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Investigation of Conduction Processes of γ-irradiated EPR Insulation by Conduction Current and Extended Voltage Response Measurements

Zoltán Ádám Tamus [1], *Lorenzo Villani* [2], *Simone Vincenzo Suraci* [2], *Davide Fabiani* [2]

[1] Department of Electric Power Engineering, Budapest University of Technology and Economics, Budapest/Hungary

[2] Laboratory of Innovative Materials for Electrical Systems (LIMES), Department of Electrical Energy and Electronic Engineering, University of Bologna, Bologna/Itay

Abstract:

The γ-irradiation initiates several degradation mechanisms in insulating polymers, including cross-linking, chain scission, and oxidation. These processes lead to a deterioration in both the mechanical and electrical properties of the materials. Traditionally, the elongation properties are used to qualify the functionality of polymers in a radiation environment. However, there is a growing need for non-destructive material testing, as elongation tests require samples from the insulation, which can lead to destruction. One of the substantial advantages of testing electrical properties is that they can be measured without sampling or destroying the insulation. Therefore, the conductive properties of gamma-irradiated EPR insulation were investigated in this study. The subject of the research, EPR insulated cable samples, was investigated by current and extended voltage response (EVR) measurements. The samples were irradiated by a ^{60}Co source with 0.8 kGy/h dose-rate. The total absorbed dose was 1.2 MGy. The results showed that the conductive current and the slope of decay voltage showed a solid increasing trend with absorbed dose. The activation energies of conductivity increased with ab- sorbing dose from the initial 0.8 eV, reaching almost 2 eV after total dose. From the trap distribution data, the de-trapping rates were calculated for shallow and deep traps. The de-trapping rate showed strong correlation with both shallow and deep traps, which were greater for shallow traps than for deep traps by almost one order of magnitude, indicating the dominant role of shallow traps in conduction.

Keywords: electrical conduction, EPR, γ-irradiation, current measurement, EVR measurement, tarp distribution
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Corresponding author: Zoltán Ádám Tamus
E-mail: tamus.adam@vik.bme.hu