Insulating Systems for the Motor Repair Industry
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 the electro-technical industry.

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 and efficient 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, the premier supplier of electrical insulating materials to the electrical rotating equipment industry, has developed, tested, manufactured and delivered materials that are specially designed for use in electric motors and generator manufacturing and repair.

This product and application overview represents just a few of our most popular products, but it should serve as a useful guide for most basic applications.

Our insulating systems for motors and generators include the following materials:

» Magnet Wire
» Slot and Phase Insulation
» Mica Tape
» Corona Tape
» Mica Splittings and Tubes
» Support Materials
» Resins and Varnishes
» Kits and Compounds
Our Products for Motor Repair

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.
Insulating Systems for the Motor Repair Industry

Von Roll Austral specializes in the rapid delivery of copper rectangular magnet wires, both enameled and covered. Also offered are unique insulations to provide improved performance and to optimize motor and generator designs.

Rectangular wire is available in sizes ranging from as thin as 0.020” to as wide as 0.700”; 2- to 3-day delivery is available for most constructions.

<table>
<thead>
<tr>
<th>Product name</th>
<th>Thermal class</th>
<th>Composition</th>
<th>Special properties</th>
</tr>
</thead>
</table>
| HPAM               | 200°C         | Polyester enameled rectangular MW-36C | – Excellent thermal and chemical properties  
 – Suitable for windings that are subjected to constantly high temperatures and mechanical stress |
| HDT-3000®          | 200°C         | Polyester enameled rectangular MW-36C | – 100% in-line testing  
 – HDT-3000 enameled wire exceeds the NEMA-MW-36C volt requirement |
| Austraflex®        | 220°C         | Glass over enameled or bare rectangular conductor MW-46C | – A unique Daglas® insulation for AC and DC field coils |
| Austravolt®        | 200°C         | Mica covered over rectangular enameled or bare conductor | – The ultimate in conductors for high-voltage machines  
 – Excellent voltage endurance characteristics without additional turn tap |
| Polyimide HML      | 220°C         | Polyimide enameled rectangular NEMA-MW-20C | – Polyimide heavy and quadruple enameled rectangular wire |
| Polyimide          | 240°C         | Polyimide taped rectangular NEMA-MW-62C | – Induction and radiant heat-fused polyimide film  
 – Suitable for windings that are subjected to high-temperature applications |

Others
Standard enamel-, film-, paper- and glass-covered wires are, of course, also available with very rapid delivery and unexcelled quality and customer service.
Mica Mat® Tapes and Wrappers

Mica is an excellent insulator that is commonly used in formed coil and field coil applications. The commitment of Von Roll to mica is unique, starting with mining of the raw mica followed by production of paper and mica tapes. With literally hundreds of styles and sizes available, Von Roll is the world leader in the design and production of mica tapes with many options available for almost all applications. For the repair market, these are the styles most popular in the shop. For other applications, please contact your Von Roll representative.

<table>
<thead>
<tr>
<th>Product name</th>
<th>Thermal class</th>
<th>Nominal finished thickness</th>
<th>Binder</th>
<th>Application suggestions</th>
</tr>
</thead>
</table>
| Mica Mat® 77956 | 155 °C | 0.006 | Polyester | – Industry standard for dip and bake coil applications  
– The tape of choice for VPI processing with polyester resins containing DAP monomers |
| Mica Mat® 77877 | 155 °C | 0.007 | Epoxy | – Our premier VPI tape with new technology to provide a flexible tape  
– Excellent voltage-endurance properties  
– Compatible with most epoxy and polyester VPI resins used in the motor repair industry |
| Mica Mat® 77986 | 155 °C | 0.007 | Epoxy | – An industry standard for many years  
– Compatible with most epoxy and polyester VPI resins used in the motor repair industry |
| Mica Mat® 2473XS | 155 °C | 0.007 | Polyester | – A fully cured four-ply tape offering additional thickness while remaining very flexible  
– Recommended for VPI systems using resins with a DAP monomer |
| Mica Mat® 77984 | 155 °C | 0.0085 | Solventless epoxy | – This three ply B-staged tape is used to manufacture formed coils where VPI processing is not available  
– Useful in the shop for insulating connections |
| Mica Mat® 77676 (2490XS) | 155 °C | 0.0065 | Epoxy | – Very flexible 2 ply mica main wall tape ideal for VPI applications. Mica weight 180 gr/m² |
| Mica Mat® 77675 (2537XS) | 155 °C | 0.0065 | Epoxy | – Very flexible 2 ply mica main wall tape ideal for VPI applications. Mica weight 160 gr/m² |

Von Roll’s commitment to mica starts with mining and stops with the production of mica taped wires.
Corona Protection

Anytime voltages are high enough to generate partial discharge or corona, semi-conductive materials are needed to manage the discharge without damaging the insulation. Von Roll offers several styles of tapes and paints that can be used to safely control destructive voltages. These products are generally used for designs of 6 kV and above, but are sometimes useful in improving the life of 4 kV machines in inverter-driven applications.

<table>
<thead>
<tr>
<th>Product name</th>
<th>Nominal thickness</th>
<th>Color</th>
<th>Special properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronashield® 215</td>
<td>4 mils</td>
<td>Black</td>
<td>– Coated polyester tapes in the 200–1000 ohm/sq range used in slot sections motor or generator to prevent corona discharge</td>
</tr>
<tr>
<td>Coronashield® 217</td>
<td>9 mils</td>
<td>Gray</td>
<td>– Variable resistance (grading) tapes used to safely discharge voltages on the extensions or overhangs of coils – Several styles available</td>
</tr>
<tr>
<td>Coronashield® 8001 Paint</td>
<td>Gray</td>
<td></td>
<td>– Gray paint loaded with semi-conductive particles useful in repairing damaged grading on extensions or overhangs of high-voltage coils. Dries in 15–30 minutes; tack-free</td>
</tr>
</tbody>
</table>

Coronashield® conductive and semi-conductive tapes.
Slot and Phase Insulation

In random mush-wound motors, as well as some form-wound designs, a high-quality slot liner is the principal guarantee of a long electrical life of the machine. Von Roll offers a very wide range of flexible laminates and coated cloths for any application. All of the flexible laminates are available in 2, 3, 4 or more plies, and most coated materials are available with glass or Daglas® substrates.

<table>
<thead>
<tr>
<th>Product name</th>
<th>Thermal class</th>
<th>Description</th>
<th>Application suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acuflex® DMD</td>
<td>155 °C</td>
<td>Nonwoven polyester mat bonded to both sides of an electrical grade polyester film</td>
<td>Preferred choice in hand-winding applications</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Industry standard for class F designs</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- Available in either 70% or 100% saturated</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- 70% allows for improved resin absorption</td>
</tr>
<tr>
<td>Acuflex® NMN</td>
<td>180 °C</td>
<td>Aramid fiber paper bonded to both sides of an electrical grade polyester film</td>
<td>Aramid paper-based flexible laminates available in a wide range of constructions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Used where high-reliability performance is required</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Also available with polyimide film for high-temperature applications</td>
</tr>
<tr>
<td>Thermal H®</td>
<td>180 °C</td>
<td>Polyester-coated glass cloth with or without an acrylic pressure-sensitive adhesive on one side</td>
<td>Used as slot liners or phase cloth where extreme flexibility is required</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Excellent electrical, mechanical and conformability properties</td>
</tr>
<tr>
<td>Fusa-Flex®</td>
<td>155 °C</td>
<td>Flexible B-stage epoxy resin on Daglas® cloth</td>
<td>Used as core insulation on field coils as bolt insulators and repairing tubes</td>
</tr>
<tr>
<td>Fusa-Fab®</td>
<td>155 °C</td>
<td>Flexible B-stage polyester resin on Daglas® cloth</td>
<td>When properly applied it results in a watertight sealed coil with outstanding electrical strength for use where VPI is not available</td>
</tr>
<tr>
<td></td>
<td>180 °C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Support Materials

Made of 100% electrical grade glass yarns with B-staged resins, Von Roll Poly Glas® banding tapes and ropes are manufactured to provide excellent mechanical strength for supporting structures against rotational forces as well as surge inrush currents on startup. These products are normally fully cured before resin treatment, so compatibility is assured with most dip or VPI resins.

<table>
<thead>
<tr>
<th>Product name</th>
<th>Thermal class</th>
<th>Size range</th>
<th>Application suggestions</th>
</tr>
</thead>
</table>
| Poly Glas® 76870 | 220 °C        | 1/4–1” (20–80 ends) | A 220°C banding tape used in supporting traction and industrial DC armatures
|                  |               |                     | Also used for tying AC stators where maximum support is needed                           |
| Poly Glas® 76831 | 155 °C        | 1/4 – 1” diameter   | Used in conjunction with blocking and tie cords, creating a rigid support for motor and generator windings and end turns during startup and load changes. |
| Poly Glas® 76881 | 155 °C        | 1/4 – 1” diameter   | Lower temperature cure tape can be used when baking ovens are not available or when thermal sensitive materials are used |
Mica Splittings and Tubes

Sheet materials, plates and tubes made from traditional mica splittings or mica paper laminates provide excellent mechanical strength and unsurpassed electrical performance for the most extreme applications of heat and voltage stress. Special splitting tapes are also available where coil designs require their unique properties.

Molding Plates
Made with high-grade mica splittings and a variety of resins, these flexible sheets can be shaped or molded to specific configurations, then heat-cured for mechanical stability. They are useful in DC armature insulation as well as many other uses in the shop.

Segment Plates
These rigid plates, made from either mica splittings or laminated mica papers, are useful in commutator manufacturing and for mechanical machined parts where glass-based composites are not adequate. Available with modified alkyd, epoxy or inorganic binders.

Tubes
Made from either mica splittings or paper, fully cured tubes can be quickly constructed to virtually any ID or OD. They are very resistant to high temperatures and mechanical forces and are useful as bolt insulators, shaft insulators and as resistor grid components.
Permafil® varnishes and resins have been used for manufacturing and repairing motors and generators for over 100 years and have broad acceptance among repair companies expecting the highest in quality and performance. Available in different chemistries, there is a product for almost any application that requires high quality and performance.

<table>
<thead>
<tr>
<th>Product name</th>
<th>Thermal class</th>
<th>Chemistry</th>
<th>Flash point °F</th>
<th>Special properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permafil® 9637</td>
<td>220°C</td>
<td>Solvent polyester</td>
<td>88</td>
<td>General purpose polyester varnish for motors and transformers in dip tanks</td>
</tr>
<tr>
<td>Permafil® 74043</td>
<td>155°C</td>
<td>Solvent epoxy</td>
<td>88</td>
<td>General purpose epoxy varnish for motors and hermetic motors in dip tanks</td>
</tr>
<tr>
<td>Permafil® 1217</td>
<td>180°C</td>
<td>Solvent polyester</td>
<td>88</td>
<td>Fast RT curing polyester varnish for general purpose applications</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Available in clear, red or yellow</td>
</tr>
<tr>
<td>Permafil® 712/716</td>
<td>220°C</td>
<td>Solventless polyester</td>
<td>200/132</td>
<td>These two polyester resins use a DAP monomer allowing for excellent room temperature stability</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Permafil 716 contains a blend of monomers allowing it to be used in a dip or VPI application</td>
</tr>
<tr>
<td>Permafil® 707/724</td>
<td>220°C</td>
<td>Solventless polyester</td>
<td>132</td>
<td>707 sets the standard for performance in high-vibration and high-temperature applications</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>Used in many VPI tanks</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>An excellent choice for repair shops that support the steel and mining industries</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>724 is a general purpose resin used in industrial and commercial applications</td>
</tr>
<tr>
<td>Permafil® 74041</td>
<td>180°C</td>
<td>Solventless epoxy</td>
<td>200</td>
<td>High-performance resin for general purpose industrial and mining motors in VPI applications</td>
</tr>
<tr>
<td>Permafil® 74050</td>
<td>220°C</td>
<td>Solventless epoxy</td>
<td>132</td>
<td>High-performance resin used in high-voltage insulation systems</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>When used with the proper mica tapes this insulation system can be used for motors and generators up to 18 kV</td>
</tr>
<tr>
<td>Product name</td>
<td>Thermal class</td>
<td>Chemistry</td>
<td>Flash Point °F</td>
<td>Special properties</td>
</tr>
<tr>
<td>------------------</td>
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</tr>
</tbody>
</table>
| Synthite® AC-41  | 155 °C        | Solvent polyurethane  | 81             | - High-temperature, fast-cure, air-dry polyurethane varnish with excellent circuit board-coating properties  
|                  |               |                       |                | - Available in aerosol                                                                                   |
| Synthite® AC-43  | 155 °C        | Solvent polyester     | 81             | - High-temperature, fast-cure, air-dry polyester varnish                                              
|                  |               |                       |                | - Perfect for dip, spray or brushing                                                                   |
|                  |               |                       |                | - Air-dries in 1 hour or can be baked to speed-cure                                                   |
| Synthite® AC-46  |               | Solvent polyurethane  | 81             | - Air-dry polyurethane that has excellent moisture and fungus resistance                               
|                  |               |                       |                | - Available in aerosol spray                                                                         |
| Hi-Therm® BC-346A| 220 °C        | Solvent polyester     | 88             | - High-temperature varnish used in a wide range of dip and bake applications                          |
| Hi-Therm® BC-352 | 200 °C        | Solvent epoxy         | 88             | - Excellent dipping varnish used for motors exposed to moisture and harsh environments or hermetic applications |
| Dolphon® CC-1105 | 220 °C        | Solventless polyester | >200           | - High-flash, high-bond solventless polyester resin which provides excellent storage at room temperature |
| XL®-2103         | 220 °C        | Solventless polyester | >200           | - Low-odor, high-flash very low VOC solventless polyester resin. Formulated for high build in dip and bake applications |
| Synthite® ER-41/EB-41 |            | Solvent polyurethane  | 81             | - Red or black high-temperature, fast-cure, air-dry varnish, used as an insulator coating               
|                  |               |                       |                | - Both are available in aerosol spray                                                                           |
| Aqua-Therm® BC-379|               | Water borne epoxy     | >200           | - High bond strength                                                                                   
|                  |               |                       |                | - Excellent coverage                                                                                   
|                  |               |                       |                | - Low VOC/No HAPS                                                                                       
|                  |               |                       |                | - Excellent tank stability                                                                             |
## Kits and Compounds

Often, repairing electric motors and generators for special applications requires many specialty compounds, potting materials and top coats. Here are just a few of the materials available from Von Roll.

<table>
<thead>
<tr>
<th>Product name</th>
<th>Chemistry</th>
<th>Flash point °F</th>
<th>Gel time</th>
<th>Main characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permafil® 704</td>
<td>Polyester</td>
<td>132</td>
<td>3 – 4 h at 25 °C</td>
<td>Two-component pour-through resin for general purpose motors</td>
</tr>
<tr>
<td>Permafil® 74036</td>
<td>Epoxy</td>
<td>200</td>
<td>15 min at 40 °C</td>
<td>Two-component pour-through resin for general purpose motors</td>
</tr>
<tr>
<td>Permafil® 74010A/74010</td>
<td>Epoxy</td>
<td>200</td>
<td>2 – 4 h at 25 °C</td>
<td>High-performance two-component clear coating for spray or flooding applications</td>
</tr>
<tr>
<td>Permafil® 74115</td>
<td>Epoxy</td>
<td>200</td>
<td>Single part</td>
<td>Thixotropic wet winding compound for DC pole-wound coils</td>
</tr>
<tr>
<td>Permafil® 277</td>
<td>Krytox® 1)</td>
<td>55</td>
<td>Single part</td>
<td>Masking compound for use on surfaces where adhesion of a cured resin is not desired</td>
</tr>
<tr>
<td>Dolphon® CB-1069</td>
<td>Epoxy</td>
<td>200</td>
<td>R/T cure</td>
<td>General purpose, high thermal conductivity black epoxy casting compound for use in all types of electrical assemblies</td>
</tr>
<tr>
<td>Dolphon® CB-1078</td>
<td>Epoxy</td>
<td>200</td>
<td>R/T cure</td>
<td>Black epoxy compound for use in all electrical assemblies – Also used to cast end windings of wind generators and induction heaters</td>
</tr>
<tr>
<td>Dolphon® CB-1109</td>
<td>Polybutadiene</td>
<td>200</td>
<td>R/T cure</td>
<td>Two-part low-viscosity polybutadiene compound – Can be used for potting, casting and coating electrical apparatus</td>
</tr>
<tr>
<td>Dolphon® CB-1128</td>
<td>Polybutadiene</td>
<td>200</td>
<td>R/T cure</td>
<td>Two-part flexible black polybutadiene compound formulated for motor and generation encapsulation – Excellent for high abrasion and moisture environments</td>
</tr>
<tr>
<td>Dolphon® CC-1120</td>
<td>Polybutadiene</td>
<td>200</td>
<td>R/T cure</td>
<td>Low viscosity – Clear compound for potting coils and transformers – Easily repaired</td>
</tr>
<tr>
<td>Dolphon® CR-1034-H</td>
<td>Epoxy</td>
<td>200</td>
<td>R/T cure</td>
<td>Two-part semi-rigid epoxy compound specifically formulated for encapsulation by “buttering” on electric motors</td>
</tr>
</tbody>
</table>

1) Registered trademark of DuPont de Nemours.
Testing and Laboratory Systems

Von Roll has specialized low-voltage application system testing labs that are focused on client needs and requirements. We can process customer parts in the lab by dipping, trickle, roll-through, vacuum-aided dipping or VPI processing methods to produce prototype parts.

We customize systems for customers and offer the following tests:

» Full system testing
  – Long term thermal aging
  – Motorette testing
  – Formette testing

» Chemical compatibility testing
  – Short-term component aging (sealed-tube test)

» Component thermal aging
  – Twisted pair testing (TP)
  – Helical coil bond strength testing (HC)

Our Lab in Schenectady, NY is capable of performing insulation materials and systems testing to ASTM, IEEE, IEC and UL standards.
Resin and Varnish Analysis Program

At Von Roll, our focus is always on customer satisfaction and long-term relationships forged in the industry, based in part on the technical support we offer before, during and after the decision to purchase has been made. An example of this is our unique, pro-active resin analysis program, designed to promote regular testing and adjustment, if required, of resins and varnishes at our many installations at both manufacturing and repair facilities. The periodic testing of resin properties ensures manufacturing consistency yielding predictable results. An added benefit is the peace of mind that comes from the knowledge that your resin or varnish is safe and stable. The provided shipping kits and friendly reminders help keep your testing on a regular schedule, and all required adjusters are shipped directly from the factory, assuring prompt delivery and fresh material.

Basic stability tests – viscosity, gel time, moisture content, liquid and cured appearance – are performed free of charge. Additional testing such as film build, dielectric strength and helical coil bond strength is available for a nominal charge. All of this is to keep your facility producing good machines every day. Join the many Von Roll customers who have secured their investment through timely analysis, feedback and recommendations from Von Roll on keeping their tanks stable.

Laboratory Services

» Insulation materials and systems testing to ASTM standards
» NEMA-RE-2 resin compliance testing
» High-voltage testing
» IEEE 1043 voltage-endurance testing
» IEEE 1776 systems performance testing
» Partial discharge evaluation and testing
» US Army Corps of Engineers qualified testing
» Accelerated testing capabilities
» Thermal conductivity testing
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.

» Development and applications support
» Systems consulting and development
» Evaluation of systems/systems development
» Systems engineering consulting
» Plant design evaluation and consulting services

» On-site applications and engineering support
» Resin and varnish analysis program
» Development of testing protocols
» VPI processing of sample bars, coils and units
» Materials and resin prototype development
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.

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

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

Liquids
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. They can be molded, machined or semi-finished.

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

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

Water and wastewater treatment
Von Roll BHU provides solutions for process engineering tasks in the field of water and wastewater management.

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

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

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About us
We Enable Energy – As one of Switzerland’s longest-established industrial companies, Von Roll focuses on products and systems for electrical power generation, power transmission 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. Other activities of Von Roll include solutions for process engineering tasks in the field of water and wastewater management.