



Insulating Systems for Large Generators

vonRoll

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

Demand for higher performance and reliability together with higher productivity in turbo and hydro generators is continuously increasing. Electricity producers are faced with new challenges, mostly imposed by the demand for energy efficiency in power distribution grids, that strongly influence the design and choice of insulation materials.

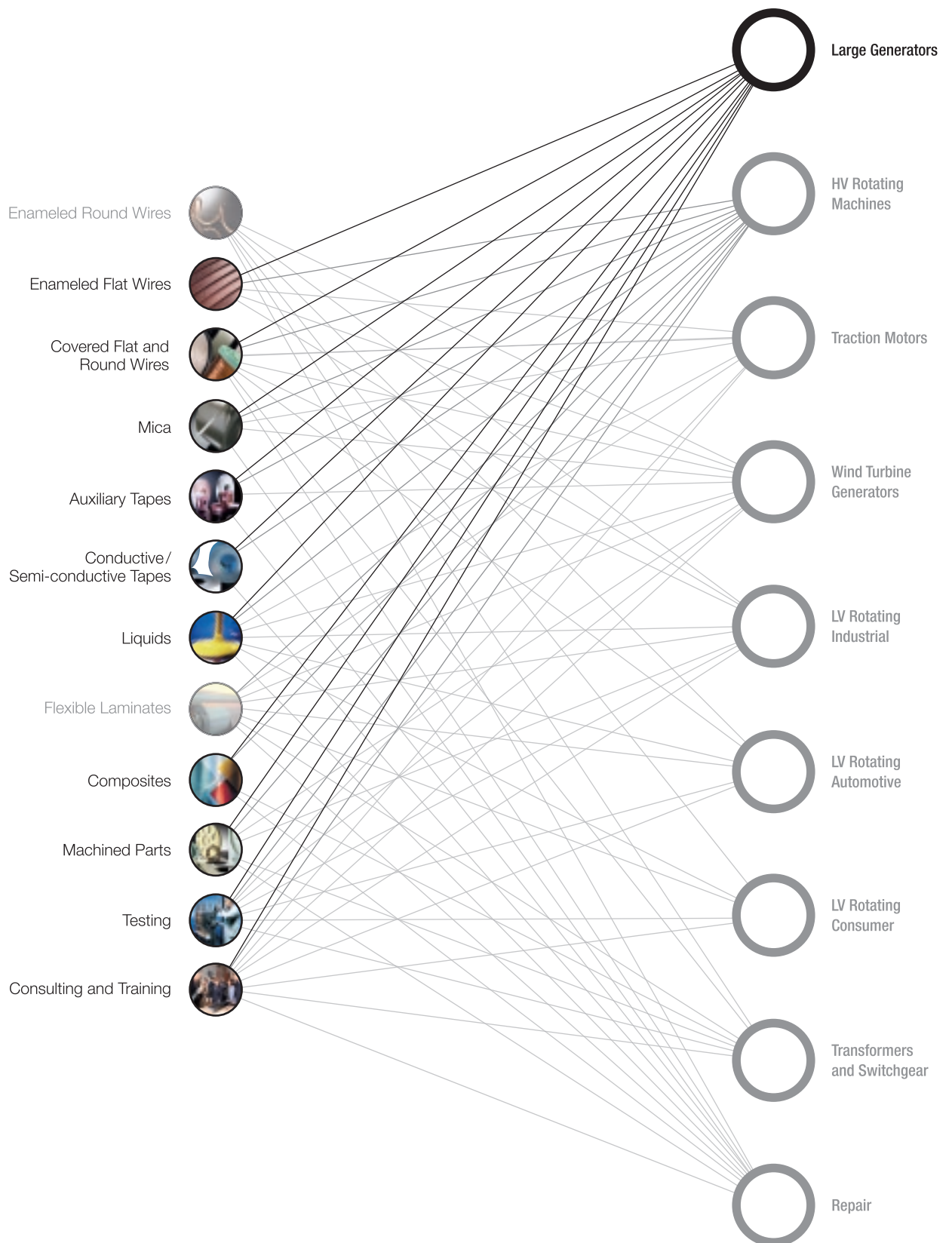
Von Roll has developed a full service solution for insulation systems and process technologies to accommodate these new challenges for turbo and hydro generators to meet our customers' global demand using both resin-rich (RR) and vacuum pressure impregnation (VPI) techniques.

Examples of such developments are:

- » High thermal conductivity main wall tapes (HTC) that enable higher performance through better thermal conductivity of the insulation
- » Fast-curing materials that substantially increase productivity
- » New generations of conductive tapes that are more stable against corona effects with time and considerably increase the life span of electrical machines



Our Products for Large Generators



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.



Conductors

Roebel bars in hydro and turbo generators need especially mechanically robust insulation at the crossover parts of the bars. Von Roll has developed yarn-covered enameled conductors with a high bonding strength that can be used on automatic Roebeling machines. The high thermal resistance of these rectangular yarn-insulated conductors makes them suitable for higher-temperature-operating class H generators.

Conductors are offered in a wide variety of dimensions. The table below shows the preferred materials for large generators:

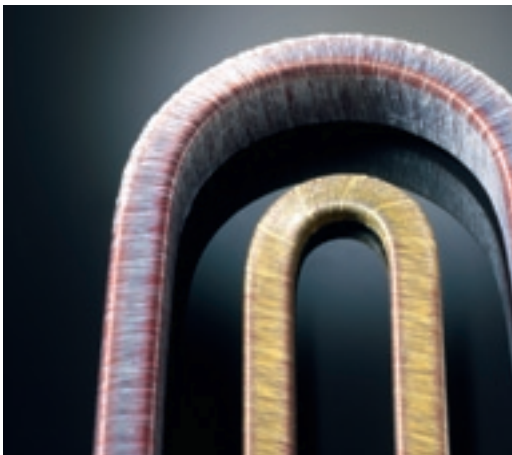
Product name	Rated voltage			Dimensions	Description
	<6 kV	6–13.8 kV	>13.8 kV		
Silix® on bare wire	•			On request	Glass-lapped wire with or without B-stage overcoat
Silix® on enameled wire	•	•	•	On request	
Daglas® on bare wire	•			On request	Daglas-lapped wire with or without B-stage overcoat
Daglas®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



Enameled rectangular wire covered with glass/polyester yarn blend (Daglas®).



Conductor stack with thermosetting-varnish-coated Daglas® wire.



Daglas® and Silix® wires for large generators.



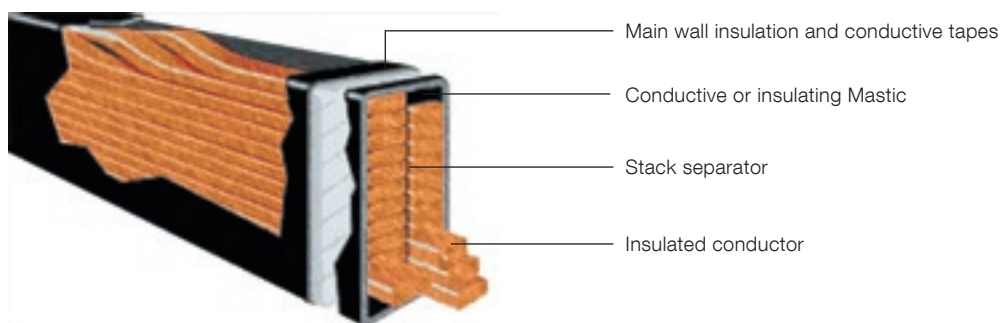
Spool with rectangular wire covered with Daglas®.



Stack Consolidation

Von Roll has developed state-of-the-art materials for stack consolidation:

Product name	Form	Thickness mm	Description
Glasoflex® 261.10-03	Tape	0.50	Impregnated glass fleece with high resin content for overhangs
Glasoflex® 371.62-02	Tape	1.00	Impregnated glass fleece/glass fabrics/glass fleece
Glasoflex® 371.27	Tape	0.85	Impregnated glass fleece/glass fabrics/glass fleece
Mastic 4356	Tape	On demand	Nonconductive Mastic in extruded tape form
Conductive Mastic 8004	Tape	On demand	Conductive Mastic in extruded tape form
Samica Mastic 362.01	Sheet	On demand	Nonconductive Mastic in sheet form



We have the right solutions you need to increase your productivity and efficiency. Our full range of fast-curing materials enables to halve processing time and reduce energy requirements.

Conventional

Fast Curing

» Curing conditions	60 min/150 °C	15 min/130 °C
» Shelf life (at 20 °C)	6 months	3 months
» Shelf life (at 5 °C)	9 months	9 months
» Thermal class	F	F

Recommended fast curing materials are:

Product name	Form	Thickness mm	Description
Glasoflex® 261.10-06	Tape	0.40	Impregnated glass fleece for overhangs
Glasoflex® 371.30	Tape	0.85	Impregnated glass fleece/glass fabrics/glass fleece
Fast-curing Mastic 4363	Mastic	On demand	Nonconductive Mastic in extruded tape form
Fast-curing Conductive Mastic 8019	Mastic	On demand	Conductive Mastic in extruded tape form



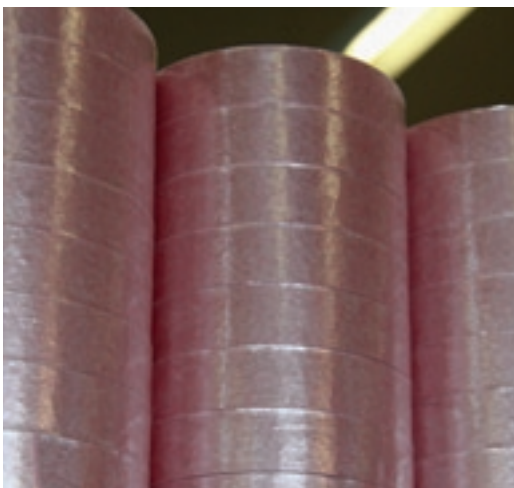
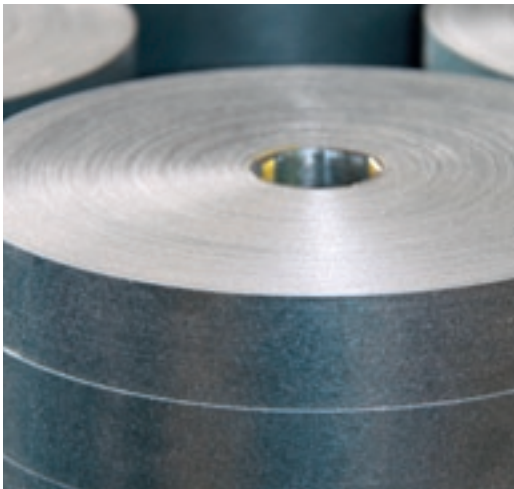
Main Wall Tapes for the VPI System

We are continually developing and advancing the quality and cost-effectiveness of high-voltage insulation for you. Effective solutions include insulation systems based on VPI (Vacuum Pressure Impregnation) as well as RR (Resin-Rich) processing systems.

With Samicapor®, Von Roll has designed a range of VPI mica tapes that fulfill the requirements of main wall and end-winding insulation. The resins associated with these tapes are listed under “VPI impregnation resins» and are described in detail in a separate brochure.

Our Samicapor® VPI mica tapes are the perfect choice, because they:

- » Have high dielectric strength
- » Resist corona discharge
- » Impregnate fast and easily
- » Retain resin without draining
- » Can be applied smoothly without creasing
- » Can be applied by machines or manually
- » Are fully compatible with a predefined resin system



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

The table below shows the preferred mica tapes for VPI applications:

Product name	Rated voltage			Thickness mm	Weight g/m ²		Composition	Composition Non-accelerated epoxy/ anhydride	Accelerated epoxy VPI system
	<6 kV	6 – 13.8 kV	>13.8 kV		Total	Mica			
Samicapor® 366.55-20	•	•	•	0.15	200	160	Mica/Glass	Yes	No
Samicapor® 366.55-30	•	•	•	0.15	200	160	Mica/Glass	Yes	No
Samicapor® 366.58	•	•	•	0.15	195	160	Mica/Glass	No	Yes
Samicapor® 366.58-18	•	•	•	0.15	213	180	Mica/Glass	No	Yes
Samicapor® 366.58-20	•	•	•	0.17	224	180	Mica/Glass	No	Yes
Samicapor® HTC 381.55-20	•	•	•	0.20	259	160	Mica/Glass	Yes	No

In addition, we have developed a special tape, mainly for indirectly cooled turbo generators, to expand the limits of power output. The Samicapor® HTC tapes can be applied like conventional mica tapes and have the following supplementary advantages to conventional tapes:

- » Increased thermal conductivity of the main wall insulation by a factor $\cong 2$ voltage
- » Increased endurance
- » Increased thermal and mechanical properties



Main Wall Tapes for the RR System

For optimum quality of the main wall insulation, careful selection of the micaceous tape and detailed attention to the way the tape is applied and processed are necessary. Von Roll has created a complete range of RR main wall insulation tapes and systems under the name of Samicatherm® for both conventional and hydrostatic pressing, and under the names of 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 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 dryer
Samicatherm® 366.28-05	•	•		0.19	265	120	Mica/Glass with embossed interleaving foil, slightly dryer
Samicatherm® 366.28-06	•	•		0.20	277	120	Mica/Glass without interleaving foil, 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

Generator main wall tapes for hydrostatic pressing:

Product name	Thickness mm	Weight g/m ²		Description
		Total	Mica	
Samicatherm® V 374.29	0.22	368	150	Glass/Mica/Polyester fleece tape
Samicatherm® V 374.30	0.21	173	60	Glass/Mica/Polyester fleece tape





Corona Protection

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

- » Conductive tapes
- » Semi-conductive tapes
- » Conductive mastics
- » 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.



Machine Winding and Bracing

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	Diameter mm	Description
Isocord® 151.10	Cord	From 1.8–50	Braided silane E glass yarn outside with staple glass filler
Isocord® 151.12	Cord	From 1.5–60	Braided polyester yarn outside with staple glass filler



Glass or glass polyester cords.



Composite Materials for Large Generators

Von Roll offers a variety of composite materials that can be delivered as U & L profiles, strips and sheets, machined parts or special components for use in different areas of large generators. The following are just a selection. Please ask our specialists about additional products.



High- and low-pressure laminates.



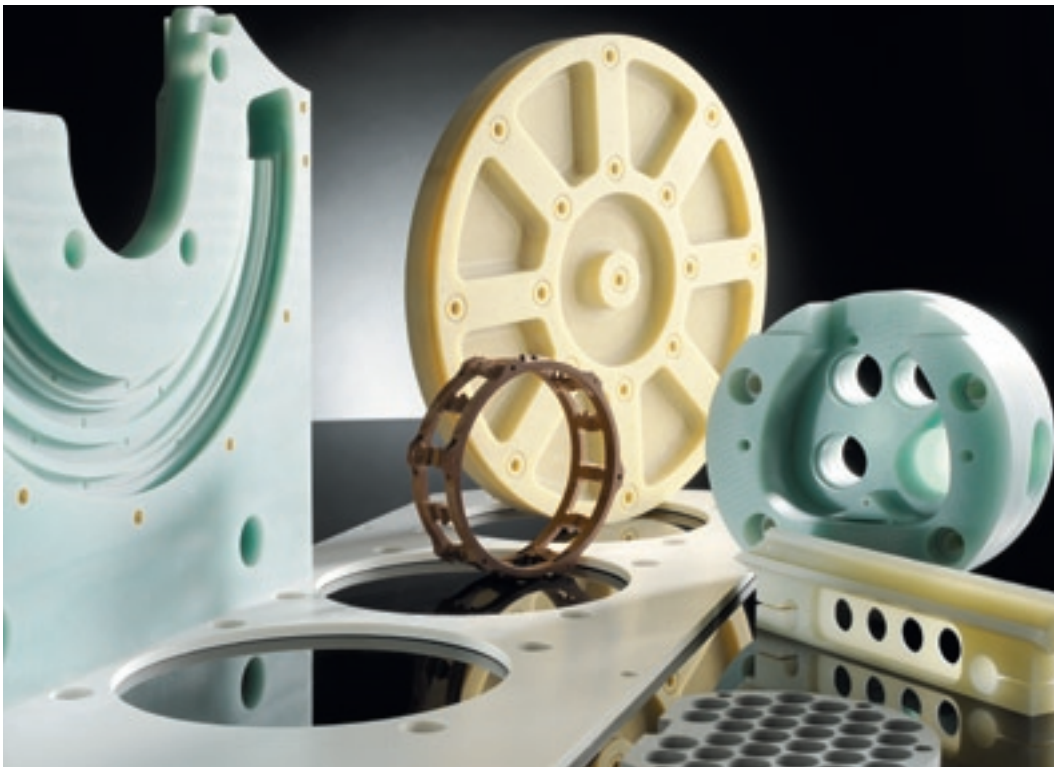
Long parts tailored to customer specifications.



Rotor Components

The following materials represent excellent choices for rotor components and their applications:

Product name	Form	Rated voltage			Slot insulation	Pole face packing	End-winding packing	Slot bottom packers	Bottom packers	Slot top packers	Interturn insulation
		< 6 kV	6–13.8 kV	>13.8 kV							
Vetronite® 64170/G11	U or L profile, machined components, strips, rolls or full-size sheet	•	•	•	•	•		•		•	•
Vetronite® 69020/64480	Machined parts, rolls or strips	•	•	•					•	•	•
Delmat® 68660	Machined components	•	•	•		•	•				
Delbond® 54000	Machined parts, rolls or strips	•	•	•							•
Polyfibrte® 63020	Machined components and strips	•	•	•			•	•			





Stator Components

The following materials represent excellent choices for stator components and their applications:

Product name	Form	Rated voltage			Top slot wedging	End caps	Slot wedges	Support brackets
		<6 kV	6–13.8 kV	>13.8 kV				
Vetronite® 64170/G11	Machined parts or full-size sheet	•	•	•			•	
Conductive Vetronite® 432.10	Machined parts or full-size sheet	•	•	•			•	
Delmat® 68660	Machined parts or full-size sheet	•	•	•			•	•
Delmat® 68420	Machined parts or full-size sheet	•	•	•			•	
Conductive and nonconductive ripple springs	Strips or full size-sheets	•	•	•	•		•	
Vetroferrite® 432.20/432.21	Molded parts	•	•	•		•		



VPI Impregnation Resins

Von Roll has developed a variety of high-performance resins that meet expected electrical and mechanical characteristics when cured for hydro and turbo generators. The factors that influence the final choice of resin used 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
- » Mechanical properties
- » Thermal conductivity
- » Continuous and maximum peak operating temperature

Our high-performance resins are described in detail in a separate brochure. The following represent a selection:

Product	Type	Thermal class	Rated voltage			Impregnation temperature	Curing process	Description
			< 6 kV	6–15 kV	15–22 kV			
Damisol® 3313	Epoxy modified/Polyester-imide	180 (H)	•	•		23 °C	8 h at 150 °C	One component room temperature impregnating resin with high thermal properties and excellent bonding power
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 tapes 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.

Selection table	Color	Rated voltage			Thermal class	Drying time	Comments on products and use
		< 6 kV	6–15 kV	<15–22 kV			
Damicoat® 2404	N/RB/G	•	•		155 (F)	15–20 h	Highly chemically resistant overcoat varnish
Damicoat® 2407	RB	•	•		155 (F)/180 (H)	1–2 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. Von Roll HV laboratories can test their 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

Customer Service

Europe

Von Roll Schweiz AG

Passwangstrasse 20

4426 Breitenbach

Switzerland

P +41 61 785 5111

F +41 61 785 5188

Asia/Pacific

Von Roll Asia Pte Ltd.

6 Serangoon North Avenue 5 #03-01

Singapore 554910

Singapore

P +65 6556 4788

F +65 6556 4959

Americas

Von Roll USA, Inc.

200 Von Roll Drive

Schenectady

NY 12306

USA

P +1 518-344-7100

F +1 518-344-7288

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.