Title: SEMICONDUCTIVE PEELABLE CROSSLINKED RESIN COMPOSITION AND INSULATING CABLE MANUFACTURED USING THE SAME

Abstract: The present invention relates to a peelable and water-crosslinked semiconductive resin composition. The peelable and water-crosslinked semiconductive resin composition includes 100 parts by weight of a basic resin; 20 to 80 parts by weight of carbon black based on weight of the basic resin; and 0.05 to 5.0 parts by weight of an anide-based lubricant based on weight of the basic resin, wherein the basic resin is a mixed resin including 60 to 80 weight\% of an ethylene-based copolymer resin or its alkali metal salt; and 5 to 40 parts by weight of an ethylene propylene copolymer containing 5 to 20 weight\% of ethylene, or a propylene resin.
Published:

— with international search report (Art. 21(3))
Description

SEMICONDUCTIVE PEELABLE CROSSLINKED RESIN COMPOSITION AND INSULATING CABLE MANUFACTURED USING THE SAME

Technical Field

[1] The present invention relates to a peelable and water-crosslinked semiconductive resin composition and an insulating cable using the same, and in particular, to a peelable and water-crosslinked semiconductive resin composition that is bonded with an unsaturated organic silane, includes carbon black and an anide-based lubricant, and has a predetermined melting point or above, consequently can be crosslinked at high temperature, and an insulating cable using the same.

Background Art

[2] Generally, a resin composition, in which an unsaturated silane is bonded to a polyethylene or ethylene copolymer, is crosslinked to meet electrical and mechanical characteristics of resin. In the crosslinking, time is a function related to temperature, and as temperature of water increases, crosslinking time reduces. Thus, high temperature is a preferable crosslinking condition in aspect of production efficiency. Accordingly, if a cable is crosslinked, a resin composition for the cable should have a higher melting point than a crosslinking temperature so that the cable can be crosslinked at a predetermined temperature or below.

[3] To reduce the water-crosslinking time, it requires to increase the temperature of a crosslinking chamber. Thus, a resin for a cable should have such a high melting point to avoid thermal deformation at high temperature.

[4] According to the prior art disclosed in U.S. Patent No. 6,284,374, in the case that a resin composition having a lower melting point than a crosslinking temperature is used, a wound cable may be stuck together or pressed down during crosslinking. In the case that an ethylene vinyl acetate copolymer resin is used, the content of acetate in the resin should be decreased to increase a melting point of the resin, but compatibility between a polyethylene insulator and an outer semiconductive composition increases, resulting in difficult separation therebetween.

Disclosure of Invention

Technical Problem

[5] Therefore, the present invention is designed to solve the above-mentioned problems.
An object of the present invention is to provide a peelable and water-crosslinked semiconductive resin composition that has an increased melting point through composition control and can be crosslinked at high temperature to reduce the crosslinking time, and an insulating cable using the same.

Technical Solution

[6] In order to achieve the above-mentioned object, a peelable and water-crosslinked semiconductive resin composition according to the present invention includes 100 parts by weight of a basic resin; 20 to 80 parts by weight of carbon black based on weight of the basic resin; and 0.05 to 5.0 parts by weight of an arride-based lubricant based on weight of the basic resin, wherein the basic resin is a mixed resin including 60 to 80 weight% of an ethylene-based copolymer resin that is bonded with an unsaturated organic silane and has a melting point of \(80^\circ\text{C}\) or above; 5 to 20 weight% of an ethylene-acrylic acid copolymer or its alkali metal salt; and 5 to 40 parts by weight of an ethylene propylene copolymer containing 5 to 20 weight% of ethylene, or a propylene resin.

[7] Preferably, the ethylene-based copolymer resin of the basic resin is any one selected from the group consisting of an ethylene vinyl acetate copolymer resin, an ethylene ethyl acrylate copolymer resin, an ethylene methyl acrylate copolymer resin and an ethylene butyl acrylate copolymer resin.

[8] Preferably, the ethylene vinyl acetate copolymer resin selected as the ethylene-based copolymer resin contains 9 to 25 weight% of vinyl acetate, the ethylene ethyl acrylate copolymer resin selected as the ethylene-based copolymer resin contains 9 to 35 weight% of ethyl acrylate, the ethylene methyl acrylate copolymer resin selected as the ethylene-based copolymer resin contains 9 to 35 weight% of methyl acrylate, and the ethylene butyl acrylate copolymer resin selected as the ethylene-based copolymer resin contains 9 to 35 weight% of butyl acrylate.

[9] Preferably, the arride-based lubricant contains an arride function (-CON-) in a hydrocarbon main chain, is represented by the following Chemical Figure 1, and has a melting point of \(50^\circ\text{C}\) to \(120^\circ\text{C}\).

[10] Chemistry Figure 1

[Chem.1]
where R is a hydrocarbon main chain, and R' and R" each is hydrogen or a hydrocarbon chain.

Preferably, the anide-based lubricant is any one selected from the group consisting of stearanide, oleananide, erucanide, hydrogenated tallowanide, oleyl palnitanide and stearyl stearanide, or mixtures thereof.

In order to achieve the above-mentioned object, an insulating cable according to the present invention includes a center conductor; an inner seniconductive layer surrounding the center conductor; a water-crosslinked insulating layer surrounding the inner seniconductive layer; an outer seniconductive layer surrounding the water-crosslinked insulating layer; a copper tape surrounding the outer seniconductive layer; and a sheath layer surrounding the copper tape, wherein outer seniconductive layer is formed using the above-mentioned peelable and water-crosslinked seniconductive resin composition.

Brief Description of Drawings

Preferred embodiments of the present invention will be more fully described in the following detailed description, taken accompanying drawings. However, it should be understood that the description proposed herein is just a preferable example for the purpose of illustrations only, not intended to limit the scope of the invention.

FIG. 1 is a cross-sectional view of an insulating cable having an outer seniconductive layer formed using a composition according to the present invention.

Best Mode for Carrying out the Invention

Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings. The description proposed herein is just a preferable example for the purpose of illustrations only, not intended to limit the scope of the invention, so it should be understood that other equivalents and modifications could be made thereto without departing from the spirit and scope of the invention. The preferred embodiments of the present invention are provided to help persons having ordinary skills in the art understand the present invention more completely.

To evaluate the effectiveness of the present invention, as shown in the following Table 1, resin compositions were prepared according to examples 1 to 5 of the present invention and comparative examples 1 to 5, and polymer material samples and cable samples were manufactured using the compositions.

Table 1
In Table 1, the 'resin a' is an ethylene vinyl acetate copolymer resin that is bonded with an unsaturated organic silane, contains 19 weight% of vinyl acetate and has a melting point of 84 °C, the 'resin b' is an ethylene vinyl acetate copolymer resin that is bonded with an unsaturated organic silane, contains 30 weight% of vinyl acetate and has a melting point of 72 °C, the 'resin c' is an ethylene methyl acrylate copolymer resin that is bonded with an unsaturated organic silane, contains 30 weight% of methyl acrylate and has a melting point of 86 °C, the 'resin d' is an ethylene propylene copolymer resin that contains 5 weight% of ethylene and has a melting point of 137 °C, the 'resin e' is an ethylene acrylic acid copolymer resin that contains 9 weight% of acrylic acid and has a melting point of 97 °C, and the 'resin f' is a sodium salt of an ethylene acrylic acid copolymer resin that contains 9 weight% of acrylic acid, is partially in the form of a sodium salt, and has a melting point of 88 °C. As the lubricant, an anide-based lubricant, erucanide was used. As the additive, 2 parts by weight of zinc stearate was used based on 100 parts by weight of the resin. And, as an antioxidant, 1.5 parts by weight of tetrakis[methylene-3-(3,5-di-t-butyl-4'-hydroxyphenyl)propionate]methane was used based on 100 parts by weight of the resin.

Cable samples were manufactured using the compositions prepared according to Table 1 with a cross-sectional shape of FIG. 1 by means of a single screw extruder.
FIG. 1 is a cross-sectional view of an insulating cable having an outer semi-conductive layer formed using a composition according to the present invention. Referring to FIG. 1, the insulating cable includes a center conductor 10, an inner semi-conductive layer 12, a water-crosslinked insulating layer 14, an outer semiconductive layer 16, a copper tape 18 and an outermost PVC sheath layer 20. The outer semiconductive layer 16 was formed using the composition prepared according to Table 1. The cable sample was tested to measure and evaluate characteristics at room temperature, characteristics at heating, peel force, volume resistance and thermal deformation characteristics during water-crosslinking at 80°C for 16 hours. The evaluation results are shown in the following Table 2.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Examples</th>
<th>Comparative examples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Room temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tensile strength</td>
<td>1.43 1.49</td>
<td>1.45 1.03</td>
</tr>
<tr>
<td>(kgf/mm²)</td>
<td>1.42 1.72</td>
<td>1.35 1.56</td>
</tr>
<tr>
<td>Elongation (%)</td>
<td>196 210 145 180 250</td>
<td>215 85 225 350 55</td>
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<tr>
<td>Heating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual tensile strength</td>
<td>124 130 122 120 105</td>
<td>122 115 119 120 110</td>
</tr>
<tr>
<td>(%)</td>
<td>97 110 93 95 102</td>
<td>96 92 91 99 97</td>
</tr>
<tr>
<td>Residual elongation (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peel force (N/cm)</td>
<td>15 13 14 15 20</td>
<td>40 25 20 fail fail</td>
</tr>
<tr>
<td>Volume resistance (Ωm)</td>
<td>0.03 0.04 0.03 0.03 0.05</td>
<td>0.03 0.04 0.03 5000 0.01</td>
</tr>
<tr>
<td>Thermal deformation</td>
<td>pass pass pass pass pass pass fail pass pass</td>
<td></td>
</tr>
<tr>
<td>resistance</td>
<td></td>
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</table>

The characteristics at room temperature of the cable sample were measured
according to IEC 60502-2, and when a tension test speed is 250mm/min, a preferable tensile strength is 0.92 kgf/mm² or above and a preferable elongation is 100% or above. It is found through Table 2 that the cable samples of the examples 1 to 5 have good tensile strength and elongation, but the cable samples of the comparative examples 2 and 5 have elongation below standard.

[25] The characteristics at heating of the cable sample were measured according to IEC 60502-2 after the cable sample was left at 136°C for 168 hours, and a preferable residual tensile strength is 75% or above and a preferable residual elongation is 90% or above. It is found through Table 2 that the cable samples of the examples 1 to 5 and the comparative examples 1 to 5 satisfy the residual tensile strength and residual elongation standards.

[26] The peel force of the cable sample was measured according to IEC 60502-2, and a preferable peel force between an outer seniconductive layer and an insulating layer is 4 N/cm to 45 N/cm. It is found through Table 2 that the cable samples of the examples 1 to 5 and the comparative examples 1 to 3 satisfy the peel force standard. However, the cable samples of the comparative examples 4 and 5 do not satisfy the peel force standard, and a peel force of the cable sample of the comparative example 1 reaches a maximum value of the standard.

[27] The volume resistance of the cable sample was measured according to IEC 60502-2, and a preferable volume resistance of an outer seniconductive layer is 100 Ωm or below. It is found through Table 2 that the cable samples of all the examples and the comparative examples except the comparative example 4 satisfy the volume resistance standard.

[28] In the case that the cable sample is wound on a bobbin and crosslinked, the cable sample should be resistant against thermal deformation. The cable samples of all the examples and the comparative examples except the comparative example 3 satisfy the thermal deformation resistance standard.

[29] As such, the preferred embodiments of the present invention are described in detail with reference to the accompanying drawings. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

**Industrial Applicability**

[30] The present invention can be crosslinked at high water-crosslinking temperature
without thermal deformation to reduce the crosslinking time, thereby improving process efficiency and performance of products.
Claims

[1] A seniconductive peelable water-crosslinked resin composition, comprising:
100 parts by weight of a basic resin;
20 to 80 parts by weight of carbon black based on weight of the basic resin; and
0.05 to 5.0 parts by weight of an anide-based lubricant based on weight of the basic resin,
wherein the basic resin is a nixed resin including:
60 to 80 weight% of an ethylene-based copolymer resin that is bonded with an unsaturated organic silane and has a melting point of 80°C or above;
5 to 20 weight% of an ethylene-acrylic acid copolymer or its alkali metal salt; and
5 to 40 parts by weight of an ethylene propylene copolymer containing 5 to 20 weight% of ethylene, or a propylene resin.

[2] The seniconductive peelable water-crosslinked resin composition according to claim 1,
wherein the ethylene-based copolymer resin of the basic resin is any one selected from the group consisting of an ethylene vinyl acetate copolymer resin, an ethylene ethyl acrylate copolymer resin, an ethylene methyl acrylate copolymer resin and an ethylene butyl acrylate copolymer resin.

[3] The seniconductive peelable water-crosslinked resin composition according to claim 2,
wherein the ethylene vinyl acetate copolymer resin selected as the ethylene-based copolymer resin contains 9 to 25 weight% of vinyl acetate.

[4] The seniconductive peelable water-crosslinked resin composition according to claim 2,
wherein the ethylene ethyl acrylate copolymer resin selected as the ethylene-based copolymer resin contains 9 to 35 weight% of ethyl acrylate.

[5] The seniconductive peelable water-crosslinked resin composition according to claim 2,
wherein the ethylene methyl acrylate copolymer resin selected as the ethylene-based copolymer resin contains 9 to 35 weight% of methyl acrylate.

[6] The seniconductive peelable water-crosslinked resin composition according to claim 2,
wherein the ethylene butyl acrylate copolymer resin selected as the ethylene-
based copolymer resin contains 9 to 35 weight% of butyl acrylate.

[7] The seniconductive peelable water-crosslinked resin composition according to claim 2,
wherein the anide-based lubricant contains an amide function (-CON-) in a hydrocarbon main chain, and has a melting point of 50°C to 120°C.

[8] The seniconductive peelable water-crosslinked resin composition according to claim 7,
wherein the anide-based lubricant is any one selected from the group consisting of stearanide, oleanide, erucanide, hydrogenated tallowanide, oleyl palnitanide and stearyl stearanide, or mixtures thereof.

[9] An insulating cable, comprising:
a center conductor;
an inner seniconductive layer surrounding the center conductor;
a water-crosslinked insulating layer surrounding the inner seniconductive layer;
an outer seniconductive layer surrounding the water-crosslinked insulating layer;
a copper tape surrounding the outer seniconductive layer; and
a sheath layer surrounding the copper tape,
wherein outer seniconductive layer is formed using the seniconductive peelable water-crosslinked resin composition defined in any one of claims 1 to 8.
A. CLASSIFICATION OF SUBJECT MATTER

C08K 3/04(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 8  C08K 3/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<tr>
<th>Category</th>
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<th>Relevant to claim No</th>
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<td>JP 11-297121 A (HITACHI CABLE LTD) 29 October 1999 See the abstract, the description paragraphs [0015],[0017],[0020],[0021], and claims 1-9</td>
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Further documents are listed in the continuation of Box C

See patent family annex

Date of the actual completion of the international search
15 OCTOBER 2008 (15 10 2008)

Date of mailing of the international search report
15 OCTOBER 2008 (15.10.2008)

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
Government Complex-Daejeon, 139 Seonsa-ro, Seogu, Daejeon 302-701, Republic of Korea
Facsimile No 82-42-472-7140

Authorized officer
KIM Rahn
Telephone No 82-42-481-5543
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