

Study on Comparability of Space Charge Measurement Results using PEA and LIPP Measurement Setups

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ABSTRACT

Many space charge measurement results obtained by methods like PEA (Pulsed Electro-Acoustic) and LIPP (Laser Induced Pressure Pulse) have been published and discussed in the last years. While many contributions have focused on the improvement of measurement configurations, post-processing and the investigation of space charge behaviour of various materials, topics like maintaining repeatability and comparability are only rarely discussed. This publication focuses on the comparability of measurement results obtained by the LIPP- and the PEA-method. Space charge measurement performed on flat polyethylene samples are compared and discussed. Sources of error and encountered problems are pointed out.

KEYWORDS

HVDC cables, Space Charge Measurement, PEA, LIPP

INTRODUCTION

During the last decades the demand on polymeric HVDC cable insulation systems increased. To evaluate potential insulation materials the space charge behaviour must be studied. Worldwide, many measurement systems have been developed and used to study the space charge behaviour of various insulation materials. Mainly three measurement principles were used, which are PEA (Pulsed Electro-Acoustic), LIPP (Laser Induced Pressure Pulse) and TSM (Thermal Step Method) [1]. Comparison between the LIPP and PEA methods and the derived results were performed in the past, e. g. [2], [3]. The measurement results of both methods were in good agreement. In this work the results from a PEA setup at GEIRI Europe laboratories and a LIPP setup at the department of High Voltage Engineering at Technical University Berlin are explicitly compared with the aim of evaluating the accuracy and repeatability of the respective measurement setup and identifying possible sources of error.

DESCRIPTION OF LIPP AND PEA MEASUREMENT SETUPS

In the following subsections a short overview of the measurement principles and details of the used LIPP and PEA setups are given.

LIPP Setup

The LIPP method is based on an acoustic wave that travels through a sample, displacing any charges present, resulting in a current signal that can be measured using a current amplifier. Under specific assumptions the current signal can be interpreted as directly proportional to the space charge density distribution inside the sample [4]. The

setup is described in detail in [5]. Here, instead of water an acrylic ink-water dilution is used. The acoustic pulses generated have a higher amplitude compared to using water as the target material. In addition, the acoustic pulse has a Gaussian shape and there is no 'tail' after the main pulse. An overview of the setup is given in Fig. 1.

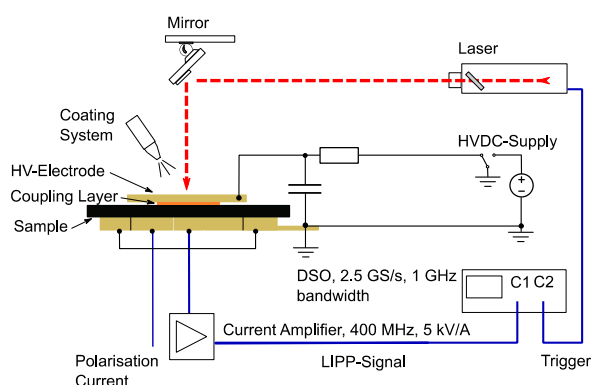


Fig. 1 Overview LIPP-Setup

The recorded signals are filtered with a 25 MHz low-pass filter and signal offset is removed. The conversion of measurement signals to space charge densities is described in [6]. The conversion factor is determined from every single measurement signal. By integrating the measurement signal an electric field equivalent curve is calculated. This curve is integrated over the sample dimensions and the value is set equal to the polarisation voltage. From these equations the conversion factor is determined. To apply this procedure, the measured signals have to be corrected. Due to the acoustic impedance mismatch acoustic reflection and destructive superposition occur at the specimen - ground electrode or backing material interface. Disturbed signal parts can be corrected by an appropriate algorithm, which is also described in [6]. Basically, the position, peak value and width of a Gaussian is determined by an algorithm, so that the resulting electric field is equal to zero outside the sample dimension. The disturbed signal parts are replaced by this Gaussian, respectively parts of the Gaussian.

Acoustic attenuation and dispersion of the acoustic pulse is not corrected, here. In general, attenuation and dispersion can be determined directly from the space charge-free LIPP signals when an appropriate backing material is used. The backing material must have the same acoustic impedance as the specimen. Investigations on the acoustic transfer behaviour inside the setup showed that acoustic attenuation is small. The effect of dispersion decreases the spatial resolution in direction of the lower electrode but does not introduce an error on the derived electric field distributions. To apply established correction methods plane wave transmission must be ensured. Results of the