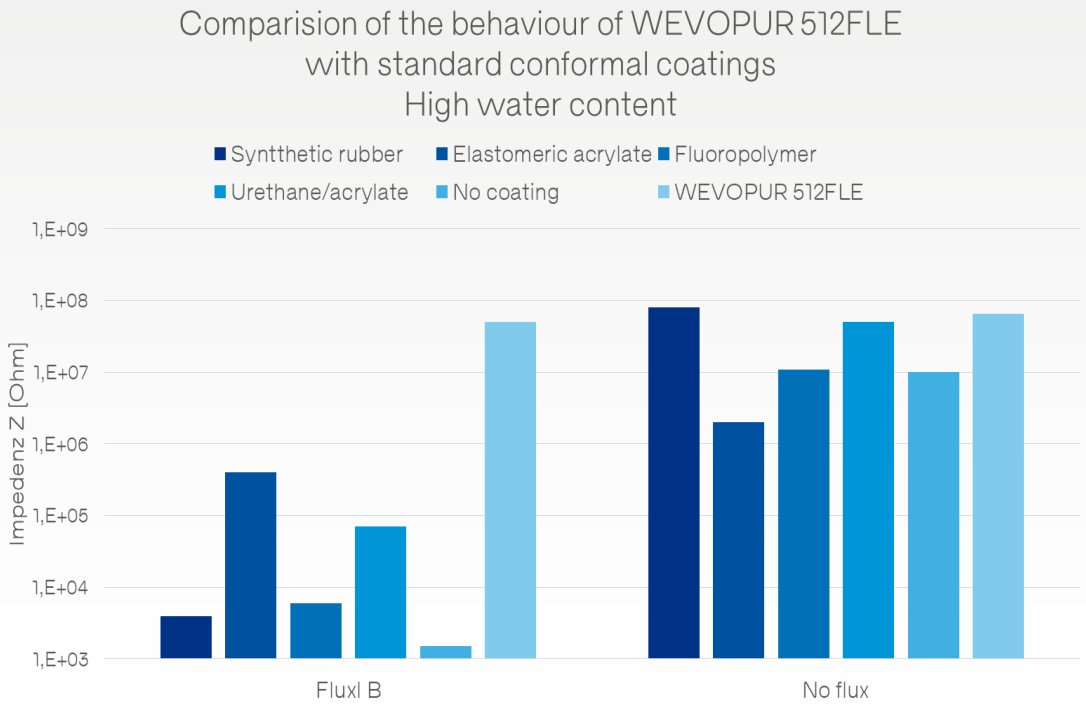


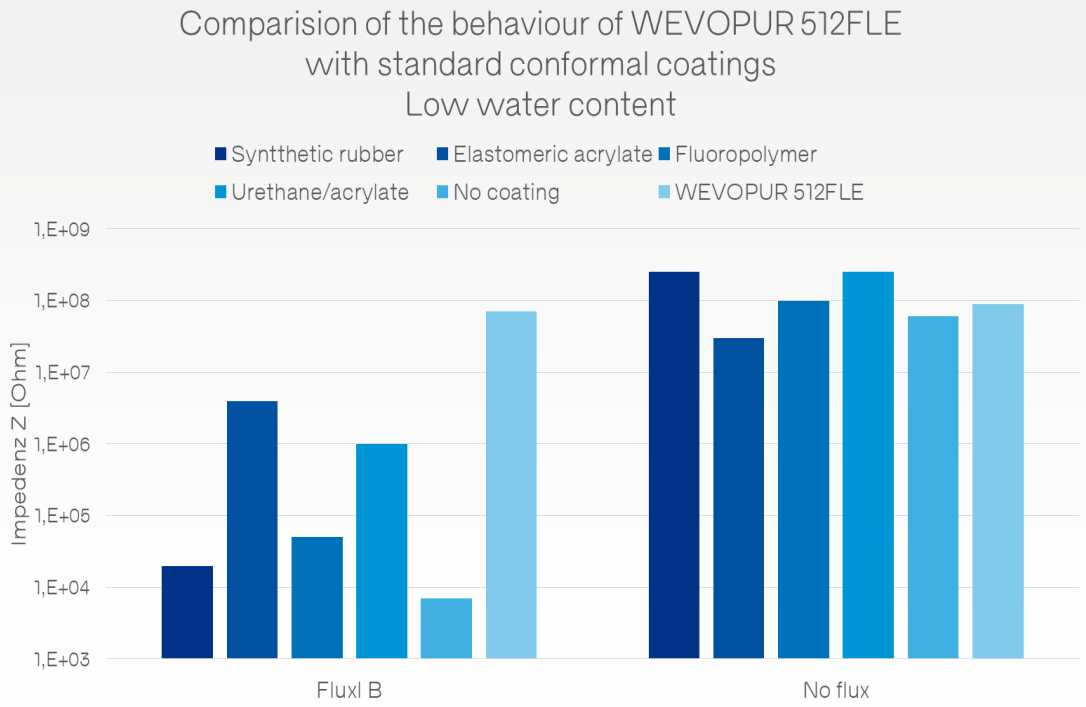
		Time to failure (h)	Failure rate
Synthetic rubber	Flux A	2.3/4.2/28.8/5.3/10.5/15.8	100%
	Flux B	0.8/2.9/0.48/1.1/1.2/0.7	100%
	No flux	NA/NA/NA/NA/NA/NA	0%
Acrylate polyurethane	Flux A	NA/NA/NA/NA/NA/NA	0%
	Flux B	NA/0.17/NA/NA/NA/NA	16.77%
	No flux	NA/NA/NA/NA/NA/NA	0%
Elastomeric acrylate	Flux A	NA/NA/NA/NA/NA/NA	0%
	Flux B	NA/NA/NA/NA/NA/NA	0%
	No flux	NA/NA/NA/NA/NA/NA	0%
Fluoro-polymer	Flux A	NA/NA/7.46/NA/15.9/32.93	50%
	Flux B	8.8/0/0/2.88/0/NA	83.33%
	No flux	NA/NA/NA/NA/NA/NA	0%
Urethane-acrylate	Flux A	NA/NA/NA/NA/NA/NA	0%
	Flux B	NA/NA/NA/NA/NA/NA	0%
	No flux	NA/NA/NA/NA/NA/NA	0%
Acrylic	Flux A	NA/NA/NA/NA/NA/NA	0%
	Flux B	0.7/1.4/2/2.2/2.5/2.1	100%
	No flux	31/NA/NA/NA/NA/NA	16.77%

*NA: No Failures

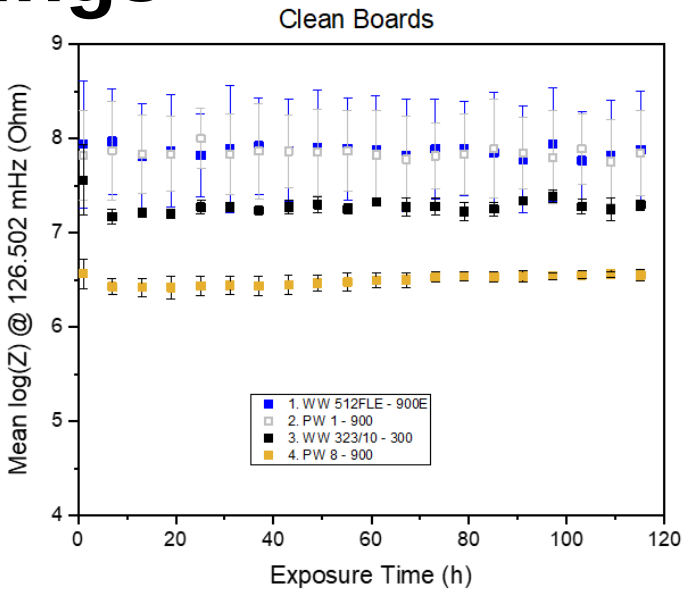
WEVOPUR 512FLE AND DERIVATE

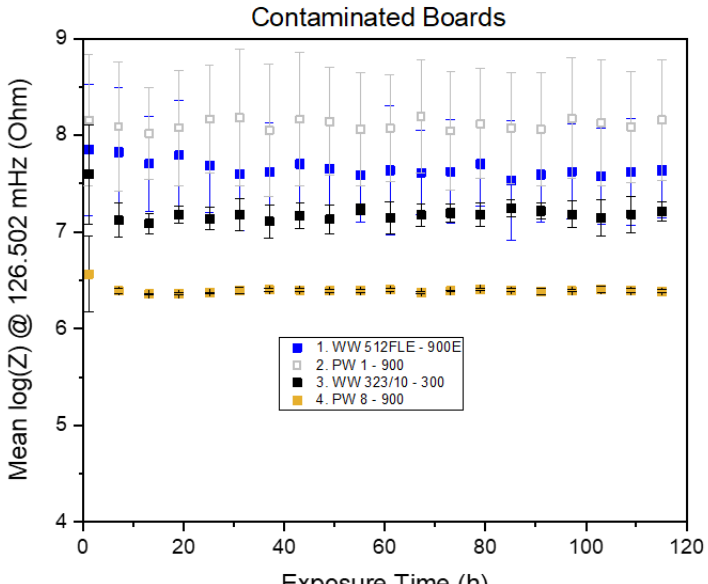
- WEVOPUR 512FLE with WEVONAT 900E
  - Validation of the system as a protection against corrosion for PCBs at the DTU
  - Even better than standard conformal coatings

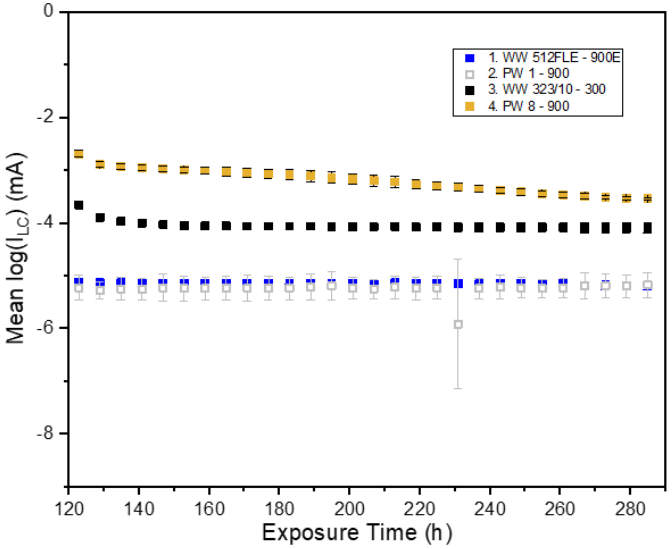


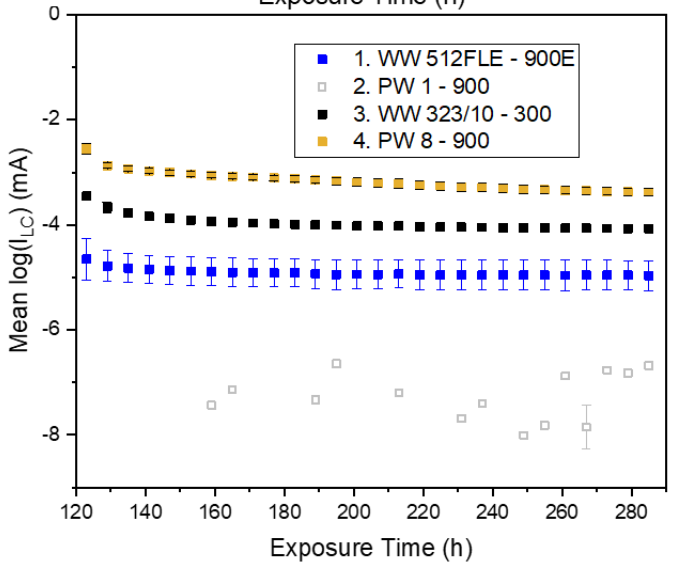


Comparison of mean Impedance and LC between 4 coatings





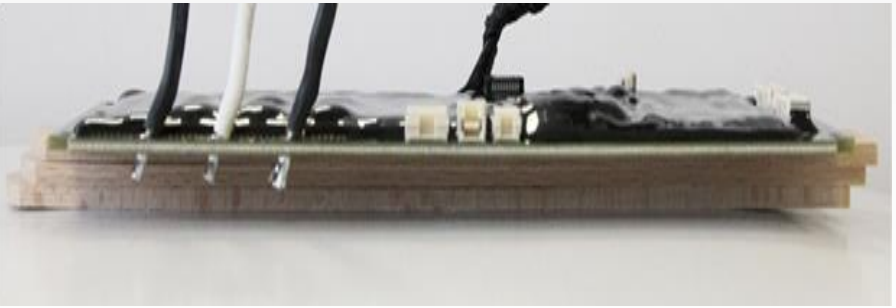




4 X WEVO POLYURETHANE SYSTEMS

WEVO & CELCORR

- High confidence level of superior e-corrosion protection
- A single product that can be applied without a housing or mould
- Coating thickness upto 1mm
- Minimal impact on warpage and electrical characteristics at board-level
- Additional key characteristics added: Thermal, Mechanical, etc.,



Photos curtesy of Cleantron BV and Bdtronic

MOTOR POTTING

WHY POTTING / IMPREGNATION

- Maintain a high current/torque without overheating
- Reducing the overall operating temperature
- Eliminating hotspots
- Electrical insulation within the windings prevents damage caused by potential short-circuiting
- Extending the machine longevity
- Improved reliability

BENEFIT OF POTTING / IMPREGNATION

- Common understanding that for every 10°C reduced operating temperature corresponds with a doubling of machine life
- Hotspots can be eliminated or reduced significantly
- Structural integrity and dampening (possible noise) can be improved
- Improved mechanical and thermal shock resistance

DESIGN CONSIDERATIONS

- Most heat generated via end-windings
- Vacuum impregnation gives substantial benefits
- Sharp edges (potential material crack/stress)
- Spacing
- Multiple dissimilar substrates
- Lubricants and coatings
- Tolerances

DESIGN CONSIDERATIONS

- Operating temperatures upto

  +200°C – Silicone

  Cannot be heated to reduce viscosity

  Higher peak temperature resistance for short periods

  180°C – Epoxy

  Can be heated as high at 65°C to reduce viscosity

  Higher peak temperature resistance for short periods

  130~155°C – Polyurethane

  Can be heated as high at 50°C to reduce viscosity

  Higher peak temperature resistance for short periods

WE ARE MUCH MORE THAN A SUPPLIER

From development to volume production – we support our customers every step along the way.

WE PIONEER PROGRESS

We are a proven partner in project-driven innovation with a decades-long track record.

WE INITIATE INNOVATION

We develop new ideas for every area of electrical component casting, bonding and sealing.

CONTACT DETAILS

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