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PII: S0969-806X(16)30445-5
DOI: http://dx.doi.org/10.1016/j.radphyschem.2017.04.007
Reference: RPC7517

To appear in: Radiation Physics and Chemistry

Received date: 27 October 2016
Revised date: 9 March 2017
Accepted date: 14 April 2017

Cite this article as: Ahmedou Sidi, Juliette Colombani, Jean-François Larché and Agnès Rivaton, Multiscale analysis of the Radiooxidative degradation of EVA/EPDM composites. ATH filler and dose rate effect, Radiation Physics and Chemistry, http://dx.doi.org/10.1016/j.radphyschem.2017.04.007

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Multiscale analysis of the Radiooxidative degradation of EVA/EPDM composites. ATH filler and dose rate effect

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Abstract
This study is focused on the radiooxidative degradation of polymeric insulation of electric cables used in Nuclear Power Plants (NPPs). In order to investigate the degradation mechanisms of the insulation, model composites with ATH (Aluminium TriHydrate) filler and blends (without filler) based on a cross-linked mixture of EVA (Ethylene Vinyl Acetate) and EPDM (Ethylene Propylene Diene Monomer) were submitted to gamma-rays. In normal operating conditions of a NPP, the dose rate which electric cables are exposed to is around 0.1 Gy h\textsuperscript{-1}. In this work, artificial accelerated ageing test process has been applied at a relatively low dose rate of 7 Gy h\textsuperscript{-1}. Gamma-irradiations at higher dose rates typically used to accelerate the ageing, in the range 0.2 - 1 kGy h\textsuperscript{-1}, were also carried out. The first part of the study is focused on irradiations performed at relatively low dose rate and is devoted to the highlighting of the radiooxidative degradation mechanisms of EVA/EPDM blend with and without ATH filler. Correlations between the evolutions of the chemical, morphological and mechanical/electrical properties of the materials occurring after the ageing process are presented. It is shown that the degradation process is governed by radical oxidation mechanism involving chain scissions leading to the formation of carboxylic acids as end-groups. One of the main effects of the ATH filler is the progressive loss of the mechanical properties of the composite upon radiooxidation whereas they are maintained in the case of the unfilled sample. Despite the oxidation of the polymer, no change in the electrical properties of the blend and of the composite could be observed.
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