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EVALUATION OF DIFFERENT METHODS TO CHARACTERIZE FAILURE MECHANISMS OF COMPOSITE MATERIALS USED AS ELECTRICAL INSULATION IN HIGH VOLTAGE APPLICATIONS

D. Lenko [a,*], S. Schloegl[a], S. Bichler [b], G. Lemesch [b], F. Ramsauer [b], W. Kern[c]

[a] *Polymer Competence Center Leoben GmbH, Roseggerstraße 12, 8700 Leoben, Austria,*

[b] *Andritz Hydro GmbH, Dr. Karl-Widdmann-Straße 5, 8160 Weiz, Austria and* [c] *University of Leoben, Institute for Chemistry of Polymeric Materials, Otto-Gloeckel Straße 2, 8700 Leoben, Austria.*

**Corresponding author: dietmar.lenko@pccl.at*

At present, the most common electrical insulation for high voltage generators is an epoxy composite material with a multi-layer structure. The production involves the winding of different types of bands, containing glass fibres and mica, around a copper conductor (Roebel rod). This is followed by a vacuum-pressure impregnation (VPI process) using a low-viscosity epoxy resin which is cured under high pressure and elevated temperature. These systems are often sensitive to various stresses including thermal, electrical and mechanical stresses during the operation.
The aim of this work was to develop and assess measurement systems, which are suitable to determine defects (e.g. delaminations, void) in insulation systems. The present work is focusing on the characterization of failure mechanism including delamination mechanisms of VPI high-voltage insulations. The insulators were exposed to different thermal stresses due to heat cycling and electrical stresses to investigate the influence of various stresses to the delamination behaviour. In order to visualize and locate failures in the composite material the insulations were investigated using computer tomography (CT) and ultrasonic measurements. Regarding the potential delamination mechanisms the thermal expansion coefficients of the insulator in every direction was determined by thermo mechanical analysis (TMA) and interlaminar shear (ILS) tests.