Measurements of Current and Space Charge Profiles under 10kV/mm Application in Laminated Elastomer Sheets Fabricated by 3D printing

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Introduction

Organic polymer materials are widely used as insulating materials in HVDC power equipment, which is expected to have a high insulating reliability for a long life-time. The shape of the insulating components molded from insulating materials is one of the factors that determine the size of the power equipment. Thus, the use of 3D printer, which enables molding of optimized geometries, offers clear advantages. However, insulating materials fabricated by 3D printer contain a laminated structure. The influence of this laminated structure on the fundamental DC properties of insulating materials remains unclear. In this study, we analyzed the current and space charge profiles of elastomer sheets fabricated using stereolithographic 3D printer, focusing on the profiles below DC 10 kV/mm.

Experimental Procedures

The thickness of samples of laminate elastomer sheets made by stereolithographic 3D printer was around 0.5mm. The controlled laminating pitch was 0.05mm. Samples have two different laminating directions, namely horizontal (sample H) and vertical (sample V) directions to the sample surface. A sample which had no laminating area (sample N) was also prepared. The conduction current of samples H,V and N was measured using a current integration meter(1). Space charge distributions in samples were also measured using the pulsed electro-acoustic (PEA)(2) system.

Results and Discussion

Figure 1 shows the electric field dependence of the conductivity calculated from the current in samples N, V, and H. Up to about 5kV/mm there was very little increase in conductivity, but above 5kV/mm conductivity increased with increase of electric field irrespective of difference among samples. The magnitude of conductivity in all samples was almost the same. The space charge distribution in samples N and V are shown in figures 2 and 3, respectively, which show that positive charge was formed near the cathode above 5kV/mm. The amount of accumulated positive charge in sample H was larger near the anode above 5kV/mm as shown in figure 4. It was considered that increase of conductivity of samples N, V and H in the range of 5 to 10kV/mm was caused by the Poole-Frenkel mechanism.

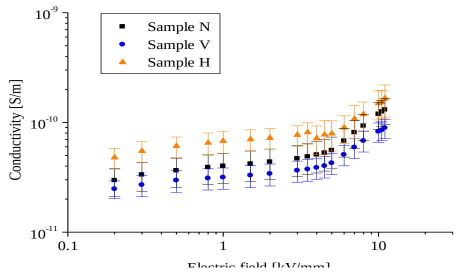

Figure1 Characteristics of conductivity vs. electric field

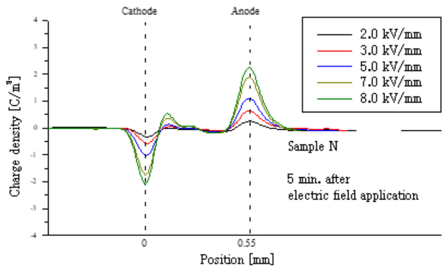

Figure2 The space charge distribution signals in sample N

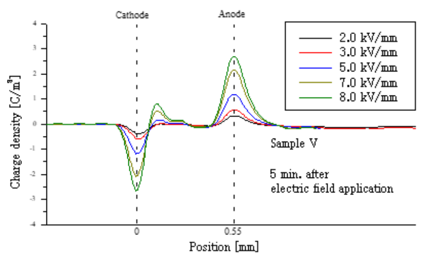

Figure3 The space charge distribution signals in sample V

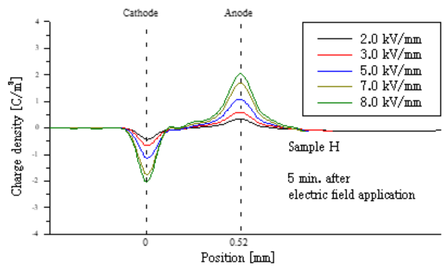

Figure4 The space charge distribution signals in sample H

References

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