Sustainable solutions for the production of electrical cable insulators via polyethylene silane-crosslinking

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Nowadays, electricity supply plays a crucial role in energy transition and great effort is devoted to developing new solutions with low environmental impact. Polyethylene (PE) serves as an excellent insulator for electrical cables due to its high dielectric strength, low electrical conductivity, toughness, flexibility, and durability. However, its relatively low thermal resistance compromises its effectiveness during electrical overloads and short circuits, which lead to significant temperature spikes.

Cross-linking represents the most effective strategy for enhancing thermal resistance, raising the operating temperature from 75°C for thermoplastic PE to 90°C for cross-linked PE (XLPE). Among the various cross-linking methods, silane is particularly advantageous due to its cost-effectiveness and straightforward processing. Despite its advantages, silane cross-linking poses significant challenges concerning the sustainability of the reactive agents, specifically the peroxide radical initiator and the organotin catalyst. In addition to their environmental toxicity, organotin compounds can also cause serious health issues [1].

Several strategies can be proposed to enhance the sustainability of PE-based electrical cable insulation materials. Adjusting the crystalline structure of PE could provide a viable approach for developing an eco-friendlier cable insulation material than standard XLPE. By achieving a microstructure with high crystallinity and large microcrystals, it may be possible to improve thermal stability, resulting in enhanced thermomechanical properties and high-temperature electrical performance [2].

The present work aims at deepening the scientific knowledge of PE silane cross-linking technology while seeking sustainable solutions for the production of electrical cable insulation materials. In this study, thermal (Differential Scanning Calorimetry) and thermomechanical (Dynamic Mechanical Analysis) characterizations were conducted on PE, both before and after silane cross-linking, to assess the effects of reactive agents and the manufacturing process on XLPE performance. The innovations resulting from this research are expected to significantly impact the cable jacketing industry, thus contributing to addressing the energy transition challenges.

Keywords: *cross-linked polyethylene*, *electrical cable insulation, sustainability*

References:

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