Abstract: A water-resistant orthopedic undercast sleeve, including a tubular sheet material having hydrophobic properties and a thickness sufficient to provide both cushioning and moisture transport in a single layer between a cast and a limb onto which the sleeve is applied, and moisture egress channels formed in the sheet material for transporting moisture away from the limb, longitudinally along the length of the sleeve, and out of the space between the sleeve and cast, the sheet material having sufficient resistance to compression so as to maintain the moisture egress channels subsequent to application of a cast over the sheet material.
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
WATER-RESISTANT ORTHOPEDIC UNDERCAST SLEEVE PRODUCT

Technical Field and Background of the Invention

[0001] The invention relates to a water-resistant undercast sleeve. In this application, the term "stockinette" is used to refer to prior art structures that are applied directly to the skin. In conventional casting practice, a stockinette is first applied to the injured limb to reside directly against the skin of the patient. The stockinette is usually formed of a thin circular-knit product that has sufficient stretch to allow it to fit onto the limb and closely conform to the varying shapes, contours and dimensions of the limb without wrinkles, overlaps or puckers that could cause discomfort or abrasion to the skin.

[0002] A padding is then applied over the stockinette onto the injured limb before the application of the cast tape. The padding provides a cushion and spacing between the skin and the cast tape, and protection to the bony prominences of the limb, and further aids in patient comfort. The stockinette and padding together form a system that collectively provides protection to the limb while the overlying cast tape provides the necessary support and rigidity to immobilize the limb during healing.

[0003] However, the conventional stockinette and padding system is not resistant to perspiration and/or moisture, and when wet can give off odor and become uncomfortable to wear. This leads to a higher incidence of skin irritation and maceration, and in many instances may require removal and replacement of an otherwise medically-effective cast. These factors have traditionally provided the majority of complaints regarding what is otherwise a medically-sound and cost-effective treatment regimen for bone fractures and other conditions requiring extended immobilization of a limb.

[0004] The invention described in this application discloses an undercast sleeve, which will replace both the conventional stockinette and padding. In addition to providing a satisfactory level of cushioning, this sleeve also repels water and dries
quickly when wetted. The water-resistant sleeve of this invention is aimed at providing more freedom to the patient and help them carry out daily routine activities with much ease. Similar efforts have been conducted in the past to develop a water-resistant undercast sleeve, as described in US Patent No. 5, 540,964 and WO2005/004765. However, none of the efforts have resulted in a successful working product.

[0005] The '964 Patent discloses a sleeve constructed using hydrophilic fibers with an applied hydrophilic finish. The recited principle is to wick moisture away from the skin. However, the cast material itself is relatively impervious to both air and moisture transfer, so the wicking action moves the moisture into the overlying padding and cast material, where it accumulates in the padding and in the structure of the cast.

[0006] The WO '765 publication discloses using microdenier fibers to wick moisture away from the skin, but this product has not proven effective for reasons similar to the '964 Patent.

[0007] In contrast to these prior art attempts to solve the moisture-retention problem with hydrophilic products, applicant has discovered a means of utilizing hydrophobic materials to drain moisture away from the skin.

**Summary of the Invention**

[0008] Therefore, it is an object of the invention to provide a single product that replaces both a conventional stockinette and undercast padding system.

[0009] It is another object of the invention to provide a sleeve that resists moisture accumulation and retention.

[0010] It is another object of the invention to provide a sleeve that dries rapidly when wet.

[0011] It is another object of the invention to provide a sleeve that can be fabricated from a variety of materials.
It is another object of the invention to provide a sleeve that can be used with both plaster and synthetic casting materials.

These and other objects and advantages of the invention are provided in a water-resistant orthopedic undercast sleeve, comprising a tubular sheet material having hydrophobic properties and a thickness sufficient to provide both cushioning and moisture transport in a single layer between a cast and a limb onto which the sleeve is applied, and moisture egress channels formed in the sheet material for transporting moisture away from the limb, longitudinally along the length of the sleeve, and out of the space between the sleeve and cast, the sheet material having sufficient resistance to compression so as to maintain the moisture egress channels subsequent to application of a cast over the sheet material.

According to one preferred embodiment of the invention, the tubular sheet material comprises a tubular fabric.

According to another preferred embodiment of the invention, the tubular sheet material comprises a tubular knitted fabric.

According to yet another preferred embodiment of the invention, the tubular sheet material comprises a tubular non-woven fabric.

According to yet another preferred embodiment of the invention, the tubular sheet material comprises a tubular open cell foam.

According to yet another preferred embodiment of the invention, the tubular knitted fabric is formed in an elongate roll of sufficient length to permit multiple lengths suitable for application to a limb to be severed from the roll, as and when needed.

According to yet another preferred embodiment of the invention, the tubular knitted fabric is provided in pre-cut lengths suitable for application to a limb of a predetermined size and length.
According to yet another preferred embodiment of the invention, the tubular knitted fabric is low moisture regain hydrophobic fiber selected from the group consisting of polyester and polypropylene.

According to yet another preferred embodiment of the invention, the construction of the tubular knitted fabric is selected from the group consisting of a single knit rib construction and a double knit rib construction.

According to yet another preferred embodiment of the invention, the tubular knitted fabric comprises a rib knit construction wherein the ribs extend longitudinally along the length of the sleeve.

According to yet another preferred embodiment of the invention, the sleeve is knitted from a hydrophobic, low filament, multifilament yarn with a filament count of at least 10 and having a total denier of between 50 and 2000.

According to yet another preferred embodiment of the invention, the sleeve is knitted from a hydrophobic, low filament, multifilament yarn with a filament count of at least 10 and having a total denier of between 500 - 1500.

According to yet another preferred embodiment of the invention, the sleeve is a 2 x 2 rib-knit formed a hydrophobic, low filament, multifilament yarn with a filament count of at least 10 and having a total denier of between 50 and 2000.

According to yet another preferred embodiment of the invention, the sleeve is constructed from yarns pre-treated with a water-resistant surface coating to impart enhanced water-resistant properties to the sleeve.

According to yet another preferred embodiment of the invention, the sleeve comprises a sleeve treated with a water-resistant surface coating to impart enhanced water-resistant properties to the sleeve.

According to yet another preferred embodiment of the invention, a water-resistant orthopedic undercast sleeve is provided, comprising a tubular rib-knitted sleeve having hydrophobic properties and spaced-apart, longitudinally-extends ribs of sufficient thickness sufficient to provide both cushioning and moisture transport in a
single layer between a cast and a limb onto which the sleeve is applied. Moisture egress channels are formed between adjacent ribs for transporting moisture away from the limb, longitudinally along the length of the sleeve, and out of the space between the sleeve and cast, the sheet material having sufficient resistance to compression so as to maintain the moisture egress channels subsequent to application of a cast over the sheet material. The hydrophobic properties of the sleeve are at least in part provided by a surface treatment to the sleeve of a material that imparts enhanced hydrophobic characteristics.

According to yet another preferred embodiment of the invention, the tubular knitted fabric is low moisture regain hydrophobic fiber selected from the group consisting of polyester and polypropylene, and the construction of the tubular knitted fabric is selected from the group consisting of a single knit rib construction and a double knit rib construction.

**Brief Description of the Drawings**

Some of the objects of the invention have been set forth above. Other objects and advantages of the invention will appear as the invention proceeds when taken in conjunction with the following drawings, in which:

- Figure 1 is a perspective view of a continuous roll of the sleeve product;
- Figure 2 is a perspective view of a sleeve in place on the forearm of a patient; and
- Figure 3 is a perspective view of a cast in place on a limb, including the sleeve according to an embodiment of the invention.

**Description of the Preferred Embodiment and Best Mode**

Referring now specifically to the drawings, a water-resistant orthopedic undercast sleeve product according to the present invention is illustrated in Figure 1 and shown generally at reference numeral 10. The particular embodiment shown in
Figure 1 is a roll-form product, and can be cut to length as needed. Indicia noting particular lengths can be placed on the product 10 to indicate where a cut may be made. The indicia may be a mark, a series of dropped stitches, or any other suitable manner of indicating a particular length.

Alternatively, the product 10 may be pre-cut into one or more lengths and packaged in that form, for example, in a bag or envelope from which a pre-cut length of product 10 is removed when needed.

Referring now to Figure 2, the sleeve product 10, whether originally in roll-form or pre-cut, is placed on a limb to form a water-resistant orthopedic undercast sleeve 20. The sleeve 20 can be constructed using suitable materials that provide adequate cushioning underneath a cast and are easy to mold around the injured limb, such as foam, knitted or stretch-woven textile substrate, polymeric film, plastic material or a combination of these. In a preferred embodiment shown in Figure 2, the sleeve 20 is constructed of a suitable textile fabric, which can be constructed using any suitable organic or inorganic fiber or a blend of these. The sleeve 20 is preferably constructed using a low moisture regain, hydrophobic fiber such as polyester or polypropylene. The textile substrate can be either a single knit or a double knit construction.

In the most preferred form, the sleeve 20 is knitted using a hydrophobic fiber, such as polypropylene. The yarns selected for knitting the sleeve 20 can be a monofilament or a multifilament or a blend of both. In the preferred embodiment, the sleeve 20 is knitted using a hydrophobic, low filament, multifilament yarn with a filament count of at least 10 and having a total denier of between 50 and 2000, and preferably 500 - 1500.

The textile substrate can be knitted using any suitable knit structure and design, including but not limited to plain knit, rib knit, jersey knit, loop/terry knit and an interlock knit. In the most preferred form the sleeve 20 is knitted using a rib design such as 1 x 1, 2 x 1, 2 x 2 or 3 x 1 rib. A typical rib 2 x 2 rib knit pattern is shown in Figure 2.
The water-resistant performance of the undercast sleeve 20 will depend on the type of fiber, yarn and fabric construction. Hence the sleeve 20 may or may not require further treatment or finishing to enhance its water resistance. The sleeve 20 can be constructed from pre-treated yarns, i.e. yarns that have been treated with a wax, silicone, fluorochemical product or coated with a nano-coating or any other suitable water-resistant product. In an alternate construction, the 20 sleeve can be treated with a suitable fluorochemical or plasma treatment, or similar product that improves or imparts a water-resistant characteristic to the sleeve 20. As is shown in Figure 3, the sleeve 20 resides against the skin and beneath an overlying wrapping of cast tape 25 to form a completed cast structure 30. As noted above, the sleeve 20 is intended to replace both the stockinette and padding of a conventional cast system. For this reason, the sleeve is constructed with a loft, bulk or thickness that provides adequate protection to the skin and bony prominences when applied under an orthopedic cast.

It has been observed during development that a sleeve with a hydrophobic performance will not function correctly without a means of conveying the moisture not only away from the skin, but out of the space between the sleeve 20 and cast tape 25. This is accomplished by, in the knitted embodiment, utilizing the rib knit to define egress channels between the ribs to convey moisture longitudinally along the length of the cast 30 to the surrounding air. Water movement and drying of the textile substrate is greatly improved by fewer yarn filaments and orientation, which can trap water molecules retaining a feeling of wetness in the area of the skin.

Alternatively, spacer fabrics may be suitable, with spaced-apart faces of the fabric defining an intermediate channel for transporting moisture away from both the sleeve and the cast tape. The spacer fabric is formed as or into a tube and has sufficient elasticity to form to the shape of the limb in the same manner as the sleeve 20 shown in Figure 2.
Further alternatives may include open cell foam products in the form of sheets with channels or grooves molded or otherwise formed into the surface of the foam to serve as channels for transporting moisture away from the foam sleeve and the cast tape. The sheets are formed as or into tubes and have sufficient elasticity to form to the shape of the limb in the same manner as the sleeve 20 shown in Figure 2.
We claim:

1. A water-resistant orthopedic undercast sleeve, comprising:
   (a) a tubular sheet material having hydrophobic properties and a thickness sufficient to provide both cushioning and moisture transport in a single layer between a cast and a limb onto which the sleeve is applied, and
   (b) moisture egress channels formed in said sheet material for transporting moisture away from the limb, longitudinally along the length of the sleeve, and out of the space between the sleeve and cast, the sheet material having sufficient resistance to compression so as to maintain the moisture egress channels subsequent to application of a cast over the sheet material.

2. A water-resistant orthopedic undercast sleeve according to claim 1, wherein the tubular sheet material comprises a tubular fabric.

3. A water-resistant orthopedic undercast sleeve according to claim 1, wherein the tubular sheet material comprises a tubular knitted fabric.

4. A water-resistant orthopedic undercast sleeve according to claim 1, wherein the tubular sheet material comprises a tubular non-woven fabric.

5. A water-resistant orthopedic undercast sleeve according to claim 1, wherein the tubular sheet material comprises a tubular open cell foam.
6. A water-resistant orthopedic undercast sleeve according to claim 1, wherein the tubular knitted fabric is formed in an elongate roll of sufficient length to permit multiple lengths suitable for application to a limb to be severed from the roll, as and when needed.

7. A water-resistant orthopedic undercast sleeve according to claim 1, wherein the tubular knitted fabric is provided in pre-cut lengths suitable for application to a limb of a predetermined size and length.

8. A water-resistant orthopedic undercast sleeve according to claim 1 or 6, wherein the tubular knitted fabric is low moisture regain hydrophobic fiber selected from the group consisting of polyester and polypropylene.

9. A water-resistant orthopedic undercast sleeve according to claim 1 or 6, wherein the construction of the tubular knitted fabric is selected from the group consisting of a single knit rib construction and a double knit rib construction.

10. A water-resistant orthopedic undercast sleeve according to claim 1 or 6, wherein the tubular knitted fabric comprises a rib knit construction wherein the ribs extend longitudinally along the length of the sleeve.
11. A water-resistant orthopedic undercast sleeve according to claim 1 or 6, wherein the sleeve is knitted from a hydrophobic, low filament, multifilament yarn with a filament count of at least 10 and having a total denier of between 50 and 2000.

12. A water-resistant orthopedic undercast sleeve according to claim 1 or 6, wherein the sleeve is knitted from a hydrophobic, low filament, multifilament yarn with a filament count of at least 10 and having a total denier of between 500 - 1500.

13. A water-resistant orthopedic undercast sleeve according to claim 1 or 6, wherein the sleeve is a 2 x 2 rib-knit formed a hydrophobic, low filament, multifilament yarn with a filament count of at least 10 and having a total denier of between 50 and 2000.

14. A water-resistant orthopedic undercast sleeve according to claim 1 or 6, wherein sleeve is constructed from yarns pre-treated with a water-resistant surface coating to impart enhanced water-resistant properties to the sleeve.

15. A water-resistant orthopedic undercast sleeve according to claim 1 or 6, wherein sleeve comprises a sleeve treated with a water-resistant surface coating to impart enhanced water-resistant properties to the sleeve.

16. A water-resistant orthopedic undercast sleeve, comprising;
   (a) a tubular rib-knitted sleeve having hydrophobic properties and spaced-apart, longitudinally-extends ribs of sufficient thickness sufficient to provide both
cushioning and moisture transport in a single layer between a cast and a limb onto which the sleeve is applied,

(b) moisture egress channels formed between adjacent ribs for transporting moisture away from the limb, longitudinally along the length of the sleeve, and out of the space between the sleeve and cast, the sheet material having sufficient resistance to compression so as to maintain the moisture egress channels subsequent to application of a cast over the sheet material; and

(c) the hydrophobic properties of the sleeve being at least in part provided by a surface treatment to the sleeve of a material that imparts enhanced hydrophobic characteristics

17. A water-resistant orthopedic undercast sleeve according to claim 16, wherein the tubular knitted fabric is low moisture regain hydrophobic fiber selected from the group consisting of polyester and polypropylene, and wherein the construction of the tubular knitted fabric is selected from the group consisting of a single knit rib construction and a double knit rib construction.