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The effect of different screens and conditioning on the charge trap sites in XLPE cables

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Résumé

Deux modèles de câble MV extrudé, possédant une isolation identique, mais dont les écrans à semi-conducteurs sont soit technologie ancienne, soit nouvelle technologie, ont été étudiés. On a observé des différences significatives de la résistance au claquage à l'état vierge, mais aucune explication n'a été trouvée après une étude des propriétés physiques. On a donc utilisé la technique du courant de décharge stimulé thermiquement (TSDC) pour étudier les propriétés de charge de ces câbles. Les spectres TSDC montrent des différences au niveau de l'énergie et de la densité des sites de piégeage de charge dans les câbles, aussi bien avant qu'après le conditionnement à 80°C. Ces résultats suggèrent que la charge piégée dans les câbles équipés des écrans à semi-conducteurs nouvelle technologie, durant les mesures de claquage, est inférieure.

Abstract

Two designs of MV cable extruded with the same insulation, but old and new technology semicon screens have been investigated. Significant differences in the virgin breakdown strength were seen, but no explanation could be found after an investigation of the physical properties. Therefore the Thermally Stimulated Discharge Current (TSDC) technique was used to investigate the charge properties of these cables. The TSDC spectra show differences in the energy and density of charge trap sites within the cables; both before and after conditioning at 80°C. These results suggest that less charge is trapped in cables with new technology semicon screens during breakdown measurements.

Introduction

An important area of development for MV and HV cables is the composition of the semicon screens. This is because the interfacial region between the insulation and the screens is a major site for the generation of water and electrical trees. The use of cleaner materials and improvements to the extrusion process has been shown to reduce the density and size of trees at the interface. It is therefore important to continue to develop advanced semicon materials to improve the breakdown strength and extend the lifetime of such cables.

A new formulation of semicon has been developed for MV XLPE cables. In ramp breakdown measurements, these cables were found to have a breakdown strength 33% higher than cables with the same TR-XLPE insulation but older technology screens. The breakdown tests were carried out according to the Unipede specification (HD605 S1/A1 May 96 - 5.4.8). After conditioning in water at 80°C for 750 hours however, the breakdown strength of the two cables was found to be similar. This was investigated by measuring the crystalline properties of the insulation and by examining the quality of the interface, but no obvious differences were found. Consequently, the charge properties of the cables were studied using the Thermally Stimulated Discharge Current (TSDC) technique.

The TSDC technique has been widely used to study the effects of charge storage/conduction and polarisation within dielectrics [1]. More specifically, it has been used to investigate space-charge phenomena in XLPE cables. Braun *et al* [2] correlated TSDC results with interfacial roughness, and Hobdell *et al* [3] measured the effect of different combinations of semicon screens on the measured space-charge . The change in charge polarisation peaks after thermal and electro-thermal ageing has also been studied using TSDC [4].

In this paper TSDC measurements on TR-XLPE cables with the new and old technology screens before and after conditioning are reported. A significant difference between the two cables was seen, which indicates that the energy of trap sites is lower in the new technology cables before conditioning. A TSDC measurement of a third cable was recorded to investigate the origin of the current peaks. This cable was extruded with new technology semicon for the conductor screen and old technology semicon for the core screen. These results are discussed with reference to the effect of trapped space charge on electrical ageing, and how this