# Chapter 6
# Characteristics and Suppression of Space Charge in Polyethylene


## ABSTRACT

*In HVDC transmission systems, the space charge accumulation of polyethylene (PE) insulation is a major problem that threatens the safe and stable operation of cables. In this chapter, nanoparticles and voltage stabilizers are used to inhibit space charge in PE, which has excellent compatibility with PE. To study the thermal, mechanical, and electrical properties of the samples, differential scanning calorimetry (DSC) testing, tensile testing, breakdown, and conductivity property were measured separately. Besides, the space charge behavior based on the PEA method was studied, and the carrier mobility was calculated by the space charge depolarization process. The experimental results indicate that PE modified by graphene oxide (GO) nanoparticles and the voltage stabilizers demonstrate the suppression of space charge accumulation in PE insulation, which has less space charge accumulation than pure PE. The results show that graphene oxide and the preferred stabilizer have broad prospects in HVDC cable applications.*


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## INTRODUCTION

Cross-linked polyethylene (XLPE) is a significant insulation used in high-voltage cable, which plays a role in HVDC transmission (Bjorlow-Larsen, 2000). Yet, space charge accumulation problem in the XLPE may be caused by-products during the manufacturing process, leading to the insulation aging and greatly limiting the application of XLPE in HVDC cables (Montanari, 2005). Since its first introduction, nanocomposites have given rise to a new research frenzy as a recognized method for solving the space charge accumulation in polymers (Lewis, 1994). A number of studies have been conducted on methods of adding nano-particles into LDPE matrices, which have been proved to improve the space charge characteristics. For the LDPE/MgO composites, the doping of the MgO nanoparticles is effective for the space charge suppression under the stretching conditions (Wang, 2016). Moreover, studies have shown that by adding an appropriate amount of MgO nanoparticles to polyethylene, space charge can be suppressed. Besides, the DC breakdown strength of the composite can be improved (Peng, 2015). The inhibition of space charge in the nanocomposites may be due to the interface between the filler and the matrix, based on which a model of multi core has been put forward, helping to explain existed research results and has been extensively recognized. (Tanaka, 2005). The nanoparticles can solve the problem of space charge accumulation of nanocomposites to some extent. Nevertheless, the amount of additives is relatively high, which will lead to agglomeration of nanoparticles and may cause unpredictable defects in composite materials. Therefore, there is an urgent need to develop new nano-fillers to achieve the purpose of inhibiting the space charge in the polymer by less added content.

Graphene oxide (GO) is one of the most major derivatives of the graphene, which has a single layer structure with a thickness as only one atom. The specific surface area of GO is large, which makes small doping amount possible. GO also possess well properties due to the destruction of its sp2 bonding network (Novoselov, 1998). These excellent properties have made GO a widespread concern since its discovery and an ideal filler for the fabrication of nano dielectric materials (Novoselov, 2004). The electrical and mechanical properties of GO and GNP doped polyurethane nanocomposites are superior