Micafil High Voltage Insulation Components
Cast Epoxy Insulators made of Fluvex® Cast Resin Systems
Outstanding versatility
Micafil can offer a large number of cast epoxy resin systems suitable for almost any electrical insulation specification. Epoxy systems filled with Al₂O₃ enable Gas Insulated Switchgear to withstand corrosive SF₆ decomposition products. In addition, the insulation components are able to meet challenging specifications regarding mechanical stress even at high service temperatures. As an alternative, epoxy systems filled with silica are used in non-corrosive environments, for instance for cable sealing ends. And as a specialty, Micafil’s semiconductive epoxy system is applied to create functional field-control electrodes directly casted into the insulation. The manufacturing technology is based on either Vacuum Casting or Automated Pressure Gelation. These process technologies assure:
- net shape casting
- void-free insulation
- excellent adhesion to metallic inserts
- low process-induced mechanical stresses within the components

Therefore, Micafil is in a position to produce insulation components meeting excellent quality standards especially with regards to:
- partial discharge
- gas-tightness
- mechanical burst strength
A wealth of creative ideas and solid expertise has made Micafil the preferred partner of the electrical industry for more than 90 years. Micafil is unique in its breadth of expertise which extends from bushings to vacuum plants and insulation components. As a result of a very close collaboration with the ABB Corporate Research Centre, Micafil has built up thorough expertise regarding material technology as well as manufacturing processes. Micafil’s high-quality insulation components for high voltage applications (up to 1000 kV) are used as barrier and support insulators in Gas Insulated Switchgear (GIS), in Generator Circuit Breakers (GCB) and in high voltage cable joints and sealing ends. Micafil offers extended support regarding all aspects of material and process technology for cast epoxy resin systems. New product developments of our customers can be accelerated using advanced tools such as Finite Element Analysis (FEM) for mechanical and electrical analysis as well as other simulation tools for the analysis of the curing behavior of the epoxy system.

**Gas Insulated Switchgear (GIS)**
Micafil combines its extensive knowledge regarding material technology with advanced process engineering skills to produce GIS insulators with outstanding mechanical and electrical properties for voltage levels up to 1000 kV.

**Generator Circuit Breakers (GCB)**
Micafil’s insulators for power generation plants with outputs up to 1000 MW meet maximum security standards and have a long reliable service life of about 30 years. The insulators are designed for short-circuit currents up to 2500 kA and for creep strength at high temperatures.

**Cable accessories**
Based on customer-specific designs, Micafil produces and supplies insulators for cable accessories to several major high voltage cable manufacturers.
Vacuum Casting Process (VCP)
The resin is premixed in batch mixers and finally mixed in a static mixer. The resin passes directly from the static mixer through the casting valve into an aluminum or steel mold placed inside the vacuumized casting chamber.

After the casting process, the molds are transferred into a separate gelling oven where the first part of the crosslinking reaction takes place.

Afterwards, the insulator is demolded and then cured in a hardening oven for several hours.

Automatic Pressure Gelation (APG)
The APG process permits short cycle times thanks to rapid gelation and demolding with automatic opening and closing of a steel mold. This results in a reduction of process steps and hence time and costs.

One central mixing and metering system can serve several clamping machines. Each clamping machine has its own static mixer and also has its own shrinkage compensation unit to maintain the pressure.

After preparing and mixing in batch mixers, the degassed cast resin compound is injected under pressure from below into the APG mold that is fixed on a clamping unit.

During the gelling process, fresh material is supplied continuously to the mold under pressure in order to prevent cracks and voids and to compensate for the shrinkage of the material.

Afterwards, the insulator is demolded and then cured in a hardening oven for several hours.
In order to ensure a high and consistent quality level, the inserts are prepared shortly before using them in the casting process.

**Washing and sandblasting**
The surface of the inserts must be free of contamination (like grease, dust, etc.). To get an optimal result during adhesion, washing is performed before and after sandblasting.

A combined inversion/ultrasonic cleaning step, followed by a vapor phase cleaning step in a completely closed process, ensures that the inserts are as clean as possible.

Sandblasting enlarges and activates the surface of the inserts remarkably. This results in optimum adhesion between insert and resin. In addition, sandblasted surfaces are more error tolerant than when using other surface-activation methods and up to today yield the best properties.

**Quality**
Quality assurance on a high level is one of Micafil’s driving forces.

The Quality Assurance department has all the means as well as skilled personnel to perform critical material and component tests to guarantee the mechanical, electrical and physical parameters specified for the respective product.

All raw materials as well as the finished products are subject to thorough inspections.
FLUVEX® Cast Resin Systems
For medium and high voltage engineered solutions/products

General purpose
FLUVEX® cast epoxy resins are specifically developed casting systems for electrical applications. A number of different standard formulations meet the high demands on epoxy castings. In addition to the standard systems, Micafil’s engineering department is well prepared to offer you customized systems. With our long experience in epoxy resin applications we can guarantee our customers the best possible solution for their epoxy castings. Up-to-date laboratories and testing equipment as well as strict quality control procedures throughout manufacturing, from the raw material to the finished component, guarantee the constant quality and security of our products.

Applications
FLUVEX® cast resin components have been giving excellent service in a wide variety of electrical systems up to a rating of 1000 kV for many years. FLUVEX® cast resins, such as for spacers, bushings or cable end terminations, are widely used in medium and high voltage Gas Insulated Switchgear all over the world. In the field of cable accessories, many FLUVEX® cast resin components are utilized. Micafil’s expertise in epoxy castings ensures components free of voids and partial discharges.
## Technical Data

<table>
<thead>
<tr>
<th>Properties</th>
<th>Standards</th>
<th>Units</th>
<th>Fluvox® 1402</th>
<th>Fluvox® 1441</th>
<th>Fluvox® 1443</th>
<th>Fluvox® 1444</th>
<th>Fluvox® 1447</th>
<th>Fluvox® 1448</th>
<th>Fluvox® 1450</th>
<th>Fluvox® 1451</th>
<th>Fluvox® 1462</th>
<th>Fluvox® 1463</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color (natural)</td>
<td>approx. RAL 70 13, approx. RAL 10 14</td>
<td></td>
<td>ivory±</td>
<td>ivory±</td>
<td>black</td>
<td>brown-grey±</td>
<td>brown-grey±</td>
<td>brown-grey±</td>
<td>grey</td>
<td>ivory±</td>
<td>brown-grey±</td>
<td>ivory-yellow</td>
</tr>
<tr>
<td>Density</td>
<td>ISO 1183, DIN 53479</td>
<td>g/cm³</td>
<td>2.1</td>
<td>2.1</td>
<td>1.7</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>2.3</td>
<td>2.0</td>
<td>1.9</td>
<td>2.1</td>
</tr>
<tr>
<td>Filler</td>
<td></td>
<td></td>
<td>Al₂O₃</td>
<td>Al₂O₃</td>
<td>SiO₂</td>
<td>SiO₂</td>
<td>SiO₂</td>
<td>SiO₂</td>
<td>Al₂O₃</td>
<td>SiO₂</td>
<td>Al₂O₃</td>
<td></td>
</tr>
<tr>
<td>Tensile strength</td>
<td>DIN EN ISO 527</td>
<td>MPa</td>
<td>70</td>
<td>45</td>
<td>&gt; 40</td>
<td>75</td>
<td>65</td>
<td>70</td>
<td>65</td>
<td>70</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Flexural strength</td>
<td>DIN EN ISO 178</td>
<td>MPa</td>
<td>140</td>
<td>60</td>
<td>–</td>
<td>110</td>
<td>100</td>
<td>110</td>
<td>110</td>
<td>120</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>Flexural modulus of elasticity</td>
<td>DIN EN ISO 178</td>
<td>GPa</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>11</td>
<td>8.5</td>
<td>8</td>
<td>–</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Charpy impact strength</td>
<td>DIN EN ISO 179</td>
<td>kJ/m²</td>
<td>2.2</td>
<td>1.6</td>
<td>–</td>
<td>1.4</td>
<td>1.7</td>
<td>1.7</td>
<td>1.5</td>
<td>–</td>
<td>1.8</td>
<td>2.2</td>
</tr>
<tr>
<td>Glass transition temperature</td>
<td>IEC 1006</td>
<td>°C</td>
<td>120</td>
<td>120</td>
<td>150</td>
<td>155</td>
<td>150</td>
<td>120</td>
<td>130</td>
<td>145</td>
<td>120</td>
<td>125</td>
</tr>
<tr>
<td>Coefficient of thermal expansion (CTE)</td>
<td>DIN 52328</td>
<td>10⁻⁷/K</td>
<td>35</td>
<td>35</td>
<td>38–40</td>
<td>35</td>
<td>38</td>
<td>35</td>
<td>–</td>
<td>35</td>
<td>–</td>
<td>35</td>
</tr>
<tr>
<td>Relative permittivity ≥ 50 Hz</td>
<td>IEC 250 / 53483</td>
<td></td>
<td>6.5</td>
<td>5.5</td>
<td>–</td>
<td>3.2</td>
<td>4.0</td>
<td>3.2</td>
<td>5.5</td>
<td>6.0</td>
<td>3.5</td>
<td>5.7</td>
</tr>
<tr>
<td>Dissipation factor tan ≥ 350 Hz</td>
<td>IEC 250 / 53483</td>
<td>%</td>
<td>1</td>
<td>1</td>
<td>–</td>
<td>0.5</td>
<td>3.5</td>
<td>0.6</td>
<td>2.8</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Volume resistivity</td>
<td>IEC 93</td>
<td>Ω cm</td>
<td>10¹⁰</td>
<td>10¹³</td>
<td>4 x 10¹⁰</td>
<td>10¹⁵</td>
<td>10¹¹</td>
<td>10¹⁵</td>
<td>10¹⁵</td>
<td>10¹⁵</td>
<td>10¹⁵</td>
<td>10¹⁵</td>
</tr>
<tr>
<td>Surface resistivity</td>
<td></td>
<td>Ω</td>
<td>10¹⁰</td>
<td>10¹³</td>
<td>–</td>
<td>10¹⁵</td>
<td>10¹³</td>
<td>10¹⁵</td>
<td>10¹³</td>
<td>10¹⁵</td>
<td>10¹³</td>
<td>10¹³</td>
</tr>
<tr>
<td>Comparative tracking index CTI (solution A)</td>
<td>DIN IEC 112</td>
<td>CTI</td>
<td>600</td>
<td>600</td>
<td>–</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Fluvox® resin systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1402</td>
<td>Solid resin: Bisphenol-A-based epoxy resin</td>
<td>Solid hardener: Phthalic acid anhydride hardener</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1441, 1442, 1443, 1444, 1447, 1448, 1451, 1462</td>
<td>Liquid resin: Bisphenol-A-based epoxy resin</td>
<td>Liquid hardener: Carbonic acid anhydride hardener</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1450</td>
<td>Liquid resin: Cycloaliphatic epoxy resin</td>
<td>Liquid hardener: Anhydride hardener</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Micafil cast epoxy insulators combine best-in-class quality with superior production know-how using state-of-the-art Vacuum Casting and Automated Pressure Gelation.

We serve numerous world-class suppliers of high voltage apparatus such as:
- Gas Insulated Switchgear (GIS)
- Generator Circuit Breakers (GCB)
- Cable Joints and Sealing Ends

ABB Switzerland Ltd
High Voltage Components
Badenerstrasse 780
CH-8048 Zurich, Switzerland
Phone +41 (0)58 586 03 33
Fax +41 (0)58 586 03 01
info.micafil@ch.abb.com

www.abb.com/insulation