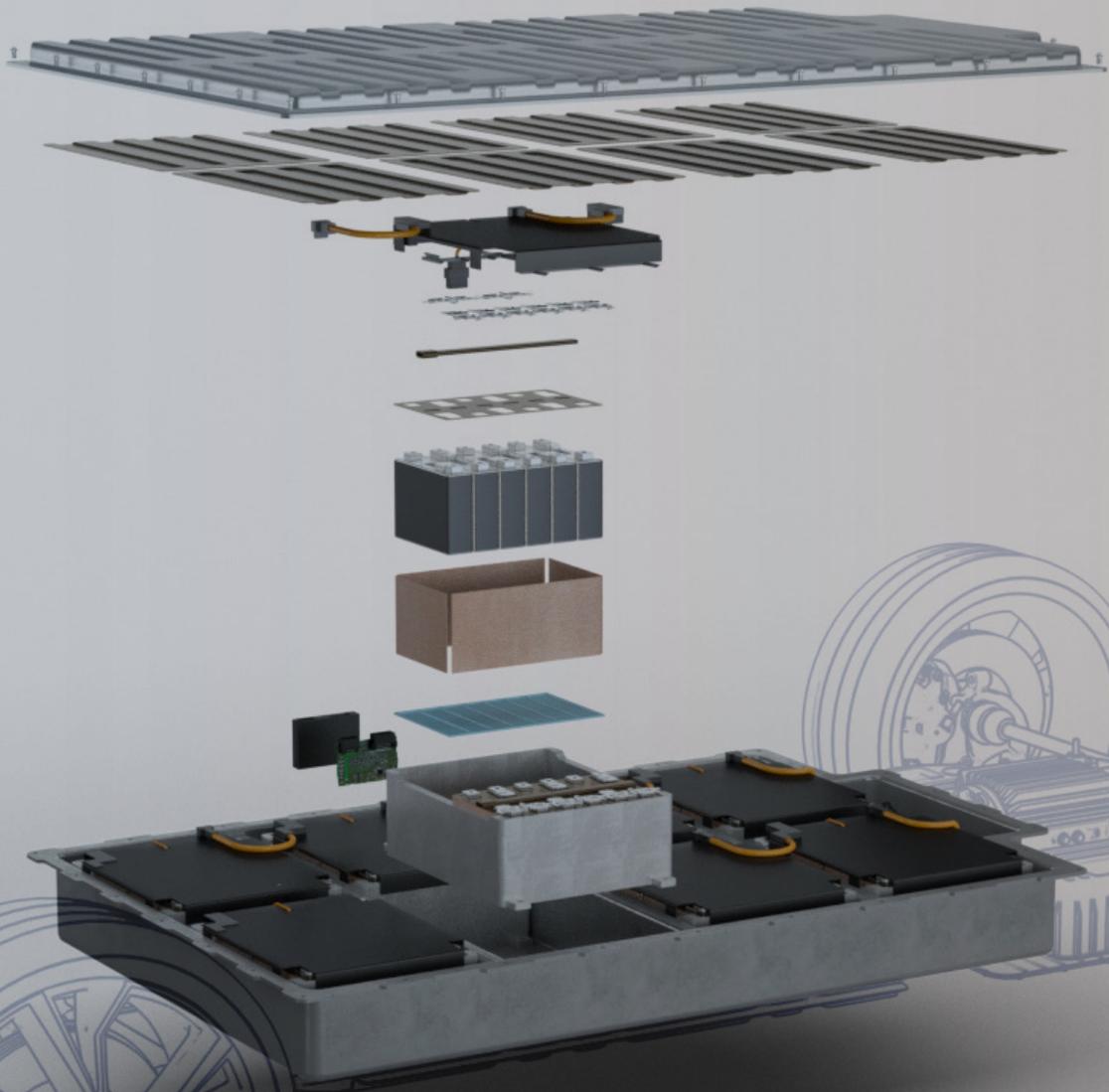


MARKETS // **PRODUCTS**

SHIELD T PRODUCTS

FOR BATTERY PROTECTION



vonRoll

SOLUTIONS FOR BATTERY PROTECTION

Von Roll is a market leader in **thermal and electrical insulation materials**. Special products are available to satisfy the need of the emerging urban air mobility market, especially for **battery protection**.

Failure of a single battery cell can trigger a chain reaction known as thermal runaway, which leads to immediate destruction of the whole battery pack or even the electric vehicle itself. Von Roll developed a special range of products to protect batteries for current and next generation electric planes.

VON ROLL SAMICA TAPES

Cells and bus bar, wrapped in electrical insulation tape based on mica structure



VON ROLL SHIELD T

Module covers offer proven thermal and mechanical stability under all critical conditions



Cell spacer for protection of cells from thermal runaway



VON ROLL MPC HOUSINGS

Stress-proven battery housing made of multipurpose-composite materials



VON ROLL MPC COVERS

High thermal stability MPC parts for excellent thermal and electrical insulation

VON ROLL MICA TUBES

Insulation composite tube Based on mica or woven glass fiber fabric

VON ROLL MYOFLEX

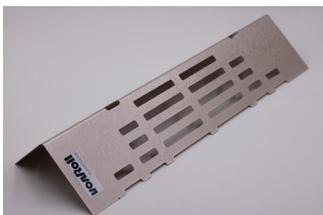
High-quality laminates for electrical shielding and insulation

VON ROLL GAP FILLERS

High thermally conductive potting for easier thermal management of cells

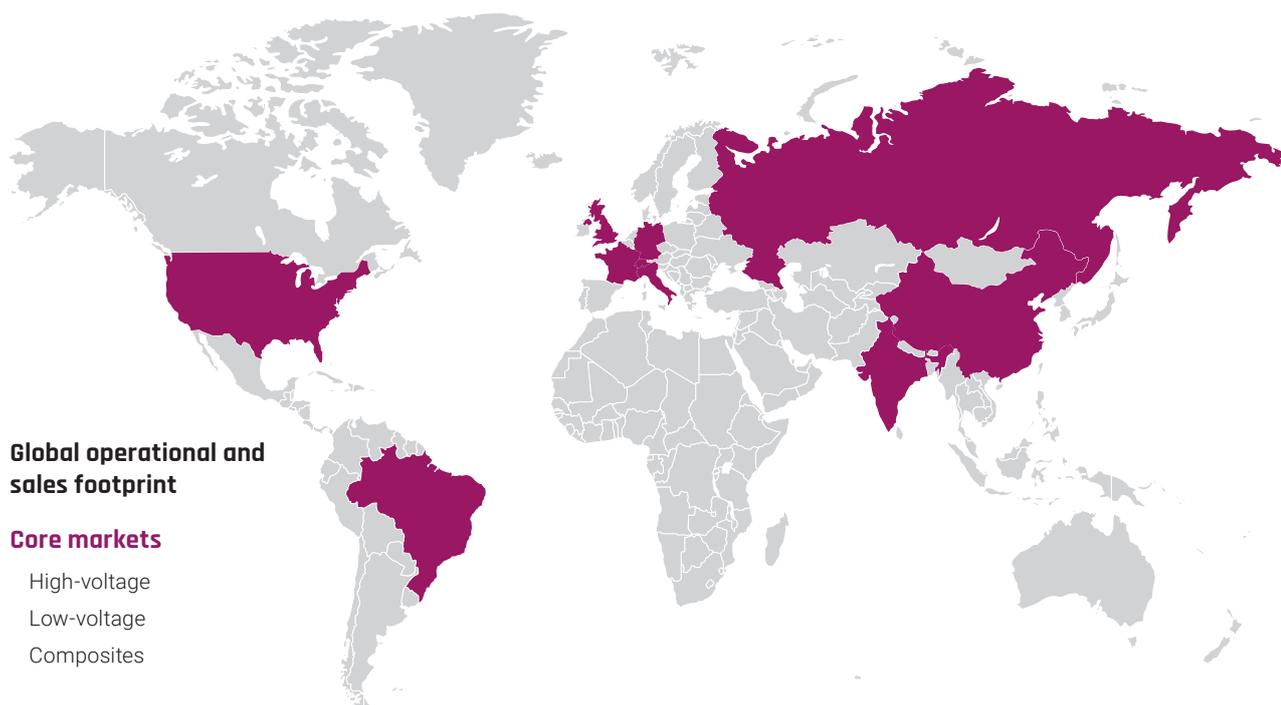
Mica based product portfolio comprises:

- + Rigid Mica plates - Mica with low content of resin press-cured above 150°C
- + Compressible Mica products - Mica with silicone combined with additional layers for multifunctional purposes
- + Flexible Mica products as a single or multilayer structure



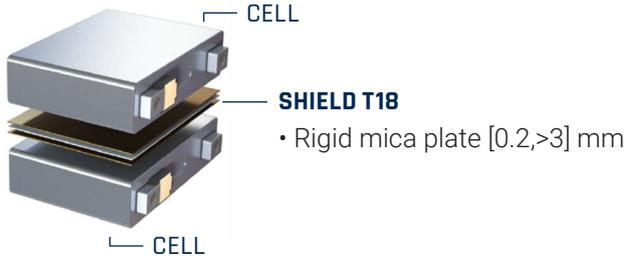
WHO ARE WE?

Von Roll is a traditional Swiss industrial company, since 1803. We are market leader for high voltage insulation systems. Our composites product line delivers products along the value chain to aviation, automotive, energy generation and distribution, electronic, defence and general industrial markets.

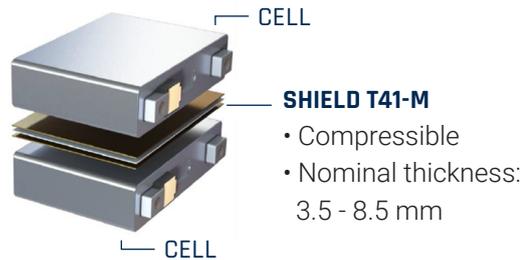
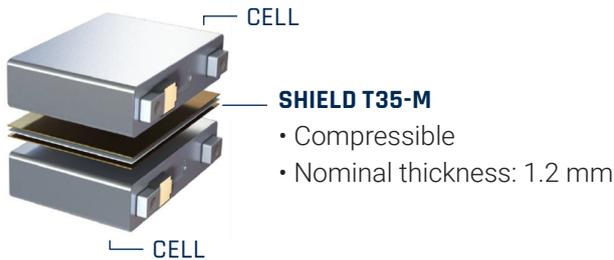


SHIELD T PRODUCT PORTFOLIO

1-PLY SYSTEMS

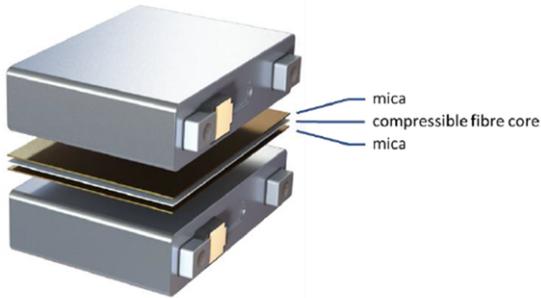


MULTI-PLY SYSTEMS



	SHIELD T18		SHIELD T29		SHIELD T29 G2		SHIELD T27		SHIELD T35-M		SHIELD T41-M	
Description	Standard rigid product, easy to machine		Flexible product for complex shapes				Sandwich product for compensate cell expansion and contraction					
Construction	Mica impregnated with silicone resin		Mica impregnated with silicone resin		Mica impregnated with silicone resin, glass cloth		Mica paper / silica fleece / mica paper		Mica paper / glass fleece / mica paper		Mica paper / needled glass fleece / mica paper	
Flexibility	Rigid		Flexible				Flexible and compressible					
Available thickness	0.2 - 50 mm		0.2 - 0.7 mm		0.15 - 0.6 mm		4.8 - 8.5 mm		0.9 - 1.2 mm		3.5 - 10 mm	
Thermal conductivity through plane [W/mK]	RT	150°C	RT	150°C	RT	150°C	RT	150°C	RT	150°C	RT	150°C
	0.22	0.19	0.13	0.11	0.13	0.11	0.04	0.06	0.05	0.07	0.04	0.06
Breakdown voltage [kV/mm]	20		10		13		> 5		8.5		> 5	
Density [g/cm³]	2.1		1.7		1.7		0.3 - 0.6		0.75		0.3 - 0.6	
Temperature resistance [°]	1000		1000		1000		950		650		650	

CELL SPACER MATERIALS



Von Roll cell spacer concept

KEY PRODUCT FEATURES

- + For prevention, delay or containment of thermal runaway in LIB
- + Thermal shielding material
- + Excellent thermal resistance
- + Excellent electrical insulation characteristics
- + Particularly suited as cell spacer of prismatic and pouch cells



Top view

GENERAL INFORMATION

- + Easy compression
- + Density \ll steel
- + Thickness range from 1mm to 10mm
- + Possibility for supplying with adhesive layers



Lateral view

KEY COMPONENTS

- + External Mica layers are assuring product robustness, thermal stability, fire protection, humidity barrier.
- + Low density fiber core is assuring tailored compressibility behaviour and low thermal conductivity.

VON ROLL MICA SOURCE FOR BATTERY PROTECTION

- + Mica is a type of phyllosilicate that exhibits a two-dimensional sheet or layer structure.
- + The crystal structure explains Mica's extraordinary shape.

Von Roll can provide full traceability of Mica sourcing and transformation to products for battery protection

WHY MICA?

- + Ideal combination of electrical, fire and thermal resistance performance.
- + The crystal structure explains Mica's extraordinary shape and features

GETTING FROM A ROCK TO THE INSULATION MATERIAL



1. Mica mining



2. Mica sorting



3. Mica paper manufacturing

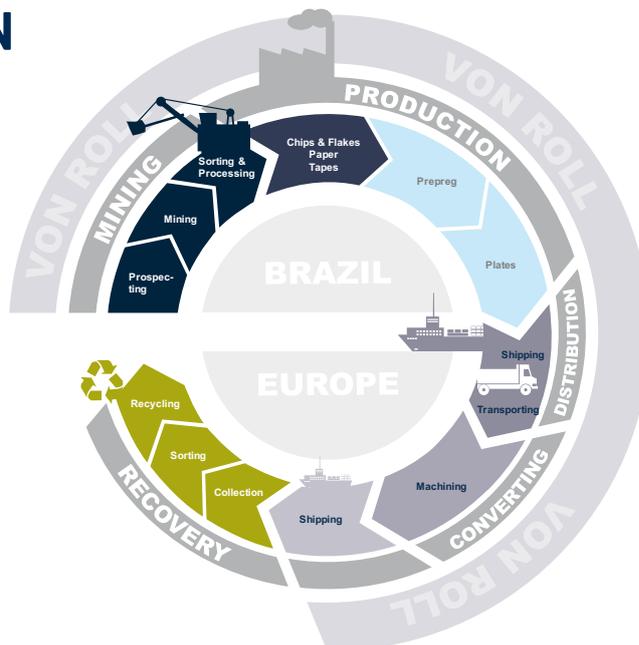


4. Lamination



5. Final product (Shield T41-M)

WE MAP THE ENTIRE VALUE CHAIN IN-HOUSE!



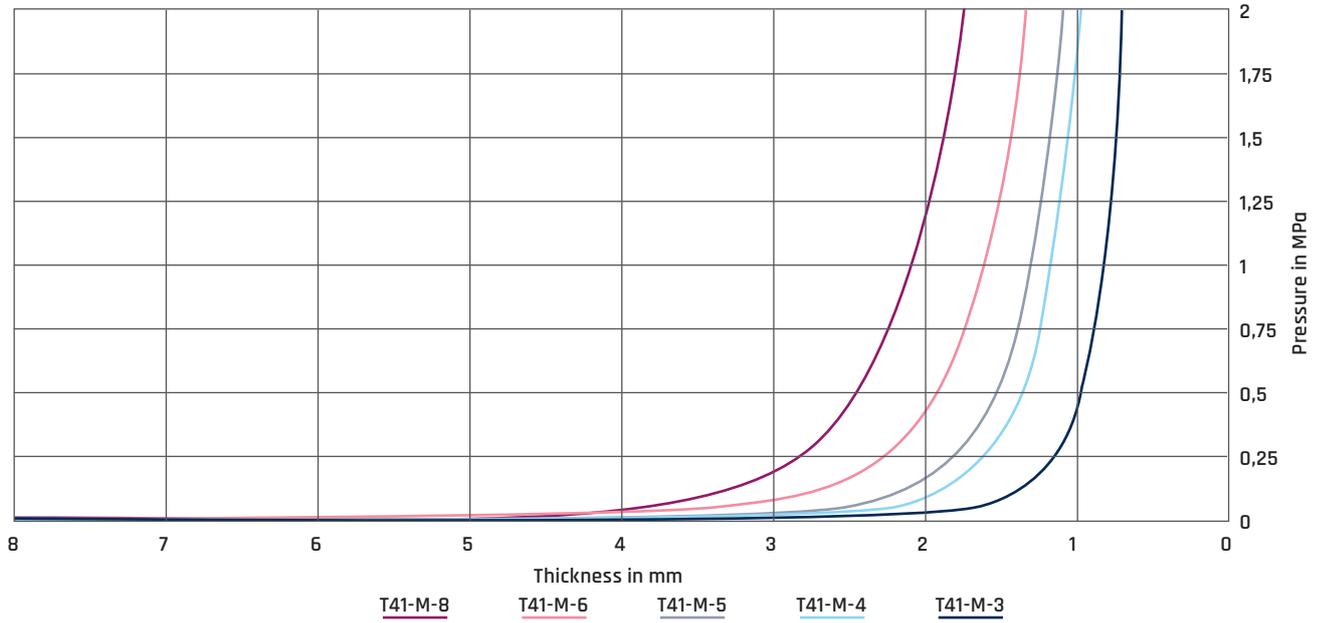
SHIELD T MATERIAL PERFORMANCE



MECHANICAL BEHAVIOUR

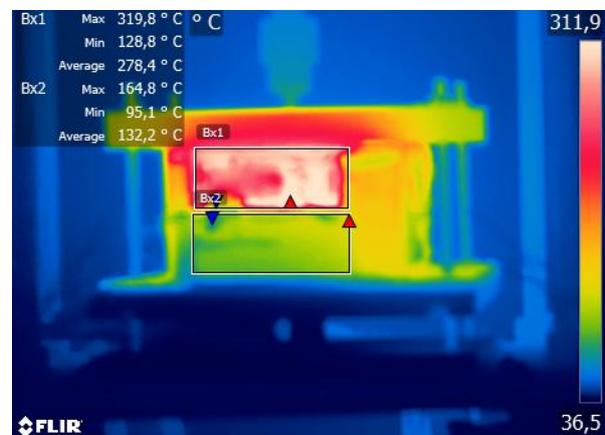
Different thickness provides flexibility to battery designers. Tailored core grammage allows to have cell spacer thickness, according to specific customer BOL and EOL requirements.

Compressibility T41-M Variants



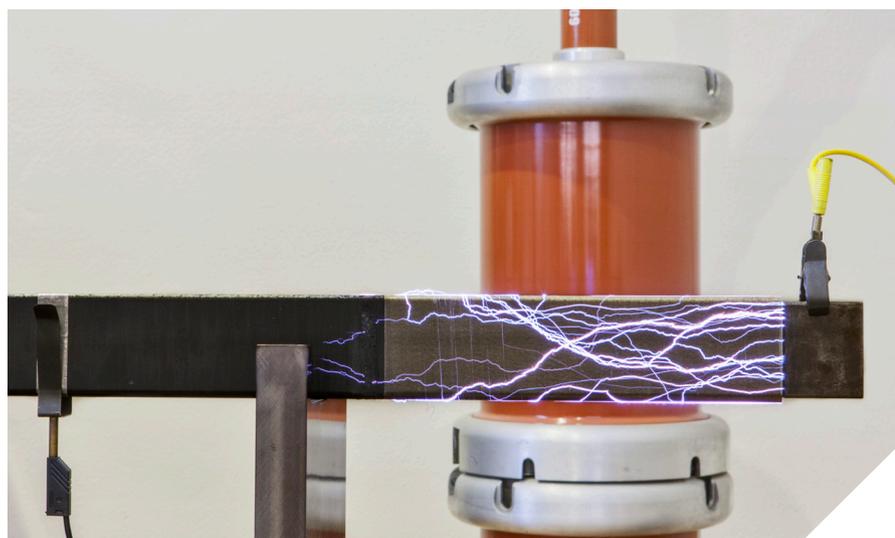
FIRE AND THERMAL BEHAVIOUR

Mica melts above 1250°C – then acts as perfect fire protection layer for several battery applications. In addition specific cell spacer products exceed for their low thermal conductivity values.



ELECTRICAL INSULATION

All the Shield T products provide superior insulation and high Break-down Voltage



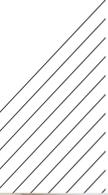
TESTING



Materials and systems have to be tested in order to ensure the requested specifications concerning mechanical, electrical and thermal characteristics.

At Von Roll HV laboratories we are able to test our customers' materials and systems according to IEC, UL and other specifications.

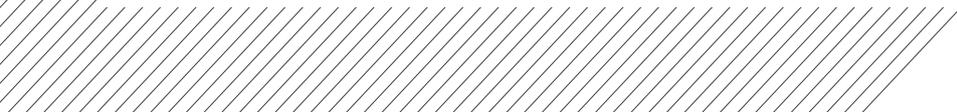
- + Thermal, electrical and mechanical aging tests
- + Tan δ -measurements at different temperatures
- + Partial discharge measurements with different voltage ranges



TRAINING

For a number of years we have been offering a unique program of high-voltage insulation training within our Von Roll Corporate University. The objectives of this program are:

- + Better understanding of high-voltage insulation technology for rotating machines and up-to-date knowledge on insulating materials and systems
- + Practical experience in the application of electrical insulating materials



WE ENABLE ENERGY

Von Roll is the sole full-range supplier of materials and systems for the insulation of electrical machines as well as high-performance products for various high-tech industries.



Mica

All materials related to high-voltage insulation. Von Roll's commitment to mica starts with mining and ends with finished tapes.



System components

Producer of integrated and ready-to-install system components for high-voltage electric motors, railway drives and generators.



Cables

Mica tapes for fire-resistant cables. Von Roll provides a wide range of products that are ideally suited to all commonly used standards.



Resins

Impregnation resins for high- and low-voltage, potting resins, casting resins, as well as encapsulating and conformal coatings.



Composites

Engineered materials made from a resin and a support structure with distinct physical, thermal and electrical properties. We offer molded, machined or semi-finished products.



Flexibles

Insulating flexible materials for low-voltage applications.



Ballistic Protection

High-quality systems for armored defense based on thermoset / thermoplastic products in single-use or tailored combinations.



Testing

Von Roll provides electrical, thermal and mechanical testing of individual materials as well as of complete insulating systems.



Training

Von Roll Corporate University provides a training program in high- and low-voltage insulation for its customers.

As one of Switzerland's longest-established industrial companies, Von Roll focuses on products and systems for electrical power generation, transmission, storage and industrial applications.

Von Roll's business portfolio is divided into the following businesses: Von Roll Insulation offers electrical insulation products, systems and services for generators, high- and low-voltage motors, transformers and other applications. Von Roll Composites produces composite materials and parts for a variety of industrial equipment.

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