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Space charge distribution in two-layer dielectrics

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Abstract

Silicone rubber(SKT) and ethylene propylene diene monomer(EPDM) are widely used in accessory of cross-linked polyethylene insulated (XLPE) power cable. The prepared two-layer dielectric samples comprise two different thin slabs of SKT or EPDM with XLPE, respectively. Space charge distributions in above two samples, pre-stressed at a dc voltage for a certain period, are measured by pulsed electro-acoustic method before and after being short-circuited. Observation shows that the magnitude of charge peaks at interface between two dielectrics increases under lower electric stress and decreases under higher electric stresses with voltage application time. In addition the charge peak of SKT/XLPE sample is higher than EPDM/XLPE sample. However, after being short-circuited, the result shown is contrary. It is considered that the charge trap density at interface of SKT/-XLPE sample is less than that of EPDM/XLPE sample. The charge polarity is dependent on the polarity of electrode next to SKT or EPDM slab. Under low electric stresses, polarity of space charges in SKT or EPDM slab are the same as the interfacial charge, but the both polarities in XLPE slab are opposite. Under high electric stresses, the charges of hetero-polarity are formed in dielectric material next to electrode.

It is found that silicone grease spread on the interface between two-layer dielectric materials weakens the peak of interfacial charge and accelerates the formation of hetero-polar charge in dielectric material next to the electrode.

The formation process of interfacial charges is assumed as migration of charges.

Introduction

250kV dc power XLPE cable has been successfully developed [1] and a 500kV one is under development [2]. The pre-fabricated joints and terminals, which work reliably and install conveniently, are necessary accessories of HV XLPE cable. EPDM (ethylene propylene diene monomer) and SKT(silicone rubber) are extensively used in cable accessories to manufacture a stress cone. To study on their interfacial properties with XLPE is important for design of stress cone.

The interfacial properties of EPDM/XLPE have been reported. It is found that the interfacial charges are dependent on the ingredient of EPDM and temperature treatment of sample [3]. Interfacial phenomena in several two layer dielectrics has been explained by polarization theory of Maxwell-Wanger [4].

EPDM can be extruded and vulcanized. The vulcanized EPDM exhibits satisfactory elasticity and electrical properties. Processing EPDM needs a large extrusion press. Processing SKT can adopt the vacuum casting method. In order to understand their merits and demerits, the space charge distributions in two layer dielectrics of EPDM/XLPE and SKT/XLPE are investigated in this paper.

Experimental Method

Samples: XLPE slab: The grains of XLPE are homogeneously mixed on the mixing mill at 110°C, then XLPE pressed in a mound at 120°C for 5 min and then the temperature of mound raised up to 160°C for 15 min. After cross-linked, sample is cooled down to room temperature under pressure. The thickness and area of sample are 0.3 mm and 100×100 mm^2.

EPDM slab: The EPT, Carbon-white, DCP and antioxygen are homogeneously mixed on the mixing mill at 90°C. The mixed materials are pressed in a mound at 100°C for 5 min and then the temperature of mound raise up to 160°C for 15 min. After being cross-linked, the sample is cooled down to room temperature under pressure. The size of sample is same as XLPE slab.

SKT slab: Five ingredients – methane-ethyl silicone resin, 2-4 dichloride benzoyl peroxide, TiO2, silsica aerogel and biphenyl silandiol are mixed at a certain ratio at 90 °C and then pressed in a mound at 200°C for 15 min. After being cross-linked, the sample is cooled down to room temperature under pressure. The size of sample is as same as XLPE laminate.

2. Measurement of space charges: Space charge distribution in sample is observed by pulsed electro-acoustic method (PEA)[5]. The schematic diagram of measuring setup is shown in Fig.1.

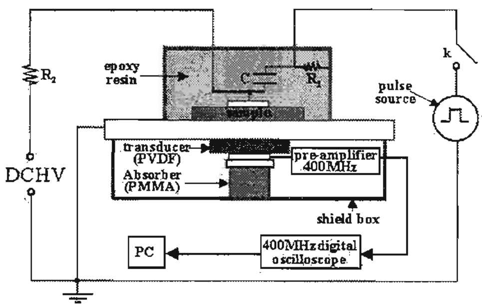

Fig.1 Measuring setup of PEA method

Pulsed amplitude is 200V and pulse width is 20ns. Thickness of PVDF film is 30μm. The acoustic coupling agent is silicone oil. The samples were cleared in alcohol and treated in oven at 80°C for 5 hrs.