Chapter 1
Collection of Breakdown and Discharge Research on Advanced Materials

ABSTRACT

Epoxy resins are widely used to build insulators in GIL. Epoxy/AlN nanocomposite can be produced by adding AlN nanoparticals to the epoxy resin. By studying the surface discharge behavior of the nanocomposites under different operating temperature, it is helpful to improve the creeping voltage of epoxy resin. Polypropylene is a kind of material which is usually chosen to build film capacitors. The effects of voltage form on surface charge and discharge behavior were studied. Furthermore, a modification method of a polypropylene film which can suppress surface charge accumulation is proposed. Polypropylene also has great application potential in HVDC cable insulation, provided that its toughness is to be overcome. Different mass fractions of ULDPE and graphene were added to polypropylene to improve mechanical and insulating properties, respectively. Studies on the DC conductivity, space charge behavior, trap level distribution, and breakdown strength of the new material were carried out.

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INTRODUCTION

In the fields of urban power supply and electrical power delivery, high-voltage direct current (HVDC) transmission is widely used (Du, 2017). The advantages of gas insulated transmission line (GIL) include small footprint, high operational reliability and environmental friendliness compared to overhead lines (Zhang, 2017). An epoxy resin is used to make an insulator therein in a gas insulated pipeline transmission system. At DC voltage, the voltage distribution across the insulator depends on the distribution of its conductivity. When overload operation or partial discharge occurs, the operating temperature of the insulator rises, which causes a decrease in insulation performance of the insulator (Du, 2013). During the operation of gas insulated pipelines, creeping discharge is a serious problem. Compared with pure gas breakdown or breakdown of insulating material body, the voltage of creeping discharge is lower, and one of the important reasons for flashover occurs is surface charge concentration (Shao, 2017). The concentration and dissipation behavior of surface charge is affected and decided by the trap distribution characteristics in the materials. At the same time, related research shows that the flashover characteristics of the surface are also closely related to the charge trap (Li, 2010). Therefore, studying the dielectric behavior of epoxy resin under temperature rise is of great significance for improving the operational reliability of gas insulated transmission pipelines. With the development of nanotechnology, many scholars have studied the charge and discharge behavior of epoxy nanocomposites. Studies have found that the insulation properties of materials at higher temperatures are worse than at room temperature (Du, 2016). As the temperature increases, the charge dissipates faster and the traps are deeper and less (Du, 2017). Properly adding nanoparticles helps introduce new traps to capture free charges to achieve the effect of increasing the flashover voltage. However, what will happen if adding nanoparticles and under high temperature environments to the surface charge and flashover behavior of materials remains unknown. Aluminum nitride nanoparticles, a kind of material having high thermal conductivity and low dielectric constant at the same time, were selected as representative particles to be added to the epoxy resin. The effect of adding nanoparticles and different ambient temperature on the surface charge behavior and trap distribution of epoxy resin was studied by surface potential decay method,