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(54) Title of the Invention: **Cable and/or cord suitable for use in a hospital environment or in a controlled atmosphere environment and method for the manufacture thereof**
Abstract Title: **Antimicrobial cable**

(57) The present invention relates to a cable and a cord suitable for use in a hospital environment or in a controlled atmosphere environment, and to the method for the manufacture thereof and to the use thereof. In particular, the invention provides a cable comprising: i) a polymer composition; ii) at least one active agent composed of an antimicrobial or microbicidal inorganic compound; said at least one active agent being coupled to the polymer composition via iii) at least one organosilane coupling agent; wherein ii) is selected from silicate, zeolite, titanate or antimonate substituted with silver, copper, zinc, tin, bismuth, lead, cadmium or chromium, and wherein iii) has the formula $R^1{}_3SiR^2$, wherein R^1 is methoxyl or ethoxyl, and R^2 is a) vinyl, b) phenyl, c) aminoalkylaminoalkyl having independently C_2 or C_3 alkyl groups, d) $C1_{-4}$ linear or branched alkyl optionally substituted with suphanyl or halogen.

GB 2464610 A

The following terms are registered trademarks and should be read as such wherever they occur in this document:

Santoprene
Hostalen

Cable and/or cord suitable for use in a hospital environment or in a controlled atmosphere environment and method for the manufacture thereof

The present invention relates to a cable and a cord suitable for use in a hospital environment or in a controlled atmosphere environment, and to the method for the manufacture thereof and to the use thereof.

It is often critical, in a hospital environment or in a controlled atmosphere environment, such as chambers under positive pressure or under negative pressure, to control the entry and/or the departure of pollutants or contaminants (bacteria, dust, and the like) and necessary to provide an impeccable quality of cleanliness, indeed even sterilization, of the equipment or device used. Controlling these various parameters makes it possible to protect staff and/or patients from any possible contamination and/or to guarantee a healthy environment for the manufacture of products, such as pharmaceuticals or semiconducting devices.

In the specific case of medical centres and hospitals, numerous electronic and computer devices are installed. The disinfecting, which is a regulatory requirement, of the surfaces of these items of equipment and of their peripheral components, such as cables and cords, has to be carried out regularly using disinfectants. It would thus be advantageous to render these surfaces of items of equipment and these peripheral components antibacterial or bactericidal from their manufacture in order to eliminate or reduce disinfecting operations.

Patent Application JP 11-199732 describes a cable composed of an antibacterial external coating, the composition of which is mainly composed of a polymer and of an antibacterial agent. Although this type of cable exhibits antibacterial properties, it is not sufficiently reliable over time.

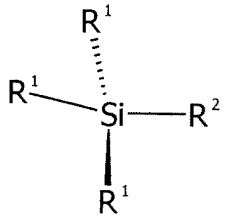
There thus exists a real need to provide an item of equipment or a device, in particular a cable or a cord, which is more effective than existing cables.

The aim of the invention is to devise a cable or a cord which makes

it possible to effectively minimize or to prevent risks of contamination and to provide a method for manufacturing this cable or this cord.

According to its first subject matter, the invention relates to a cable suitable for use in a hospital environment or in a controlled atmosphere environment, said cable comprising:

- a polymer composition;
- at least one active agent composed of an antimicrobial or microbicidal inorganic compound, said inorganic compound preferably being chosen from the group consisting of silicates, zeolites, titanates and antimonates, in particular calcium silicate, calcium titanate, sodium antimonate and magnesium aluminometasilicate, the ions of which have been replaced by one or more antimicrobial or microbicidal metal ion(s) selected from silver, copper, zinc, tin, bismuth, lead, cadmium or chromium ions;
- said at least one active agent being coupled to the polymer composition via at least one organosilane coupling agent, preferably of formula (I):



(I)

in which:

- R^1 denotes a methoxyl (CH_3-O- or MeO-) or ethoxyl (CH_3-CH_2-O- or EtO-) group; and
- R^2 is chosen from the group consisting of the vinyl (H_2C=CH-) group, the phenyl (C_6H_5-) group, the aminoalkylaminoalkyl group, in which the alkyls independently have from 2 to 3 carbon atoms, and the linear or branched C_1-C_4 alkyl group, optionally substituted by a sulphanyl group or by a halogen atom.

Generally, the term "antimicrobial" is understood to mean an agent which inhibits the growth or prevents the proliferation of microorganisms. Microorganisms comprise bacteria, viruses, protozoa and fungi, including yeasts and moulds. The term "antimicrobial" thus encompasses the terms "antibacterial", "antifungal" and "antiviral".

Analogously, the expression "microbicidal compound" represents an agent which destroys or kills microorganisms. The expression "microbicidal compound" encompasses, inter alia, bactericidal and fungicidal compounds.

The coupling agent is a compound which makes it possible mainly to connect said at least one active agent of inorganic nature to said polymer composition of organic nature and to disperse said at least one active agent in said polymer composition. This linkage, also known as "coupling", of chemical and/or physical nature is provided, in the present case, by an organosilane which exhibits two types of reactive functional groups: one of the two functional groups will react with the inorganic compound, that is to say with said at least one active agent, and the remaining functional group with the polymer composition.

Said at least one organosilane coupling agent employed in the present invention preferably comprises:

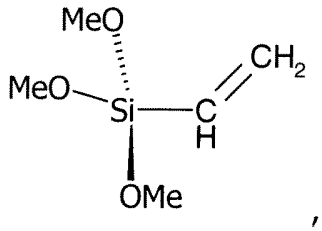
- three alkoxyl groups R^1 (either methoxyl or ethoxyl) which, after hydrolysis (either by addition of water or by the presence of residual water originating from the active agent), are converted into hydroxyl (-OH) groups. The latter groups then react with the active agent;
- a group R^2, as defined above, which reacts chemically and/or physically with the polymer composition. The polymer composition is chosen depending on its reactivity with respect to that of the R^2 group of the organosilane coupling agent.

According to a particularly advantageous alternative embodiment of the invention, said aminoalkylaminoalkyl group is aminoethylaminopropyl (H_2N-CH_2-CH_2-NH-CH_2-CH_2-CH_2-).

According to another particularly advantageous alternative

embodiment of the invention, said C_1-C_4 alkyl group is isobutyl or mercaptopropyl.

According to yet another particularly advantageous alternative embodiment of the invention, said at least one organosilane coupling agent is chosen from the group consisting of:



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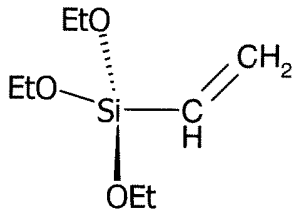
(I_a)



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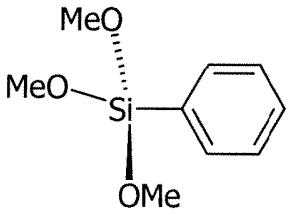

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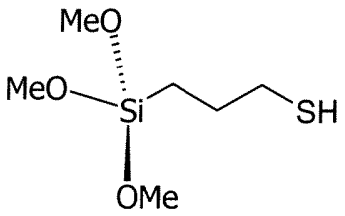

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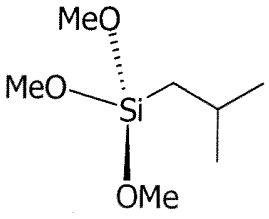

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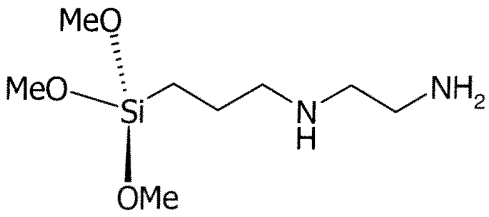

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According to an advantageous embodiment of the invention, the polymer composition is chosen from polyvinyl chloride (PVC), polyethylene (PE), preferably high density polyethylene (HDPE), polypropylene (PP), polytetrafluoroethylene (PTFE), poly(styrene/butadiene/acrylonitrile)

(ABS), poly(styrene/butadiene/styrene) (SBS), polycarbonate (PC), polyoxymethylene (POM), poly(ethylenimine) (PEI), polysulphone (PSU), polyetheretherketone (PEEK), polyether block amide (PEBA), thermoplastic polyurethanes (TPU), epoxy polymers (or polyepoxide), silicones (or polysiloxanes), fluorinated ethylene/propylene copolymer (FEP), ethylene/tetrafluoroethylene copolymer (ETFE), thermoplastic elastomers (TPEs) resulting from a blend of EPDM (ethylene/propylene/diene terpolymer) and polypropylene, and a blend of at least two of these polymers.

According to a particularly advantageous alternative embodiment of the invention, said polymer composition is chosen from polyvinyl chloride (PVC), high density polyethylene (HDPE) and thermoplastic elastomers (TPEs) resulting from a blend of EPDM (ethylene/propylene/diene terpolymer) and polypropylene.

According to a specific embodiment of the invention, said at least one active agent is an antibacterial or bactericidal inorganic compound. The term "antibacterial" is understood to mean an agent which inhibits the growth or prevents the proliferation of bacteria and the term "bactericidal" is understood to mean an agent which destroys or kills bacteria.

According to an advantageous alternative embodiment of the invention, said at least one active agent comprises silver ions.

According to another advantageous alternative embodiment of the invention, said at least one active agent is a zeolite comprising silver ions and optionally zinc ions.

According to yet another advantageous alternative embodiment of the invention, said zeolite comprises from 1 to 2% by weight of zinc and from 0.2 to 0.8% by weight of silver, with respect to the total weight of the zeolite based on silver and on zinc. Preferably, said zeolite comprises 1.36% by weight of zinc and 0.44% by weight of silver, with respect to the total weight of the zeolite based on silver and on zinc.

According to an advantageous embodiment of the invention, said cable additionally comprises titanium dioxide.

According to another advantageous embodiment of the invention, said cable additionally comprises a dispersant or surface-active agent,

preferably chosen from the group consisting of a polyether polyol and an ethoxylated nonionic fluorinated surface-active agent of formula $F(CF_2CF_2)_yCH_2CH_2O(CH_2CH_2O)_xH$ where x = 0 to 15 and y = 1 to 7.

According to yet another advantageous embodiment of the invention, said cable comprises:

- from 0.1 to 5.0% by weight of said at least one active agent, with respect to the total weight of the combination formed by said polymer composition, said at least one active agent, said at least one organosilane coupling agent and optionally the titanium dioxide and a dispersant; and/or
- from 0.02 or 0.05 to 1.0% by weight of said at least one organosilane coupling agent, with respect to the total weight of the combination formed by said polymer composition, said at least one active agent, said at least one organosilane coupling agent and optionally the titanium dioxide and a dispersant.

Said cable preferably comprises from 0.1 to 1.0%, with 1.0% excluded, and more advantageously from 0.1 to 0.5% by weight of said at least one active agent, with respect to the total weight of the combination formed by said polymer composition, said at least one active agent, said at least one organosilane coupling agent and optionally the titanium dioxide and a dispersant.

In the presence of titanium dioxide and/or of dispersant in the cable, the combination to be considered for the total weight is formed by said polymer composition, said at least one active agent, said at least one organosilane coupling agent, said titanium dioxide and/or said dispersant.

According to an advantageous alternative embodiment of the invention, said cable comprises:

- from 0.02 to 1.0% by weight of said at least one organosilane coupling agent when said at least one coupling agent is chosen from the organosilanes I_c and I_e; or
- from 0.05 to 1.0% by weight of said at least one organosilane coupling agent when said at least one coupling agent is chosen from the organosilanes I_a, I_b, I_d and I_f.

According to an advantageous embodiment of the invention, said

cable comprises from 0.1 to 1.5% by weight of titanium dioxide, with respect to the total weight of the combination formed by said polymer composition, said at least one active agent, said at least one organosilane coupling agent, said titanium dioxide and optionally a dispersant.

According to its second subject matter, the invention relates to a cord composed of a cable as described above and at least one connecting element, said at least one connecting element preferably comprising an electrical connector, a USB connector, and the like. "Cord" is thus understood to mean a device comprising a cable and one or more connecting elements. The connecting element can comprise any type of connector, in particular a connector for the transmission of data, such as a USB or RJ45 connector; or also a connector for the transmission of current, such as a two-phase or three-phase plug or socket, and the like. Likewise, the cable can denote any type of cable, in particular a single fibre or multi-fibre cable, a flat cable, and/or a coaxial cable; the cable can also be a cable used for the transfer of fluids (gases, liquids) or for the transmission of optical signals via at least one optical fibre or of pressure signals via a fluid.

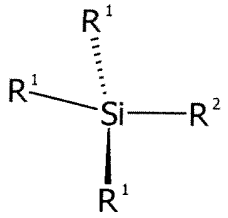
Another subject matter of the invention is the use of the cable as described above or of the cord as defined above in a hospital environment or in a controlled atmosphere environment.

According to its fourth subject matter, the invention relates to a method for manufacturing a cable or cord suitable for use in a hospital environment or in a controlled atmosphere environment, characterized in that it comprises the steps consisting in:

a. preparing a premix in a mixing device at ambient temperature (15-25°C), said premix comprising:
   - at least one active agent composed of an antimicrobial or microbicidal inorganic compound, said inorganic compound preferably being chosen from the group consisting of silicates, zeolites, titanates and antimonates, in particular calcium silicate, calcium titanate, sodium antimonate and magnesium aluminometasilicate, the ions of which have been replaced by one or more antimicrobial or microbicidal metal ion(s) selected from

silver, copper, zinc, tin, bismuth, lead, cadmium or chromium ions;

- at least one organosilane coupling agent, preferably of formula (I):



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in which:

- R^1 denotes a methoxyl (CH_3-O-) or ethoxyl (CH_3-CH_2-O-) group; and
- R^2 is chosen from the group consisting of the vinyl (H_2C=CH-) group, the phenyl (C_6H_5-) group, the aminoalkylaminoalkyl group, in which the alkyls independently have from 2 to 3 carbon atoms, and the linear or branched C_1-C_4 alkyl group, optionally substituted by a sulphanyl group or by a halogen atom;

- optionally titanium dioxide; and
- optionally a dispersant or surface-active agent, preferably chosen from the group consisting of a polyether polyol and an ethoxylated nonionic fluorinated surface-active agent of formula $F(CF_2CF_2)_yCH_2CH_2O(CH_2CH_2O)_xH$ where x = 0 to 15 and y = 1 to 7;

b. continuously compounding:
by feeding an extruder with a polymer composition and the premix obtained in the previous step, said extruder kneading the premix with the polymer composition at temperatures of between 150°C and 255°C; and
by conditioning the product resulting from the compounding, known as compound or composite, in the form of granules once the composite

has cooled; and

c. forming the cable by a sheath extrusion operation, or a method of injection moulding using the composite granules.

Compounding is a method which makes possible the melt blending of plastics and additives. This method has the result of modifying certain physical, thermal or indeed even aesthetic features (by the introduction of colouring metal oxide(s)) of the plastic. By incorporating a broad range of additives, fillers and reinforcements, it is possible to obtain a large number of conductivity, flame retardance or wear resistance properties and/or a variety of advantageous structural properties. In our case, the compounding step according to the present invention makes it possible to render the composite antimicrobial or microbicidal. The final product resulting from the compounding step is known as compound or composite.

One of the difficulties encountered in the prior art in manufacturing composites intended for the production of antibacterial cables lies in the complexity of the method employed. When a composite is mainly formed from a polymer and an antibacterial inorganic compound, a good degree of homogeneity of the composite can only be achieved only after multiple passes (at least two passes) through a compounder (machine which makes it possible to carry out the compounding step). Such a method involves the use of numerous devices in series in order to make possible a continuous method or else the use of a single compounder in a noncontinuous method. The method for manufacturing an antibacterial cable or cord of the prior art is consequently relatively expensive.

The method of the present invention effectively solves the problems encountered in the prior art. Said method makes it possible to manufacture an antimicrobial or microbicidal, in particular antibacterial or bactericidal, cable or cord which exhibits a uniform antimicrobial or microbicidal activity. This uniform antimicrobial or microbicidal activity is based on the homogeneity of the blend obtained from the polymer composition and the premix. In other words, said activity depends on the homogeneity of the composite resulting from the compounding step. The achievement of such a homogeneity is made possible by the formulation of the composite (choice of the combination of the compounds

constituting the composite) and/or by the step of preparation of the premix, followed by the implementation of the compounding step. Surprisingly, the inventors have discovered that the method of the invention makes it possible to reduce the amount of the active agent used while retaining the desired antimicrobial or microbicidal activity. The method of the present invention thus provides a solution which is both simple to implement and economically advantageous.

According to a particularly advantageous alternative embodiment of the method, the compounding step is carried out at temperatures of:

- between 150°C and 255°C, when the polymer composition is composed of high density polyethylene (HDPE);
- between 160°C and 255°C, when the polymer composition is composed of polyvinyl chloride (PVC);
- between 170°C and 255°C, when the polymer composition is composed of thermoplastic elastomers (TPEs) resulting from a blend of EPDM (ethylene/propylene/diene terpolymer) and polypropylene.

According to an advantageous embodiment of the method, said method additionally comprises a step consisting in:

d. forming a cord from the cable obtained in step c and at least one connecting element, said at least one connecting element preferably comprising an electrical connector or a USB connector.

The method can be employed in the manufacture of cables or cords as defined above, according to any one of their embodiments or alternative forms.

According to an advantageous embodiment of the method, said premix comprises titanium dioxide.

According to another advantageous embodiment of the method, said premix comprises a dispersant or surface-active agent, preferably chosen from the group consisting of a polyether polyol and an ethoxylated nonionic fluorinated surface-active agent of formula $F(CF_2CF_2)_yCH_2CH_2O(CH_2CH_2O)_xH$ where x = 0 to 15 and y = 1 to 7.

According to yet another advantageous embodiment of the method,

said premix comprises:

- from 0.1 to 5.0% by weight of said at least one active agent, with respect to the total weight of the combination formed by said polymer composition, said at least one active agent, said at least one organosilane coupling agent and optionally the titanium dioxide and a dispersant; and/or
- from 0.02 or 0.05 to 1.0% by weight of said at least one organosilane coupling agent, with respect to the total weight of the combination formed by said polymer composition, said at least one active agent, said at least one organosilane coupling agent and optionally the titanium dioxide and a dispersant.

According to an advantageous alternative embodiment of the method, said premix comprises:

- from 0.02 to 1.0% by weight of said at least one organosilane coupling agent when said at least one coupling agent is chosen from the organosilanes I_c and I_e; or
- from 0.05 to 1.0% by weight of said at least one organosilane coupling agent when said at least one coupling agent is chosen from the organosilanes I_a, I_b, I_d and I_f.

According to an advantageous embodiment of the method, said premix comprises from 0.1 to 1.5% by weight of titanium dioxide, with respect to the total weight of the combination formed by said polymer composition, said at least one active agent, said at least one organosilane coupling agent, said titanium dioxide and optionally a dispersant.

Thus, the invention makes it possible to obtain a cable or a cord suitable for use in a hospital environment or in a controlled atmosphere environment which exhibits a uniform antimicrobial or microbicidal, in particular antibacterial or bactericidal, activity over the surface of the cable or cord. The cable or cord according to the present invention thus effectively solves the technical problems stated by virtue of the combination of the compounds (the polymer composition, the active agent and the organosilane coupling agent) included in the cable or cord. The

active agent and the organosilane coupling agent are homogeneously distributed in the polymer composition. The combination of these compounds thus provides an optimum activity of the active agent, in this instance the antimicrobial or microbicidal inorganic compound, which, used in a smaller amount than in the prior art, makes it possible to obtain a cable or cord having antimicrobial or microbicidal properties at least comparable and/or superior to those of the cables or cords of the prior art.

Finally, the invention provides an effective method for manufacturing a cable or cord suitable for use in a hospital environment or in a controlled atmosphere environment. The step of preparation of the premix, followed by the implementation of the compounding step, makes it possible to obtain a homogeneous composite and thus to confer, on the polymer composition, uniform antimicrobial or microbicidal properties.

Other aims, characteristics and advantages of the invention will become clearly apparent to a person skilled in the art subsequent to the reading of the examples, which are given solely by way of illustration and which should not in any way limit the scope of the invention.

The examples form an integral part of the present invention and any feature appearing novel with respect to any state of the prior art from the description taken as a whole, including the examples, forms an integral part of the invention in the function thereof and in the generality thereof. Thus, each example has a general scope.

Furthermore, in the examples, all the percentages are given by weight, unless otherwise indicated, and the temperature is expressed in degrees Celsius, unless otherwise indicated, and the pressure is atmospheric pressure, unless otherwise indicated.

Examples of the implementation of the invention

Example 1 – Cable or cord 1

A premix is prepared in a mixing device at ambient temperature (15-25°C) from:

- a zeolite comprising 1.36% by weight of zinc and 0.44% by weight of silver, with respect to the total weight of the zeolite based on silver and on zinc. Said zeolite has antimicrobial or microbicidal properties;
- one or two organosilane coupling agent(s);
- titanium dioxide.

Compounding is carried out continuously:

- by feeding an extruder with a polymer composition or a polymer (in this instance PVC) and the premix obtained above, said extruder kneading the premix with the polymer at temperatures of between 160°C and 255°C; and
- by conditioning the composite in the form of granules once it has cooled.

The cable is formed by a sheath extrusion operation, or a method of injection moulding using the composite granules.

A cord is formed from the cable obtained and at least one connecting element, said at least one connecting element preferably comprising an electrical connector or a USB connector.

Example 1 of the implementation of the invention is illustrated in the following table, the amounts and the natures of the compounds included in the cable or cord being shown.

Antimicrobial or microbicidal compound	Zeolite having 1.36% by weight of zinc and 0.44% by weight of silver, with respect to the total weight of the zeolite based on silver and on zinc	0.5%
1st organosilane	I_f	0.3%
2nd organosilane	I_c	0.2%
Metal oxide	Titanium dioxide	0.3%
Type of polymer	PVC	98.7%

Example 2 - Cable or cord 2

A cable or cord 2 is manufactured as described in Example 1. However, the compounding step is carried out at temperatures of between 170°C and 255°C.

Antimicrobial or microbicidal compound	Zeolite having 1.36% by weight of zinc and 0.44% by weight of silver, with respect to the total weight of the zeolite based on silver and on zinc	0.5%
1st organosilane	I_f	0.3%
2nd organosilane	I_c	0.2%
Metal oxide	Titanium dioxide	0.3%
Type of polymer	Santoprene*1	98.7%

*1 this polymer corresponds to a thermoplastic elastomer (TPE) resulting from a blend of EPDM (ethylene/propylene/diene terpolymer) and polypropylene.

Example 3 - Cable or cord 3

A cable or cord 3 is manufactured as described in Example 2.

Antimicrobial or microbicidal compound	*Zeolite* having 1.36% by weight of zinc and 0.44% by weight of silver, with respect to the total weight of the zeolite based on silver and on zinc	0.5%
Organosilane	I_d	0.3%
Metal oxide	Titanium dioxide	0.2%
Type of polymer	Santoprene*[1]	99.0%

*[1] this polymer corresponds to a thermoplastic elastomer (TPE) resulting from a blend of EPDM (ethylene/propylene/diene terpolymer) and polypropylene.

Example 4 - Cable or cord 4

A cable or cord 4 is manufactured as described in Example 1. However, the compounding step is carried out at temperatures of between 150°C and 255°C.

Antimicrobial or microbicidal compound	Zeolite having 1.36% by weight of zinc and 0.44% by weight of silver, with respect to the total weight of the zeolite based on silver and on zinc	0.5%
1st organosilane	I_b	0.3%
2nd organosilane	I_e	0.2%
Metal oxide	Titanium dioxide	0.3%
Type of polymer	Hostalen*[2]	98.7%

*[2] this polymer corresponds to a high density polyethylene (HDPE).

Example 5 - Cable or cord 5

A cable or cord 5 is manufactured as described in Example 4.

Antimicrobial or microbicidal compound	Zeolite having 1.36% by weight of zinc and 0.44% by weight of silver, with respect to the total weight of the zeolite based on silver and on zinc	0.5%
1st organosilane	I_a	0.3%
2nd organosilane	I_c	0.2%
Metal oxide	Titanium dioxide	0.3%
Type of polymer	Hostalen*2	98.7%

*2 this polymer corresponds to a high density polyethylene (HDPE).

Example 6 – Antibacterial or bactericidal activity of the cable or cord obtained

Tests relating to the antibacterial or bactericidal activity are carried out according to Japanese Standard JIS Z 2801: 2000 from the cables or cords of the present invention. The results of these experiments are presented in the two tables below.

The controls are composed of the pure polymers and Tests 1 to 5 correspond respectively to the cables or cords obtained in Examples 1 to 5.

Staphylococcus aureus strain

After incubating at 37°C for 24 h

Example	Type of polymer	C_{t24}	log (C_{t24})	E_{t24}	log (E_{t24})	log (C_{t24}) - log (E_{t24})
Control	PVC	14 352	4.16			
1	PVC			32	1.50	2.66
Control	Santoprene*1	482 350	5.68			
2	Santoprene*1			0		Bactericidal
Control	Santoprene*1	482 255	5.68			
3	Santoprene*1			0		Bactericidal
Control	Hostalen*2	478 465	5.68			
4	Hostalen*2			0		Bactericidal
Control	Hostalen*2	13 946	4.14			
5	Hostalen*2			56	1.75	2.39

1) C_{t24}: the mean number of the bacteria counted in the case of the control, namely nonantibacterial, cable, after incubating for 24 hours.

2) E_{t24}: the mean number of the bacteria counted in the case of the test cable after incubating for 24 hours. When E_{t24} is zero, the activity is bactericidal.

3) log (C_{t24}) - log (E_{t24}): the activity is antibacterial when it is greater than 1.00.

Escherichia coli strain

After incubating at 37°C for 24 h

Example	Type of polymer	C_{t24}	log (C_{t24})	E_{t24}	log (E_{t24})	log (C_{t24}) - log (E_{t24})
Control	PVC	4044	3.60			
1	PVC			15	1.17	2.43
Control	Santoprene*1	20 125	4.30			
2	Santoprene*1			0		Bactericidal
Control	Santoprene*1	20 585	4.31			
3	Santoprene*1			0		Bactericidal
Control	Hostalen*2	21 897	4.34			
4	Hostalen*2			0		Bactericidal
Control	Hostalen*2	876 526	5.94			
5	Hostalen*2			7765	3.87	2.07

1) C_{t24}: the mean number of the bacteria counted in the case of the

control, namely nonantibacterial, cable, after incubating for 24 hours.
2) E_{t24}: the mean number of the bacteria counted in the case of the test cable after incubating for 24 hours. When E_{t24} is zero, the activity is bactericidal.
3) log (C_{t24}) - log (E_{t24}): the antibacterial activity is regarded as effective when it is greater than 1.00.

The homogeneity of the composite included in the cable or cord makes it possible to use a smaller amount of the antibacterial or bactericidal agent in a cable or cord of the present invention. Said cable or cord exhibits either an antibacterial activity or a bactericidal activity at least comparable and/or superior to those of the cables or cords of the prior art.

Example 7 – Cytotoxicity, sensitivity and irritation tests

Cytotoxicity test

A cytotoxicity test is carried out according to Standard ISO 10993-5: 1999 from the cable or cord obtained in Example 1.

The cytotoxicity test consists in counting the percentage of living cells after exposure of a culture of mouse fibroblast cells to an extract solution, prepared from the cable or cord of the present invention, at different concentrations. This test thus makes it possible to evaluate the biological reactivity of a culture of mammal cells with regard to the extract solutions prepared from the cable or cord of the present invention.

Results: the response obtained is of level 1 (very low) from the preparation of an undiluted sample and the response is of level 0 (no response) from extract solutions diluted to ½, ¼ and 1/8.

The cytotoxicity test from the cable or cord of the present invention is in accordance with the requirements of Standard USP 31 (United States

Pharmacopoeia) for a level of response not exceeding 2 (low).

Sensitivity and irritation tests

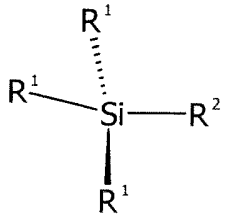
A sensitivity and irritation test is carried out according to Standard ISO 10993-10: 2002 from the cable or cord obtained in Example 1.
These tests make it possible to estimate the sensitization and/or irritation potential of the extracts obtained from the cable or cord of the present invention when the extracts are injected intradermally.

Results: the cable or cord of the present invention was evaluated as being nonsensitizing and nonirritating.

CLAIMS

1. Cable suitable for use in a hospital environment or in a controlled atmosphere environment, characterized in that it comprises:

- a polymer composition;
- at least one active agent composed of an antimicrobial or microbicidal inorganic compound, said inorganic compound preferably being chosen from the group consisting of silicates, zeolites, titanates and antimonates, in particular calcium silicate, calcium titanate, sodium antimonate and magnesium aluminometasilicate, the ions of which have been replaced by one or more antimicrobial or microbicidal metal ion(s) selected from silver, copper, zinc, tin, bismuth, lead, cadmium or chromium ions;
- said at least one active agent being coupled to the polymer composition via at least one organosilane coupling agent, preferably of formula (I):



(I)

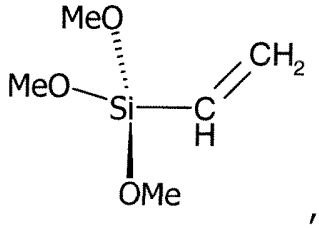
in which:

- R^1 denotes a methoxyl (CH_3-O-) or ethoxyl (CH_3-CH_2-O-) group; and
- R^2 is chosen from the group consisting of the vinyl (H_2C=CH-) group, the phenyl (C_6H_5-) group, the aminoalkylaminoalkyl group, in which the alkyls independently have from 2 to 3 carbon atoms, and the linear or branched C_1-C_4 alkyl group, optionally substituted by a sulphanyl group or by a halogen atom.

2. Cable according to Claim 1, characterized in that said aminoalkylaminoalkyl group is aminoethylaminopropyl (H_2N-CH_2-CH_2-NH-CH_2-CH_2-CH_2-).

3. Cable according to Claim 1 or 2, characterized in that said C_1-C_4 alkyl group is isobutyl or mercaptopropyl.

4. Cable according to any one of Claims 1 to 3, characterized in that said at least one organosilane coupling agent is chosen from the group consisting of:



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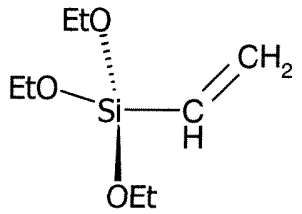
(I_a)



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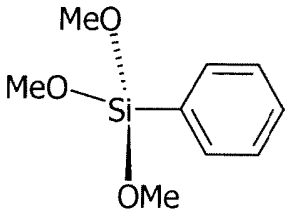
(I_b)



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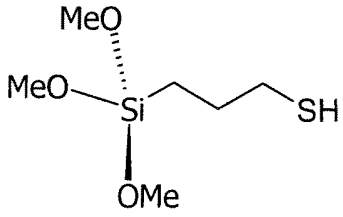
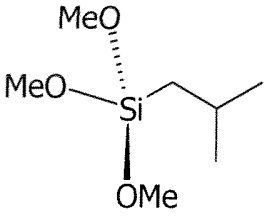
(I_c)



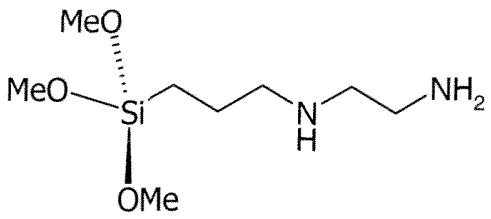
,

(I_d)



, and

(I_e)



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(I_f)

5. Cable according to any one of Claims 1 to 4, characterized in that the polymer composition is chosen from polyvinyl chloride (PVC), polyethylene (PE), preferably high density polyethylene (HDPE), polypropylene (PP), polytetrafluoroethylene (PTFE), poly(styrene/butadiene/acrylonitrile) (ABS), poly(styrene/butadiene/styrene) (SBS), polycarbonate (PC), polyoxymethylene (POM), poly(ethylenimine) (PEI), polysulphone (PSU), polyetheretherketone (PEEK), polyether block amide (PEBA), thermoplastic polyurethanes (TPU), epoxy polymers (or polyepoxide), silicones (or polysiloxanes), fluorinated ethylene/propylene copolymer (FEP), ethylene/tetrafluoroethylene copolymer (ETFE), thermoplastic elastomers (TPEs) resulting from a blend of EPDM (ethylene/propylene/diene terpolymer) and polypropylene, and a blend of at least two of these polymers.

6. Cable according to Claim 5, characterized in that said polymer composition is chosen from polyvinyl chloride (PVC), high density polyethylene (HDPE) and thermoplastic elastomers (TPEs) resulting from a blend of EPDM (ethylene/propylene/diene terpolymer) and polypropylene.

7. Cable according to any one of Claims 1 to 6, characterized in that said at least one active agent comprises silver ions.

8. Cable according to any one of Claims 1 to 7, characterized in that said at least one active agent is a zeolite comprising silver ions and optionally zinc ions.

9. Cable according to Claim 8, characterized in that said zeolite comprises from 1 to 2% by weight of zinc and from 0.2 to 0.8% by weight of silver, with respect to the total weight of the zeolite based on silver and on zinc.

10. Cable according to any one of Claims 1 to 9, characterized in that it additionally comprises titanium dioxide.

11. Cable according to any one of Claims 1 to 10, characterized in that it

additionally comprises a dispersant or surface-active agent, preferably chosen from the group consisting of a polyether polyol and an ethoxylated nonionic fluorinated surface-active agent of formula $F(CF_2CF_2)_yCH_2CH_2O(CH_2CH_2O)_xH$ where x = 0 to 15 and y = 1 to 7.

12. Cable according to any one of Claims 1 to 11, characterized in that it comprises:

- from 0.1 to 5.0% by weight of said at least one active agent, with respect to the total weight of the combination formed by said polymer composition, said at least one active agent, said at least one organosilane coupling agent and optionally the titanium dioxide and a dispersant; and/or
- from 0.02 or 0.05 to 1.0% by weight of said at least one organosilane coupling agent, with respect to the total weight of the combination formed by said polymer composition, said at least one active agent, said at least one organosilane coupling agent and optionally the titanium dioxide and a dispersant.

13. Cable according to Claim 12, characterized in that it comprises:

- from 0.02 to 1.0% by weight of said at least one organosilane coupling agent when said at least one coupling agent is chosen from the organosilanes I_c and I_e; or
- from 0.05 to 1.0% by weight of said at least one organosilane coupling agent when said at least one coupling agent is chosen from the organosilanes I_a, I_b, I_d and I_f.

14. Cable according to any one of Claims 1 to 13, characterized in that it comprises from 0.1 to 1.5% by weight of titanium dioxide, with respect to the total weight of the combination formed by said polymer composition, said at least one active agent, said at least one organosilane coupling agent, said titanium dioxide and optionally a dispersant.

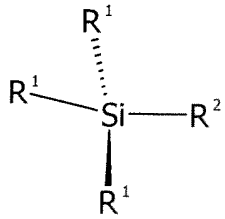
15. Cord composed of a cable according to any one of Claims 1 to 14 and at least one connecting element, said at least one connecting element

preferably comprising an electrical connector or a USB connector.

16. Use of the cable according to any one of Claims 1 to 14 or of the cord according to Claim 15 in a hospital environment or in a controlled atmosphere environment.

17. Method for manufacturing a cable or cord suitable for use in a hospital environment or in a controlled atmosphere environment, characterized in that it comprises the steps consisting in:

a. preparing a premix in a mixing device at ambient temperature (15-25°C), said premix comprising:
   - at least one active agent composed of an antimicrobial or microbicidal inorganic compound, said inorganic compound preferably being chosen from the group consisting of silicates, zeolites, titanates and antimonates, in particular calcium silicate, calcium titanate, sodium antimonate and magnesium aluminometasilicate, the ions of which have been replaced by one or more antimicrobial or microbicidal metal ion(s) selected from silver, copper, zinc, tin, bismuth, lead, cadmium or chromium ions;
   - at least one organosilane coupling agent, preferably of formula (I):



(I)

in which:

- R^1 denotes a methoxyl (CH_3-O-) or ethoxyl (CH_3-CH_2-O-) group; and
- R^2 is chosen from the group consisting of the vinyl (H_2C=CH-)

group, the phenyl (C_6H_5-) group, the aminoalkylaminoalkyl group, in which the alkyls independently have from 2 to 3 carbon atoms, and the linear or branched C_1-C_4 alkyl group, optionally substituted by a sulphanyl group or by a halogen atom;

- optionally titanium dioxide; and
- optionally a dispersant or surface-active agent, preferably chosen from the group consisting of a polyether polyol and an ethoxylated nonionic fluorinated surface-active agent of formula $F(CF_2CF_2)_yCH_2CH_2O(CH_2CH_2O)_xH$ where x = 0 to 15 and y = 1 to 7;

b. continuously compounding:
   - by feeding an extruder with a polymer composition and the premix obtained in the previous step, said extruder kneading the premix with the polymer composition at temperatures of between 150°C and 255°C; and
   - by conditioning the product resulting from the compounding, known as compound or composite, in the form of granules once the composite has cooled; and

c. forming the cable by a sheath extrusion operation, or a method of injection moulding using the composite granules.

18. Method according to Claim 17, characterized in that the compounding step is carried out at temperatures of:

- between 150°C and 255°C, when the polymer composition is composed of high density polyethylene (HDPE);
- between 160°C and 255°C, when the polymer composition is composed of polyvinyl chloride (PVC);
- between 170°C and 255°C, when the polymer composition is composed of thermoplastic elastomers (TPEs) resulting from a blend of EPDM (ethylene/propylene/diene terpolymer) and polypropylene.

19. Method according to Claim 17 or 18, characterized in that it additionally comprises a step consisting in:

d. forming a cord from the cable obtained in step c and at least one connecting element, said at least one connecting element preferably comprising an electrical connector or a USB connector.

Application No:	GB0918418.5	**Examiner:**	Mr Jason Scott
Claims searched:	1-18	**Date of search:**	19 February 2010

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	-	EP 1942375 A SAMSUNG See whole document teaching the coupling of silver nanoparticles to polymers.
A	-	US 2007/116976 A TAN See whole document teaching the use of silane coupling agents to compatibilize copper and cadmium titanates with polymer compositions.
A	-	EP 1374830 A KERR See whole document teaching a dental composition of monomers and silver ceramic. A silane coupling agent is surface coated onto a zincaluminosilicate.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

A01N; A01P; C08J; H01B

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, CASONLINE

International Classification:

Subclass	Subgroup	Valid From
C08J	0007/12	01/01/2006
A01P	0001/00	01/01/2006
H01B	0003/30	01/01/2006