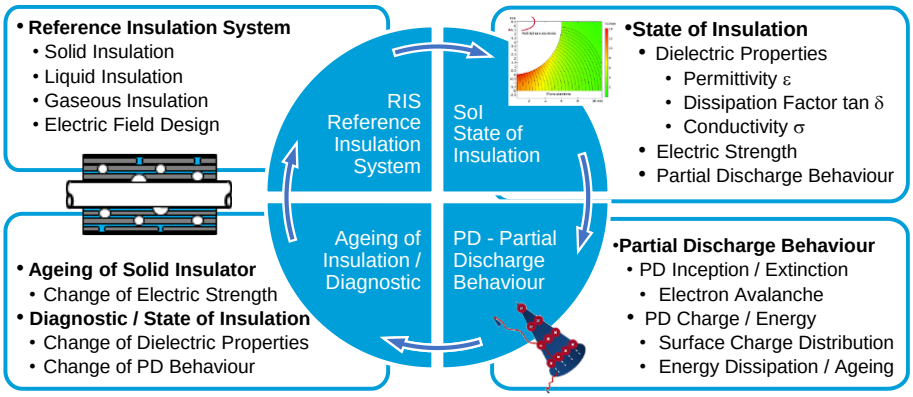
Insulation Research – Expertise and Resources

This document presents the competences and laboratory equipment in the field of insulation research of elenia. Insulation characterisation is an iterative process and requires experience in construction of test samples, design of experiment, high voltage engineering, measurement methods, analysis, modelling and simulation.



The state of insulation is characterized by a number of dielectric parameters and electric strength characteristics. The measured quantities and parameters are material-specific and depend on magnitude and time course of the field strength or temperature, etc. The long-term behaviour of insulation systems is determined by aging tests with voltage stress or partial discharge tests. Competencies and research achievements are presented in tabular form:

- **Dielectric characterization**
  - ε_r- and tan (δ)- measurement
  - Conductivity and resistance measurement with DC voltage
  - DSC analysis (25 °C - 350 °C), glass transition
  - Hydrophobic transfer behaviour
  - Polarization current measurement
- **Partial discharge (PD) diagnosis**
  - PD- measurement (-40 °C to 150 °C, 50 Hz)
  - PD measurement with inverter source up to 20 kHz
  - Parallel PD measurement for test collectives
  - Temperature range: -40 °C to 150 °C
  - Data recording system (Omicron MPD)
- **Electrical strength**
  - Assortment of test specimens
  - Testing devices with breakdown detection
  - AC, DC, lightning impulse voltage
  - Temperature range: -40 °C to 150 °C
- **Insulation material tests (el. stress)**
  - Tracking and erosion resistance
  - Inclined plane test
  - Dynamic drop test
- **Aging**
  - artificially accelerated ageing (temperature, water storage)
  - Parallel test system for electrical breakdown measurements (long-term)
  - Partial discharge ageing

- **Design of electric field grading insulation systems**
  - stationary and time-dependent field calculations
  - Design of Experiments
  - Requirements Management
  - Capacitive and resistive field grading
- **Analysis**
  - Simulation of breakdown processes and partial discharges (PD)
  - Cluster analysis
  - Image recognition
  - Electrothermal modelling

- **Manufacturing of insulation material (thermoplastic 3D printing, resin and elastomer vacuum casting)**
- **Development of field grading insulation systems**
- **National metrology institute (PTB) as Research partner in high voltage measurement technology**

Prof. Dr. Michael Kurrat and Dr. Ernst-Dieter Wilkening are the scientific directors. Technicians and research assistants manage the high-voltage laboratories and carry out the measurements. The measuring equipment is regularly checked and calibrated within the framework of the research cooperation with the national metrology institute (PTB). A selection of devices and measurements is shown in the list:

Device	**Measurement**
Schering bridge Heafely Tettex 2830/2831 with 2914 temperature measuring cell	Insulation material characterization - Relative Permittivity (ε_r) - Dielectric loss factor (tan (δ)) - 2.5 kV, 50 Hz
Impedance measuring device Omicron-Lab measuring system “Spectano 100” with sample holder “DSH 100”	Insulation material characterization - Permittivity (ε_r) - Dissipation factor (tan (δ)) - 200 V, 3 µHz-5 kHz
DC voltage source Heinzinger PNChp (30 kV)	For breakdown tests and partial discharge (PD) measurements - programmable voltage curves - Background noise level <1 pC
Shielded measuring cabin	For breakdown tests and PD measurements - Voltages up to 100 kV AC - Background noise level <1 pC
Parallel test system Up to 10 test samples with failure detection and disconnection	For breakdown tests and PD measurements - Long-term studies
Partial discharge test ciruit with coupling capacitors, measuring system MPD from Omicron, calibration generator	Partial discharge test - Data recording - Analysis - Diagnosis
AC voltage source with variable frequency (proprietary development)	Non-conventional partial discharge (PD) test - 10 kV - 20 kHz