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Study on properties of rubber improved with nanomaterial used in cable

MAN X.,LIU Y. BINGLI Y., XIAOLONG C., Xi'an Jiaotong University, China

Abstract: The properties of rubber (Chloroprene Rubber) can be improved by adding nanomaterials for the special effects expressed on the nanoparticles. This paper focuses on the mechanical, sulfuration and dielectric properties of the rubber by adding three kinds of nanoparticles (nano-Al_2O_3, nano-SiO_2 and nano-ZnO). The tests show that the properties of the base rubber change dissimilarly according to adding different kind or content of the nanoparticles. In conclusion, the tear strength and plasticity of the rubber are increased by adding the three kinds of nanoparticles. The sulfuration property of the rubber with nano-ZnO is not the same to that of the rubbers with other two nanoparticles. The deterioration of dielectric properties has not been found. In some nanoparticles content, ρ_v of the composites are improved clearly and tanδ get reduced.

Keyword: nanomaterials, cable, mechanical property, dielectric property

Résumé: Les propriétés du caoutchouc chloroprène peuvent être améliorées en ajoutant des nanomatériaux, grâce aux propriétés particulières apportées par les nanoparticules. Cet article se concentre sur l'influence de trois types de nanoparticules (nano-Al2O3, nano-SiO2, et nano-ZnO), sur les propriétés mécaniques et diélectriques, ainsi que sur la vulcanisation.
Les expériences montrent que les propriétés du caoutchouc de base changent en fonction de la nature ou des concentrations en nanoparticules.En conclusion, la résistance au déchirement et la plasticité du caoutchouc sont améliorées pour les trois types de nanoparticules.La vulcanisation du caoutchouc avec le nano-ZnO est différente de celle obtenue avec les deux autres types de nanoparticules. Les propriétés électriques sont conservées. Pour certaines concentrations en nanoparticules, la résistivité des matériaux composites est clairement améliorée, tandis que la tangente delta est diminuée

Mots clés: nanomateriaux, cable, proprieté mécanique, proprieté diélectrique

1. Introduction

The particles of the dimension between 1 nm and 100 nm have special properties, which are neither the same as the microcosmic scale nor as the macroscopical scale (atom or molecule dimension), because of their surface effect, small dimension effect, and quantum dimension effect and macroscopic quantum tunneling effect [1]. These kinds of particles are on the mesoscope state. When the dimension of any materials reduces to the mecoscope scale, they will behave special optical, electrical, mechanical and thermal properties. After particles of such dimension are compounded with macroscopical materials, the new composites will also behave many special performances [2-4]. The former study shows that when proper nano-SiO_2 particles are put into epoxy resin, the composite will be improved both at mechanical intensity and ductility without deterioration of electrical performances [5]. The common insulating and jacket rubber of the rubber cables is not perfect at flexural strength and impact strength, which directly influence the life of the cable. Through the method of compounding nanoparticles with rubber to improve the mechanical performances of it, we can increase the life of rubber cable.

2. Raw Materials and Sample Preparation

2.1 Main Materials and Recipe

Chloroprene Rubber, Type CR322; Nano-SiO_2 (Particle diameter is 10nm, radio surface area is 640±50m^2/g); Nano-ZnO (Particle diameter is 20nm, ratio of surface area is 50m^2/g); Nano-Al_2O_3 (Particle diameter is 15±5nm, ratio of surface area is 130±10m^2/g).

The sulfuration recipe of rubber: In every 100 chloroprene rubber□add 9 sulfuration(5 ZnO, 4 MgO, particle dimension is in micron level), 2.8 accelerant, 11 soft agent, 2.5 anti-aging agent, 25 SiO_2.

2.2 Preparation Method

The common methods for the preparation of composite with nanoparticles and rubber are as follow: 1. Direct Mixture Method: Before mix the raw rubber, compound the nanoparticles with other agents directly and mix them evenly. Then put them into the rubber step by step, make the nanoparticles dispersive in the