Chapter 8
Surface Charge Property of SiR/SiC Composites with Field-Dependent Conductivity

ABSTRACT

An electrical field distorted by the complicated cable accessory structure and non-uniform temperature distribution is a significant threat to high voltage direct current (HVDC) cable. Thus, the field grading material (FGM) with nonlinear conductivity can uniform local field receives attention. This chapter focuses on the surface charge property of SiR/SiC composites effected by temperature. Field strength and SiC content have a positive effect on the increase in conductivity. When the temperature increases, the threshold field decreases. At high SiC content, this phenomenon is more obvious. The influence of temperature is considered under DC voltage and impulse superimposed DC voltage.

DOI: 10.4018/978-1-5225-8885-6.ch008

INTRODUCTION

HVDC cable attachments are very important for the stable operation of HVDC transmission (Zhou, 2015). They are easier to be damaged than other components of the HVDC transmission system (Lan, 2013; Li, 2017). The reason is that the structure of the high-voltage DC cable accessory is complicated, and the insulating layer has a multi-layer structure. These characteristics lead to serious electric field distortion, which exacerbates the charge accumulation. In history, the solution to the problem has been based on dielectric constant and resistance (Virsberg, 1967; Nelson, 1984). At present, solutions based on dielectric constant and resistivity can be seen in many high voltage DC cable accessories. These solutions exist in stress cones of nonlinear conductive layer. Many studies have shown that nonlinear conductivity materials have advantages in changing local fields (Donzel, 2011; Boggs, 2015; Wang, 2012). It shows that the inorganic filler could provide high conductivity under high electric field, thereby accelerating the dissipation of interfacial charge. Based on this technology, ABB successfully fabricated a prototype 300 kV DC cable by applying FGM in the connection structure (Jacobson, 2006).

However, the cable attachment structure is not the only cause of high frequency failure. Temperature has a great effect on the electrical conductivity, which is a major factor in the field distribution under DC voltage. The HVDC cable is designed to operate at 90°C, and the conductivity of the insulating material is significantly improved (Hjerrild, 2001). The problem is that the conductivity of the insulating material increases in a different range. The conductivities of most widely used insulating materials may differ by an order of magnitude, which will certainly affect the local field (Vu, 2015). There is also a temperature gradient in the HVDC cable. The temperature in the inner insulation of the cable is high, while the temperature of the outer insulation is not high, which causes the cable to exhibit an oblique electric field from center to outside.

Another accessory failure reason to be aware of is the transient electric field. The transient overvoltage caused by the lightning and switch is inevitably generated in the HVDC transmission system. Other study has shown that lightning voltage can effect the accumulation of charge and further effect the fault beginning, such as branches. Equally important is to explain how nonlinear conductive insulation works in this situation.