EPDM COMPOUNDS DEGRADATION UNDER γ IRRADIATION: INFLUENCE OF COPOLYMER COMPOSITION AND FILLERS

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EPDM are copolymers (Ethylene Propylene Diene Monomer) widely used in the industrial domain for their numerous advantages: a good resistance to ozone and weather, to oxidant reagents, a strong thermal stability and a good electrical insulating property. EPDM are usually cross-linked thanks to the addition of peroxide during the material processing. Mineral fillers are commonly added to their formulation – such as ATH (Aluminium TriHydrates) – in order to reduce the production costs, improve mechanical properties and give a fire retardancy functionality.

EPDM are often employed as insulating sheath for cables, in particular for cables used in the nuclear power plants. For this application, because of their exposition to radiation, EPDM are degraded and eventually lose their electrical insulating property. The degradation of the mechanical properties has been proved to be the precursor of this modification of the electrical properties. Thus, for this reason, the lifetime prediction of EPDM is based on the evolution of the material elongation at break.

Studies have been performed on the different chemical [1, 2] and physical processes interacting during the degradation. Thus, an explanation of the evolution of the properties [1, 3] (mechanical and dielectrical) with the modification of the molecular structure and the crystalline morphology has been proposed. It was evidenced that the crystalline phase attenuates the impact of the degradation of the matrix. Besides, the influence of the fillers on the radiochemical degradation processes has been investigated. ATH fillers apparently accelerate the material degradation [4, 5].

Nevertheless, the mechanisms explaining this acceleration are unknown. Moreover, it is also difficult to dissociate this effect from a modification of the polymer/filler mechanical coupling. However, this is mandatory to understand the evolution of the strain and stress at break of the irradiated materials. Thus the present study is devoted to the following questions: what is the influence of the polymer architecture, the filler presence and the semi-crystalline microstructure on the mechanisms of the radiochemical degradation, and eventually on the evolution of the material properties at break?

Two EPDM copolymer are studied with two PE/PP ratio, thus one EPDM is amorphous and the second one initially contains 8% of cristallinity. Three filler types have been studied: 3 micron size surface treated and not treated ATH, 70 micron size ATH, and a smaller one of 300 nm. The different materials have been γ irradiated in O_2 at room temperature, at 1.2 kGy/h with different doses up to 450 kGy.

Compared to previous studies where the ENB content of the copolymer was below 2.5% (wt) the high ENB content (5wt) used in this study leads to a weaker degradation of the material under irradiation. This is explained by the presence of residual ENB which have not participated to the polymer crosslinking. A strong chemi-crystallization process is induced by irradiation in the case of the semi-crystalline matrix. Chain scissions are promoted during the irradiation: this promotes the crystallization initially inhibited by the high crosslinking degree of the studied material. Compared to previous studies, it is more difficult to evidence the impact of the filler on the degradation kinetic since this degradation is strongly perturbed by the residual ENB in the matrix. However, specific study is presently performed to characterize the possible evolution of the filler-matrix interface. In addition, a modeling approach is also developed to account for all the experimental results.

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