



Insulating Systems for High-Voltage Rotating Machines

We Enable Energy

As one of the oldest industrial companies in Switzerland, founded in 1803, we focus on products and systems for power generation, transmission and distribution, rotating machines and mechanical engineering. Von Roll is the global market leader for insulation products and the only company to offer the complete range of insulation products, composites, consulting, tests and services for electrical machines such as turbo and hydro generators.

For more than 100 years, we have been making outstanding contributions to this market, developing a number of highly innovative products that have enabled both steady increases in power output and more compact machines.

Customers enjoy the following benefits:

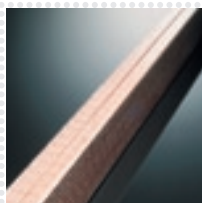
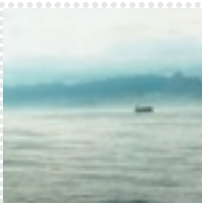
- » One single source for all insulating materials
- » Thorough expertise from power generation and transmission to its efficient utilization
- » Proven compatibility for system components
- » Testing at Von Roll of both materials and systems
- » Consulting for applications and technologies
- » Training in insulation materials and systems

Von Roll is committed to creating added value for its customers with the insulating materials and processes used in state-of-the-art electrical high-voltage motors as well as small generators with similar design. We offer the solutions you need for higher performance and reliability together with low manufacturing costs. No matter what the precise requirements of your machines, we have materials that will suit them using either resin-rich (RR) or vacuum pressure impregnation (VPI) technologies.

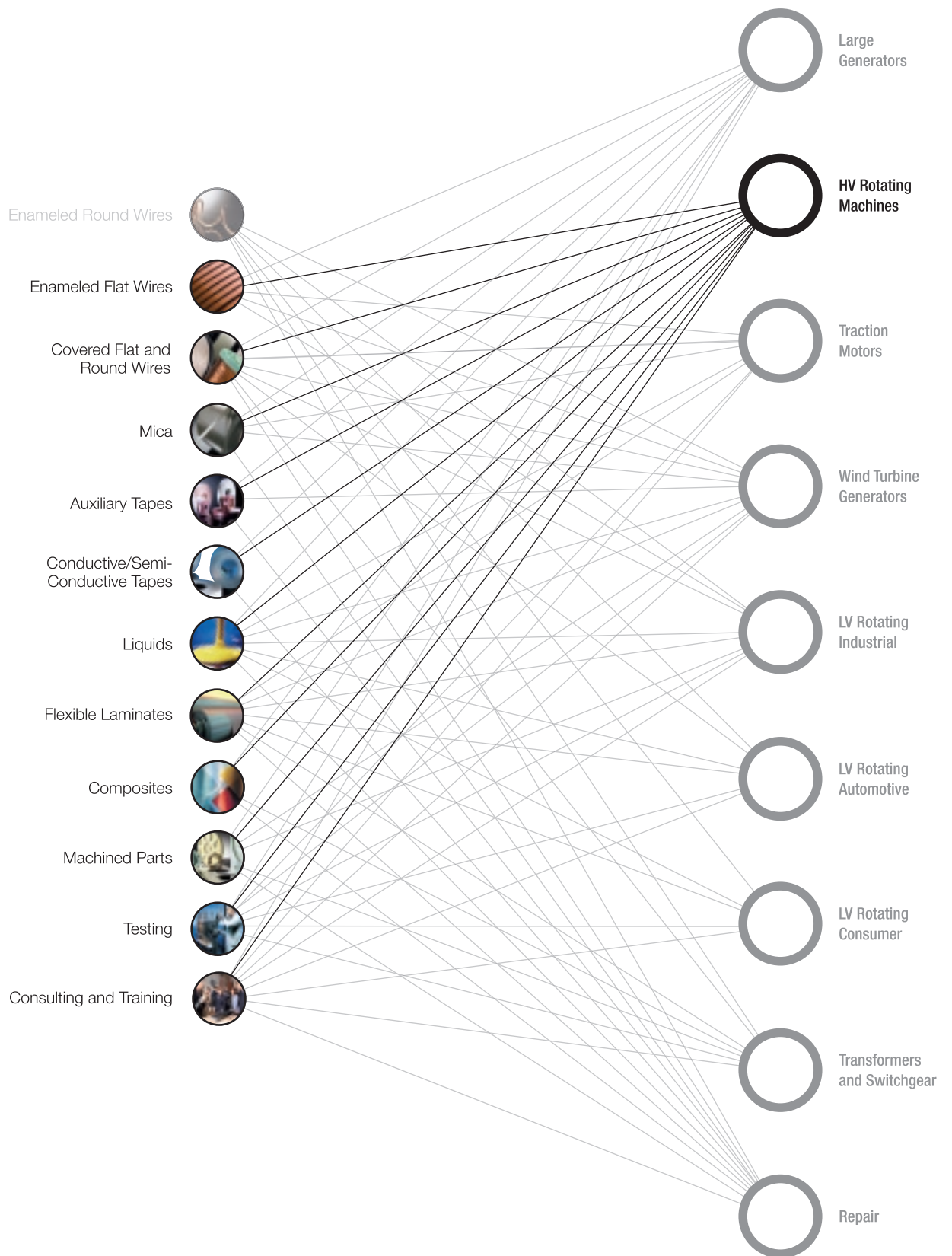
Von Roll has developed a VPI insulation system, under the name Samicabond®, with a number of distinct advantages:

- » Resins with high tank stability at room temperature
- » Imperviousness to moisture
- » Low viscosity
- » Fast curing with non-accelerated mica tapes
- » Excellent electrical properties
- » Class H
- » Very high price/quality ratio

This document introduces the main products associated with this system.



Our Products for High-Voltage Motors



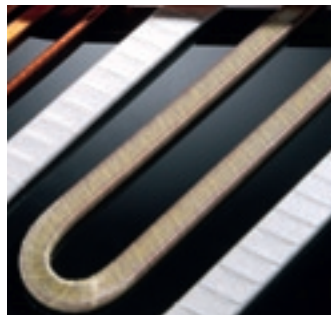
Von Roll offers full system solutions for every market shown in this application tree. Please contact us or visit our website www.vonroll.com for further information.



Mica Tapes for Insulation of Conductors

Samicafilm® products are based on Von Roll Samica® mica paper impregnated with modified epoxy resin, reinforced with one or two polyester film backings and with or without adhesive coating.

Samicafilm® type	Thickness mm	Weight g/m ²					Breakdown voltage kV	Adhesive
		Total	Mica	PET Film 1	PET Film 2	Resin		
315.11-01	0.06	72	30	32		10	≥ 5	No
315.12-01	0.07	93	50	32		11	≥ 5	No
315.70-01	0.075	101	50	42		9	≥ 8	No
315.14	0.09	131	75	42		14	≥ 8	No
315.15-01	0.09	131	75	42		14	≥ 8	No
315.11-11	0.06	76	30	32		14	≥ 5	Yes
315.12-11	0.07	97	50	32		15	≥ 5	Yes
315.15-11	0.09	135	75	42		18	≥ 8	Yes
315.72-01	0.085	124	65	32	17	10	≥ 8	No
315.23-01	0.09	112	50	32	17	13	≥ 8	No
315.25-03	0.1	141	75	42	8	16	≥ 8	No
315.72-21	0.09	133	65	32	17	19	≥ 8	1 side
315.23-11	0.09	126	50	32	17	27	≥ 8	2 sides
315.25-11	0.11	151	75	32	17	27	≥ 8	2 sides



Samicafilm® tapes show excellent corona resistance, although they are thin.



Conductors

Von Roll offers a complete range of high-quality conductors for high-voltage coils:

- » Covered wires with impregnated glass yarn (Silix®)
- » Covered wires with mixed glass/polyester yarn (Daglas®), with or without coating
- » Samicafilm® tape-covered wires
- » Flat rolled Litz wires with bare or enameled single conductors, covered with Samicafilm® tape

Samicafilm® tape covering on bare or enameled wires is the preferred conductor insulation for stator and rotor coils due to its substantial advantages:

- » Better corona resistance
- » Reduced insulation thickness
- » Softer copper, enabling easier workability
- » Greater manufacturing flexibility

Samicafilm® tapes are applied butt-lapped or overlapped to the conductor. We supply both tape and taped conductors to our customers.

Silix® coverings are impregnated with varnishes based on epoxy, polyester-imide, polyamide-imide, silicone or polyimide resins, depending on the thermal class required. For Silix® and Daglas® special grades with B-stage overcoat varnishes are also available for conductor stack consolidation. Flat litz conductors instead of solid flat wires allow smaller overhangs, bigger copper cross sections and higher efficiency by minimizing the eddy losses (proximity and skin effects).

Product name	Rated voltage			Dimensions	Description
	< 6 kV	6–13.8 kV	> 13.8 kV		
Silix® on bare wire	•			On request	Glass-lapped wire with or without B-stage overcoat
Silix® on enameled wire	•	•	•	On request	Glass-lapped wire with or without B-stage overcoat
Daglas® on bare wire	•			On request	Daglas®-lapped wire with or without B-stage overcoat
Daglas® on enameled wire	•	•	•	On request	Daglas®-lapped wire with or without B-stage overcoat



Stack Consolidation

Employing Samicafilm® with hot-melt adhesive or glass-lapped wires at B-stage enables rapid consolidation of conductor stacks without the need for additional consolidation products.

When using Samicafilm® without hot-melt adhesive or non-B-stage wires, traditional hot-press consolidation is preferred. This system can be achieved by overlapping the stack with Thermopreg® 251.78.

Von Roll standard materials for stack consolidation:

Product name	Form	Thickness mm	Description
Thermopreg® 251.78	Tape	0.10	Impregnated glass cloth
Polyester fleece 101.74-07	Tape	0.56	Nonimpregnated polyester fleece
Glasoflex® 261.10-03	Tape	0.50	Impregnated glass fleece with high resin content
Damival® 15182/9030	Resin		Solventless two-component epoxy resin



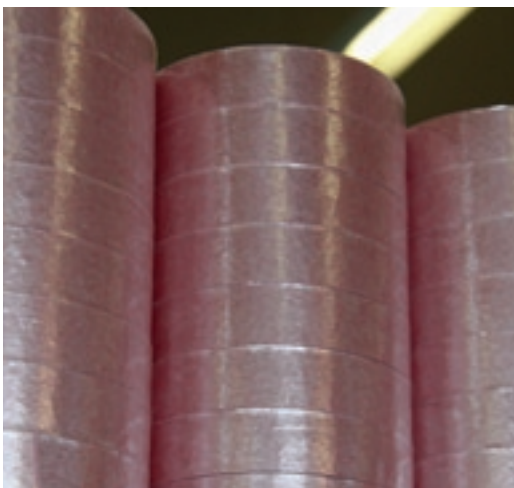
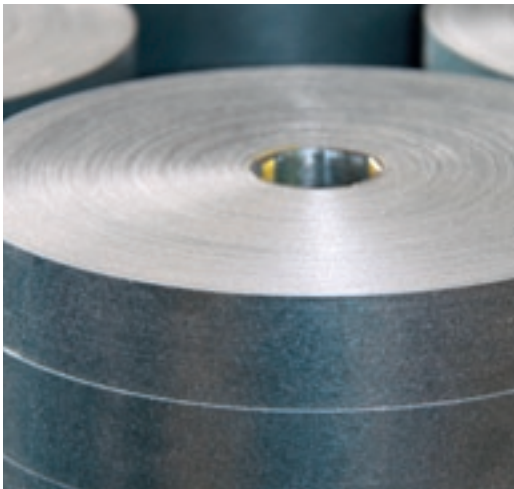
Main Wall Insulation for the VPI System

Von Roll is highly committed to mica. Our added value is visible throughout the complete manufacturing chain. It starts by mining, preparation of the mica scrap, preparation of the mica paper pulp, production of mica paper and finally production of mica tapes that can be used to the highest standards to make main wall insulations.

Von Roll has the right solution to improve the quality and cost-effectiveness of the high-voltage insulation you need for your applications.

With Samicapor®, Von Roll has designed a range of outstanding VPI mica tapes that fulfill the requirements of main wall and end-winding insulation, namely:

- » High dielectric strength
- » Corona discharge resistance
- » Fast and easy impregnation
- » Resin retention without draining
- » Smooth application without creasing
- » Both manual and fast-running machine application
- » Full compatibility with predefined resin systems



Von Roll's commitment to mica starts with mining and ends with finished tapes.

Product name	Rated voltage		Thickness mm	Weight g/m ²		Composition	Resin compatibility and thermal class		
	< 6 kV	> 6 kV		Total	Mica		Non-accelerated epoxy-anhydride	Accelerated epoxy VPI systems	Polyesterimide Samicabond® system
Samicapor® 366.55-10	•	•	0.15	200	160	Mica/ Glass	155 (F)		
Samicapor® 366.55-12	•	•	0.14	198	160	Mica/ Glass	155 (F)		
Samicapor® 366.58	•	•	0.15	195	160	Mica/ Glass		155 (F)	155 (F)/ 180 (H)
Samicapor® 366.58-18	•	•	0.15	213	180	Mica/ Glass		155 (F)	155 (F)/ 180 (H)
Samicapor® 366.58-20	•	•	0.17	224	180	Mica/ Glass		155 (F)	155 (F)/ 180 (H)
Samicapor® 374.04	•		0.18	241	160	Glass/ Mica/ PET fleece		155 (F)	155 (F)
Samicapor® 374.15	•		0.18	241	160	Glass/ Mica/ PET fleece	155 (F)		
Samicapor® P 315.33	•		0.18	241	160	Mica/ PET film	155 (F)		
Samicapor® P 315.45	•		0.18	241	160	Mica/ PET film	155 (F)	155 (F)	155 (F)



With high-speed taping machines Samicapor® und Samicatherm® tapes are precisely wrapped around the conductors.



Main Wall Tapes for the RR System

Assuring optimum quality of main wall insulation requires careful selection of micaceous tape and detailed attention to the way the tape is applied and processed.

The solutions we have devised to get you the best possible results include a complete range of resin-rich (RR) main wall insulation tapes and systems under the name Samicatherm® for both conventional and hydrostatic pressing and Filosam® and Samicaflex® for the overhang areas.

The advantages of these tapes are that they:

- » Have high dielectric strength
- » Resist corona discharge
- » Can be applied smoothly without creasing
- » Can be applied by fast-running machines or manually
- » Have short cutting times

Main wall tapes for conventional hot pressing:

Product name	Rated voltage			Thickness mm	Weight g/m ²		Description
	< 6 kV	6–13.8 kV	> 13.8 kV		Total	Mica	
Samicatherm® 366.28/366.28-02	•	•		0.19	265	120	Mica/Glass with/without interleaving foil
Samicatherm® 366.28-04/366.28-03	•	•		0.19	265	120	Mica/Glass with/without interleaving foil, slightly drier
Samicatherm® 366.28-05	•	•		0.19	265	120	Mica/Glass with interleaving foil, slightly drier
Samicatherm® 366.28-06	•	•		0.20	277	120	Mica/Glass without interleaving foil, with slightly higher resin content
Samicatherm® 366.33-62	•	•	•	0.25	350	180	Mica/Glass without interleaving foil
Samicatherm® 366.32	•	•	•	0.26	458	240	Mica/Glass with interleaving foil
Samicatherm® P 315.20/315.20-02	•			0.16	252	150	Mica/PET film with/without interleaving foil
Samicatherm® P 315.20-10	•			0.17	270	150	Mica/PET film without interleaving foil
Samicatherm® PI 315.51	•			0.09	117	60	Mica/Polyimide film, class H

Overhang tapes for conventional hot pressing:

Product name	Thickness mm	Weight g/m ²		Description
		Total	Mica	
Filosam® 326.57-20	0.15	206	109	PET film/Mica/Glass threads, highly flexible
Filosam® 326.57-50	0.13	177	75	PET film/Mica/Glass threads, highly flexible
Samicaflex® 366.18	0.12	150	75	Mica/Glass, class H, flexible for higher voltages
Samicaflex® 366.19	0.18	109	120	Mica/Glass, class H, flexible for higher voltages



Corona Protection

Electrical stress control measures are an essential component of any high-voltage machine. Von Roll has developed a number of superior products under the trade name CoronaShield®, namely:

- » Conductive tapes impregnated and in paper form
- » Semi-conductive tapes
- » Conductive varnishes

All these tapes can be applied as:

- » External corona protection – within the slot
- » End corona protection – outside the slot

Product name	Thickness mm	Resistivity Ohm/m ²	Description
CoronaShield® 215.51	0.10	200–400	Conductive tape, impregnated PET fleece, not compatible with epoxy anhydride, cured
CoronaShield® 215.55	0.085	200–400	Conductive tape, impregnated PET fleece, cured
CoronaShield® 215.63	0.17	200–400	Conductive tape, impregnated PET fleece, cured
CoronaShield® 217.01/217.21	0.22	Variable	Semi-conductive tape, impregnated PET fabric, with specific characteristics, not cured (B-stage)
CoronaShield® 217.02/217.22	0.22	Variable	Semi-conductive tape, impregnated PET fabric, with specific characteristics, not cured (B-stage)
CoronaShield® 217.03	0.22	Variable	Semi-conductive tape, impregnated PET fabric, with specific characteristics, not cured (B-stage)
CoronaShield® 217.31	0.25	Variable	Semi-conductive tape, impregnated PET fabric, with specific characteristics, cured



CoronaShield® conductive and semi-conductive tapes.



Finishing Tapes

To protect your equipment, the use of finishing tape is highly recommended. This material will protect the main wall insulation in the overhang area against:

- » Moisture
- » Mechanical load
- » Damage
- » Resin flow
- » Atmospheric pollutants

With Epoflex® Von Roll found the right solution to meet these requirements:

Product name	Thickness mm	Description
Epoflex® 215.01	0.19	Polyester fleece with epoxy resin, not cured
Epoflex® 219.61-10	0.18	Polyester glass fabric with with epoxy resin, not cured
Epoflex® 324.03	0.09	Polyester glass fabric with a polyester film and reduced binder quantity, cured





Winding and Bracing of Machines

The simplicity of the winding process for machines with “dry” coils is a recognized benefit of VPI technology. Substantial advantages arise during the end-winding bracing and support procedure. Von Roll has developed a range of ropes, cords and sleeves for “surge ring” intercoil lacing and tying applications.

The main advantages of these products are:

- » Class C (glass) and F (polyester) applications
- » Compressibility and resilience
- » Glass or polyester yarn on the outside
- » Wide range of dimensions
- » Nonimpregnated for use with VPI; no further processing
- » Impregnated polyester shrink cord for RR uses

Product name	Form	Thickness mm	Description
Isocord® 151.10	Cord	1.8–50	Braided silane E glass yarn outside with glass filler
Isocord® 151.12	Cord	1.5–60	Braided polyester yarn outside with glass filler

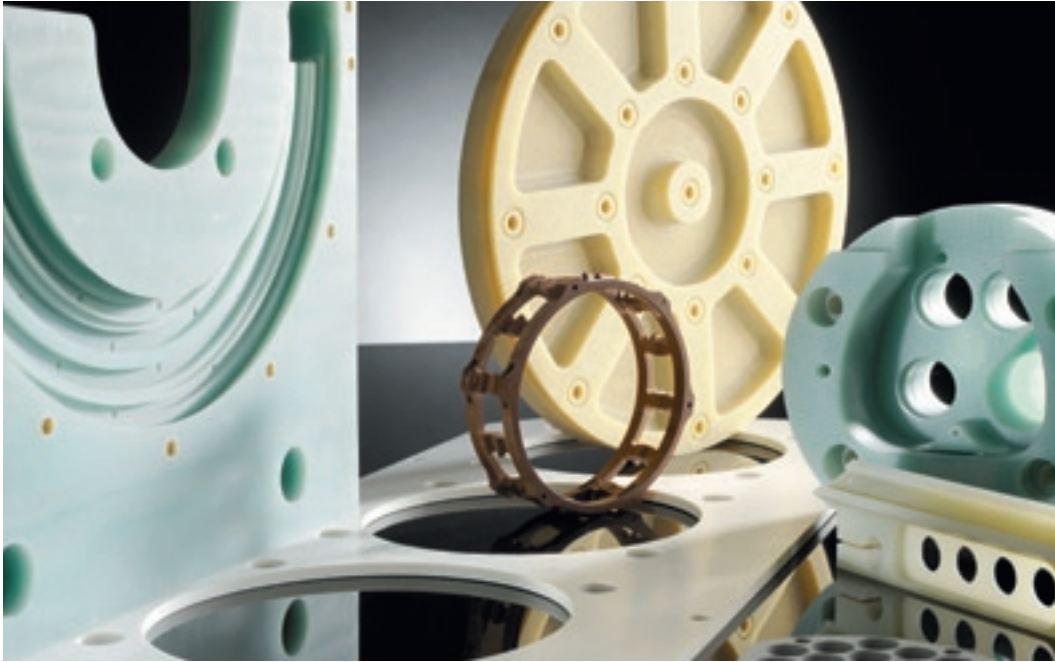


Glass and glass polyester cords.



Composite Materials

Von Roll offers a variety of state-of-the-art composite materials that can be delivered as U and L profiles, strips and sheets, machined parts or special components for use in different areas of high-voltage rotating motors. The following are just a selection. Please ask our specialists about additional products.



Machined parts tailored to customer specifications.

Different materials used for rotor and stator components:

Product name	Type	Rated voltage			Stator slot insulation	Magnetic stator slot wedges	Rotor slot wedges	Commutator
		< 6 kV	6–13.8 kV	> 13.8 kV				
Vetronit® G-11	Machined component or full-size sheet	•	•	•	•		•	
Delmat® Epoxy 68660	Machined component or full-size sheet	•	•	•	•		•	
Delmat® Polyester 68420	Machined component or full-size sheet	•	•	•	•			
Samicanite® 41120	Machined component or full-size sheet	•	•	•				•
Mica rings	Part on design	•	•	•				•
Vetroferrite® 432.20/ 432.21	Machined component	•	•	•		•		



VPI Impregnation Resins

Our wide range of high-performance resins is designed to meet the expected electrical and mechanical characteristics of high-voltage rotating machines. The factors that influence the final choice of resin are complex. Important considerations relate to features of the design of the machines and the choice of insulating system, taping and VPI processes. Important criteria include:

- » Resin thermal class
- » Tank stability
- » Storage conditions (cooled or ambient temperature)
- » Moisture sensitivity
- » VOCs (volatile organic compounds)
- » Impregnating temperature
- » Necessity of rotating curing
- » Curing time
- » Total processing time
- » Compatibility with mica tapes and remaining materials
- » Rated voltage
- » Dielectric properties
- » Thermal conductivity
- » Continuous and maximum peak operating temperature

Von Roll offers a variety of high-performance resins:

Product name	Type	Thermal class	Rated voltage			Impregnation temperature	Curing process	Description
			< 6.6 kV	6.6–15 kV	15–22 kV			
Damisol® 3340	Polyesterimide Samicabond®-System	180 (H)	•			23 °C	8 h at 150 °C	Highly reactive, yet highly stable room-temperature impregnating resin. Good results on static curing.
Damisol® 3032	Polyesterimide Samicabond®-System	180 (H)	•			23 °C	8 h at 140 °C	
Damisol® 3308	Polyesterimide Samicabond®-System	180 (H)	•	•		23 °C	8 h at 140 °C	
Damisol® 3309	Polyesterimide Samicabond®-System	180 (H)	•	•		23 °C	8 h at 150 °C	
Damisol® 3313	Epoxy/ Polyesterimide	180 (H)	•	•		23 °C	8 h at 150 °C	Low-viscosity 2K accelerated epoxy resin with outstanding mechanical properties.
Permafil® 74038	Epoxy 1K	180 (H)	•	•		23–60 °C	8 h at 160 °C	1K epoxy resin without diluent. Very low organic emission (VOC < 2%).
Damisol® 3407	Epoxy/ Anhydride 2K	155 (F)	•	•	•	40–70 °C	10 h at 170 °C	Accelerated tape needed.
Damisol® 3415	Epoxy/ Polyester	155 (F)	•	•	•	23 °C	8 h at 150 °C	Highly reactive room-temperature impregnating epoxy-modified resin. Storage below 5 °C.



Finishing Coating

The Damicoat® range of finishing and overcoat varnishes includes air-drying and oven-curing solutions. They are all single components for easy processing by spray, brush and even dipping and dip-rolling processes.

Product name	Color	Rated voltage			Drying time	Description
		< 6 kV	6–15 kV	< 15–22 kV		
Damicoat® 2404	N/RB/G	•	•		15 to 20 h	Highly chemically resistant overcoat varnish.
Damicoat® 2407	RB	•	•		1 to 2 h	High-temperature-resistant overcoat varnish, used for up to class H high-voltage and traction machines.





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



Testing in the Von Roll laboratory.



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



Our training courses are attended by customers and partners from around the globe.

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.



Ballistic Protection

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



Cables

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



Composites

Engineered materials made from a resin and a support structure with distinct physical, thermal and electrical properties. They can be molded, machined or semi-finished.



Flexibles

Insulating flexible materials for low-voltage applications such as flexible laminates and adhesive tapes.



Liquids

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



Mica

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



Transformers

High-performance transformers for power transmission and distribution, tailored solutions to all applications of today's energy-supply companies.



Wires

Insulated round, flat and Litz wires for high-voltage, low-voltage and electronic applications.



Testing

Von Roll provides electrical, thermal and mechanical testing of individual materials as well as complete insulating systems. We are UL-certified.



Training

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

Please contact us or visit our website www.vonroll.com for further information

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About Von Roll

We Enable Energy – As one of Switzerland's longest established industrial companies, Von Roll focuses on products and systems for power generation, transmission and distribution. Von Roll's business portfolio is divided into five business segments: **Von Roll Insulation** is the global market leader in insulation products, systems and services. **Von Roll Composites** produces composite materials and parts for assorted industry appliances. **Von Roll Transformers** offers complete solutions for the fast expanding market of high performance transformers. **Von Roll Water** provides solutions for process engineering tasks in the field of water and waste water management. **Von Roll Solar** is developing a third-generation solar cell.