Dielectric Properties of Polyester-Imide Resin Modified with Micro-Cellulose and Nano-SiO_2 for Sustainable Electrical Insulation Systems

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Abstract. Facing growing environmental concerns, the pursuit of sustainable materials has become essential, extending beyond regular consumer applications also into dielectric materials and electrical insulation systems. This article focuses on potential ways of producing more sustainable composite materials, emphasizing resin systems enriched with sustainable additives as an option to replace some of the resin content. The materials employed in this study were selected based on attributes like wide availability, biodegradability, and non-toxicity – properties that contribute to a reduced ecological footprint. The study highlights the critical importance of developing eco-friendly solutions to mitigate the adverse environmental impacts associated with conventional insulation materials, which often either contain harmful VOC emissions or are derived from non-renewable resources. Two such materials as a solution, namely cellulose and silica (SiO_2), are addressed in this paper. This experiment aimed to investigate their potential application as an additive in a VOC-free, rapid-curing unsaturated polyester-imide resin. Based on the evaluation of the properties and performance of SiO_2 and cellulose-modified resins, this paper points out their advantageous use in maintaining the dielectric properties of insulation systems while promoting sustainability. The incorporation of SiO_2 nanoparticles can enhance the dielectric strength of the resins, while cellulose crystals can improve biodegradability to some extent. The goal of this paper is to present initial results from ongoing experiments dedicated to advancing the sustainability of electrical insulation materials.