A wound healing material comprising wound dressings, which include materials such as textile, polymer fibers, polymer film, synthetic fiber, cellulose fiber, wool fiber or cotton fiber, wherein the wound healing material comprises substantially pure copper.
**WOUND HEALING MATERIAL COMPRISING COPPER**

**Technical field**

The present invention relates to a wound healing material comprising copper containing materials, or copper thread containing materials. The invention further relates to the use of these materials for treatment of wounds, burns and other skin problems.

**Background**

In the field of wound care, one is today facing a global problem of increasing antibiotic resistance, which not only impedes wound healing, but also is potentially fatal to persons with severe wounds, such as from burns, etc.

It is desirable to find treatments that do not involve the use of antibiotics. A recent survey in the field of antiseptic dressings, i.e. dressings that can be applied topically to the skin and prevent the propagation of, or kills, microorganisms by Lindholm (Antiseptic preparations in wound treatment) provides a review of the antiseptic dressings that are currently used in healthcare. Lindholm lists a variety of alternatives to antibiotics such as medical honey, iodine, PHMB, hydrophobic wound dressings that work by attracting bacteria to the dressing and silver.

A problem with silver is, however, leakage of silver ion to e.g. streams, which is not desirable from an environmental standpoint.

As an alternative described in Borkow (Copper Oxide ...) the use of copper oxide in different types of joints, and EP1 809306, this document also describes the use of copper oxide to various types of wound dressings.

**Summary**

An object of the present invention is therefore to provide improved wound healing materials such as burns or infected wounds, and the use of this material in various wound healing applications.

This object is provided in a first aspect a wound healing material comprising wound dressings which comprise material such as polymer fibers, polymer
films, synthetic fibers, cellulose fibers, wool fibers or cotton fibers, wherein the wound healing material comprises substantially pure copper.

By the skin having a pH value <7, at which the copper ions are precipitated, copper ions will be released upon contact with the skin, and thereby kills bacteria and viruses. Copper is however not absorbed by the body and does not emit any ions at pH above 7. When the skin has a pH of 4.5 to 5, copper ions will only be emitted in contact with the skin and will provide a local effect. Any remaining ions on the body are washed away during washing. When copper powder is contacted with an acidic and moist environment, copper ions are released. The amount of ions released depends on the pH and on the surface which is exposed to moisture. A finely ground powder releases more ions compared to a coarse powder. Human skin has according to literature typically a pH of below 6, which means that the copper ions are released upon contact with the skin, if the skin is moist. Humans are less sensitive to intake of copper because the human body regulates the uptake in the liver. Excessive copper intake via food irritates the digestive tract. Even dust can cause inconvenience. Some reported adverse effects due to copper uptake through the skin, has not been found. Bacteria and microorganisms are especially sensitive to the effects of copper ions. Copper powder is therefore classified as very toxic to aquatic organisms. Waste of copper powder in any form should be handled as hazardous waste.

By applying copper with different materials can be checked in the context where it is justified to the extent that is necessary. This product may also, in many cases replace or reduce the use of antibiotics.

By "substantially pure" copper is meant that the wound healing material comprises copper (29Cu) in any form and not the copper in the form of ions such as copper oxide, etc. Copper oxide, which is an oxidized form of copper also releases more easily from the copper ions, with the risk that the copper ions are also released not only locally where treatment is needed, which increases the risk of adverse environmental impacts.

By using pure copper in various forms and incorporate it into various materials to specifically be used when the need exists to take care of e.g., infected wounds to heal and prevent the spread of these. This can also be
used in conjunction with surgery and wound dressing when there is a risk of spreading difficult infections, for example in the form of multi-resistant bacteria and in infection wards where patients are treated with varying degrees of infection.

According to one embodiment, said copper is present as copper powder, wherein the copper powder is imbedded in the fiber such that it is at least partially exposed at the surface of said fiber. With the copper powder being at least partially exposed on the surface is meant that the copper powder can be imbedded in the fiber for example by different manufacturing processes or be mixed with the fiber such that the powder has the ability to come into contact with the skin surface the wound healing material intends to cover.

In another embodiment, said copper is present as a copper thread, which wire is woven or spun into wound healing material.

By weaving or spinning the copper thread with the materials that make up the wound healing material, it is possible to easily incorporate the copper into the material, and it may also be exposed to the skin surface to be treated through the wound healing material.

In an alternative embodiment, the material comprises both copper powder and copper thread.

In one embodiment of the first aspect of the invention, copper powder may be adhered to the material and thus directly applied to the skin during use thereof.

In a second aspect there is provided use of a wound healing materials of any preceding claim, for the treatment of wounds and tissue injuries comprising burns, infected wounds.

Wound healing material may also be used to treat other skin conditions.

By the wound healing materials including copper, there is provided for an effective local killing or limitation of bacteria that cause infections in wounds, which favors wound healing process and prevent that life-threatening conditions such as sepsis occurs.
According to one embodiment of the second aspect, the material may be a wound dressing comprising fibers which comprises copper powder or copper thread.

In a further embodiment, said material may be formed of a scrim material comprising copper powder or copper thread.

In an alternative embodiment, the material may be formed of a scrim material comprising copper powder or copper thread.

The material can be made from merino wool, which comprises copper powder or copper thread.

According to one embodiment of the second aspect, the material used may be a fabric with fibers containing copper powder or copper wire, to be contacted with smaller or larger parts of the body surface area is affected by the infection.

In a further embodiment, the material used may be an adhesive synthetic material with embedded copper powder or copper thread, which material when applied comes into contact with the skin.

The material which comprises copper powder or copper thread, and which is used according to the second aspect may be, according to one embodiment, either one of cotton, merino wool, synthetic fibers for: panties, bras, breast pads, socks, dressing for amputees, sweater.

By using materials including copper powder or copper thread, in for example a nursing pads ulcers associated with breast-feeding may be treated, or the wound material may be incorporated in, be part of, or consist of, for example briefs which can be easily applied to a patient in need of wound-healing actions.

The material used may be a wound healing textile, wound healing extruded film, filament or sheath comprising copper powder or copper thread. In an alternative embodiment, the wound healing material used may be an article of clothing or a bed and linen.

In that way you can incorporate copper into e.g. patient garments and linens for use in hospitals and other healthcare facilities.

This allows for an active wound healing without applying tight-fitting dressings.
According to this alternative embodiment, the wound healing material may wholly or partly comprise copper in the form of copper powder or copper thread. The material may for example be configured such that it is only provided with copper powder or copper thread in a limited area thereof, for example in a sleeve or on a back portion, depending on where the patient has wounds to be treated by the wound healing material comprising copper powder or copper thread.

**Brief description of the drawings**

The invention will be further described by an embodiment with reference to the accompanying drawings.

FIG. 1 is a photograph of a culture plate with applied copper threads.

Fig. 2 is a photograph of the culture plate of Fig. 1 where the copper threads are removed.

FIG. 3 is a photograph of two culture plates with applied copper containing fabric.

Fig. 4 is a photograph of the culture plates in Figure 3 where the fabric is removed.

Fig. 5 is a photograph of a tightly knitted copper textile.

**Detailed description**

According to the invention, wound healing materials include a variety of wound dressings formed from materials such as textiles, polymeric fiber, polymeric film, synthetic fibers, cellulose fibers, wool fibers or cotton fiber.

These dressings are intended to be applied to areas of skin that are covered by different types of wounds, sores, burns or other types of skin conditions such as psoriasis, blisters, pustules, etc., in order to contribute to the healing of these wounds and ailments.

Wound healing material comprises pure copper \( \text{Cu} \) in various forms as the invention is based on the discovery that pure copper which is introduced in various wound healing materials have an antibacterial and
antiseptic effect against a variety of microorganisms. By including or incorporating pure copper into the wound healing material a local effect of copper ions that kill or limit the spread of microorganisms is obtained, thereby affecting the wound healing positively.

In one embodiment the wound healing material comprises copper powder.

Copper powder may for example be of the type manufactured by Thermo Scie BID ATG GC, with CAS number 7440-50-8, but it is also possible to utilize other kinds of copper powder.

When copper powder is brought into contact with an acidic and moist environment copper ions are released. The amount of ions released depends on the pH and on the surface which is exposed to moisture. A finely ground powder releases more ions compared to a coarse powder. Human skin has according to literature typically pH below 6, which means that the copper ions are released upon contact with the skin, if the skin is moist. Humans are less sensitive to intake of copper because the human body regulates the uptake in the liver, however, there are no reported adverse effects due to copper absorption through the skin. Bacteria and microorganisms are especially sensitive to the effects of copper ions, so it is important to limit the exposure of the copper to the precise area of the skin that is in need of it, and prevent the copper ions and copper leaking into the surrounding environment.

Copper powder may be applied to the stated materials in various ways. Copper powder should, however, be applied so that the powder is somehow projected outwardly from the surface of the wound healing material, in order to come in contact with the skin surface which it is intended to treat.

In one embodiment, this can occur in connection with dyeing in which copper powder is mixed in color.

In an alternative embodiment, the powder may be sprinkled on a glue pad, when the adhesive has been added to the existing textile.

Furthermore, according to a further embodiment, the copper powder may be processed into the material by using pressure and heat.

Copper powder may, according to an alternative embodiment, be processed into textile fiber when several wires or threads are twisted.
In one embodiment, the wound dressing material is a nonwoven weave of synthetic fiber, wherein the copper powder is embedded therein, wherein a part of said particles being exposed and protruding from the surfaces thereof. According to an alternative embodiment, the wound healing material may comprise threads of copper incorporated in the material either by co-extrusion of the fiber or by being spun, knitted or woven into the material. Thus, one can weave, knit or spin up the copper wire with a textile. The wound healing material may comprise a material in which the copper threads are knitted or woven together in such a way that the material consists only of copper wires. In an alternative embodiment, the copper threads may be woven, spun or knitted together with a textile or textile yarns or any other type of fiber such that wound healing material is composed of a combination of copper wires and wires of any other material. The material may comprise copper threads arranged such that they are tightly fitted against each other, as illustrated by Figure 5. The threads may have diameter dimensions in a range from 0.005 to 0.20 mm. In one embodiment, the diameter is 0.15 mm, according to an alternative embodiment, it is 0.10 mm, and in a further embodiment, 0.010 mm. In a further embodiment, the material may comprise a combination of copper powder and copper threads. Wound healing materials may also comprise surgical textiles in the form of synthetic fibers or cotton cloth or merino wool, wherein the copper powder and / or copper thread is included, for use in connection with surgery and dressings of wounds, where there is a risk of or a documented infection. Further, wound healing material may comprise, be part of or include different types of textiles, which have been provided with copper powder and / or copper. These fabrics can be in the form of clothing, protective clothing, surgical clothing for personnel associated with the treatment of patients with anticipated or documented bacterial infection.

Example
Trials have been conducted with pure copper in various forms to ensure the antibacterial and antiseptic effect of the copper. The textile samples were placed on cultivated bacterial solutions on blood agar plates and incubated in the oven for about 16 hours, 36-37 degrees.

In trial 1 S. aureus was cultivated on blood agar which was incubated for about 16 hours at 36-37 °C. As shown in Fig. 1 copper threads, having a dimension 0.10 mm in diameter, were placed on the culture plates and they were incubated in a heating cabinet. After a period of time, the copper wire was removed and it was clearly noted that a killing of the microorganisms had taken place, which is also shown in Fig. 2.

In a second trial, S. aureus was cultivated on blood agar. As shown in Fig. 3 was a textile comprising copper wires of 0.10 mm dimension, was then placed on the culture plates and they were incubated in a heating cabinet. After a period of time the fabric was removed and it was clearly noted that a killing of the microorganisms had taken place, which is also shown in Fig. 4.

Attempts have also been made with the copper textile shown in Fig. 5, and copper powder stuck to a wound dressing. Also in these trials S. aureus was cultivated, and after incubation with an applied copper textile and "copper powder tape" it was discovered that a clear killing of bacteria had occurred.

From these trials it is clear that copper has a killing and reducing effect, even when copper is incorporated into a textile material.
CLAIMS

1. A wound healing material comprising wound dressings, which include materials such as textile, polymer fibers, polymer film, synthetic fiber, cellulose fiber, wool fiber or cotton fiber characterized in that the wound healing material comprises substantially pure copper.

2. The wound healing material as claimed in claim 1, wherein said copper is present as a copper powder, wherein the copper powder is imbedded in the material such that it is at least partially exposed at the surface of said material.

3. Wound healing material as claimed in claim 1, wherein said copper is present as copper thread, which thread is woven, knitted or spun into the wound healing material.

4. Wound healing material of claim 1 or 2, wherein the copper powder is glued to the material and thus directly contacted with the skin during use thereof.

5. Use of a wound healing material of any preceding claim, for the treatment of wounds and tissue injuries comprising burns, infected wounds.

6. Use according to claim 5, wherein the material is a wound dressing comprising fibers which comprises copper powder or copper thread.

7. Use according to any one of claims 5 or 6, wherein said material is formed of a scrim material comprising copper powder or copper thread.

8. Use according to any one of claims 5 or 6, wherein the material formed from knitted cotton material which comprises copper powder or copper thread.
9. Use according to any one of claims 5 or 6, wherein the material formed from wool, merino wool, which comprises copper powder or copper thread.

10. Use according to any one of claims 5 to 9, wherein the material is a fabric having fibers comprising copper powder or copper thread, to be contacted with smaller or larger parts of the body surface area is affected by the infection.

11. Use according to claim 5, wherein the adhesive material is a synthetic material with embedded copper powder or copper thread, which material when applied comes into contact with the skin.

12. Use according to one of claims 5 or 6 wherein the material comprising copper powder or copper thread, is any one of cotton, merino wool, synthetic fibers for: panties, bras, breast pads, socks, dressing for amputees, sweater.

13. Use according to any one of claims 5 or 6, wherein the material is a wound healing textile, wound healing extruded film, filament or sheath comprising copper powder or copper thread.

14. Use according to any one of claims 5 or 6, wherein the material is wound and a garment or a bed linen.

15. Use according to claim 14, wherein the wound healing material completely or partly comprises copper in the form of copper powder or copper thread.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
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: A61 K, A61 L, A61 P

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

SE, DK, FI, NO classes as above

Electronic database consulted during the international search (name of database and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data, BIOSIS, EMBASE, MEDLINE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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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 | Date of mailing of the international search report
02-03-2015 | 03-03-2015

Name and mailing address of the ISA/SE
Patent och registreringsverket
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This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. **Claims Nos.: 5-15**
   - because they relate to subject matter not required to be searched by this Authority, namely:

   Claims 5-15 relate to a method for treatment of the human or animal body by therapy, see PCT rule 39.1 (iv). Nevertheless, a search has been made for these claims. The search has been directed to the technical content of the claims.

2. **Claims Nos.:**
   - because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. **Claims Nos.:**
   - because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

This International Searching Authority found multiple inventions in this international application, as follows:

1. **As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.**

2. **As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.**

3. **As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:**

4. **No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:**

**Remark on Protest**
- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.
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International Patent Classification (IPC)

A61K 33/34 (2006.01)
A61L 15/18 (2006.01)
A61L 75/44 (2006.01)
A61P 17/02 (2006.01)