United States Patent Office

2,697,434

Patented Dec. 21, 1954

2,697,434

SURGICAL CAST AND PROCESS OF FORMING IT

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No Drawing. Application July 19, 1952, Serial No. 299,903

4 Claims. (Cl. 128—90)

This invention relates to stiffening bandages and their manufacture.

Calcined gypsum, commonly known as plaster of Paris ($CaSO_4 \cdot \frac{1}{2}H_2O$), is widely used for surgical casts for holding broken bones in alignment while the injured member is healing. The plaster of Paris type of cast has many inherent disadvantages, such as heavy weight, being messy to apply and, in the case of hospitals, requiring a separate room for applying.

An object of this invention is to provide an improvement in surgical casts. A further object is the provision of a lightweight surgical cast which may be readily applied to an injured body member. A still further object is the provision of a coated fabric stiffening bandage which may be quickly softened by wetting with water and may be so treated that it will dry to a stiff non-water soluble bandage, and process of making same. A still further object is the provision of a coated fabric stiffening bandage which will not adhere to a person's skin but will be cohesive when wound upon itself. These and other important objects will be readily apparent to those skilled in the art, as the description of the invention proceeds.

The foregoing objects are accomplished by impregnating and/or coating a fabric with an aqueous solution of a water-soluble Group I alkali metal salt of an acidic copolymer of vinyl acetate and crotonic acid and sufficient inert filler to impart stiffness to the coated fabric when dry and allowing the coating to dry to a relatively stiff condition but yet remain sufficiently pliable so it can be wound upon itself. The dry relatively stiff coated fabric is rendered supple and cohesive by wetting with water so that the superposed plies, when wrapped around an injured body member, will adhere and form a rigid bandage when dry. After it is in place it is treated with an aqueous solution of a polyvalent metal salt to make the coating water-insoluble when dry.

The following specific examples are given as illustrations and not as limitations. Throughout the specification and appended claims the parts and percentage figures are expressed on a weight basis.

Example I

	Per cent
Copolymer of 95 parts vinyl acetate and 5 parts crotonic acid	8.2
Sodium bicarbonate	.8
China clay	16.7
Water	74.3
	100.0

The above composition was agitated until homogeneous, forming the water-soluble sodium salt of the acidic copolymer resin in situ. A cotton gauze fabric running 10.4 yards per pound per 36" width, similar to that employed for surgical bandages, was dipped into the above composition and the excess allowed to drain off, after which the treated fabric was passed through a heat zone to evaporate the water and dry the coating.

Example II

A white stiffening bandage material was prepared in the same manner as described in Example I, except the cotton gauze was treated with the following composition:

	Per cent
Copolymer of 95 parts vinyl acetate and 5 parts crotonic acid	8.3
Sodium bicarbonate	.8
China clay	16.5
Titanium dioxide	.8
Water	73.6
	100.0

Example III

A stiff bandage material was prepared by dip coating a polyacrylonitrile fabric weighing 2.8 ounces per square yard and having a thread count of 52 x 25, with the composition of, and in the same manner as, Example II.

Example IV

A stiff bandage material was prepared by dip coating a polyethylene terephthalate fabric with the composition of, and in the same manner as, Example II.

The impregnated and/or coated fabric bandage materials described in the preceding examples are all dried immediately following the dip coating and are relatively stiff but sufficiently flexible to be rolled on a one inch diameter tube. The treated fabrics may be stored indefinitely at this stage. When the bandage is to be applied to a body member it is immersed in water for a few seconds which makes it limp and cohesive but not adhesive. It does not adhere to human skin. The water-wet bandage readily conforms to body contours when it is wrapped around a body member four to six times. After the water-wet bandage has been wrapped around a body member, and while it is still wet, it may be treated with an aqueous solution of a polyvalent metal salt, such as the polyvalent metal alums, magnesium sulfate or calcium oxide, to render the coating water-insoluble by the in situ formation of the water-insoluble salt of the polyvalent metal and the copolymer. Both aluminum and iron alums function properly, but aluminum alums are preferred since they do not discolor the bandage. The wet coating is cohesive and the several convolutions become laminated on air drying of the bandage. The amount of polyvalent metal salt required may vary but must be sufficient to render the resin binder water-insensitive.

The dry material of Examples III and IV when wetted with water became limp and cohesive and, when wound around a finger with six convolutions, stuck together and set up to a rigid bandage in about 5 minutes, and became essentially dry in 10 minutes with air drying. This is less time than is required for bandages made on a cotton gauze fabric, and is probably due to less water being absorbed by the fabric.

The bandage may be wetted by steam to render it supple and cohesive, in which case a minimum of excess water is absorbed and the drying time is reduced accordingly.

Where a water-insoluble bandage is not required the polyvalent metal salt treatment may be eliminated.

In the specific examples the acidic copolymer resin is rendered water-soluble by forming, in situ, the sodium salt of the copolymer in an aqueous medium. Other Group I monovalent alkali metal salts of the copolymer, such as the lithium, potassium, rubidium and caseium salts, may also be employed.

The water-soluble hydroxides, carbonates and bicarbonates of the Group I alkali metals may be used to form the water-soluble salt in situ. About 5 to 10 parts of the Group I monovalent alkali metal salt or hydroxide are preferred for each 100 parts of the acidic copolymer resin, although as little as 3 parts per 100 parts of resin may be used. The amount of Group I monovalent alkali metal salt or hydroxide required is the equivalent amount of alkali metal necessary to react with the acid groups present to produce essentially a neutral coating. When using the hydroxides, the amount must be sufficient to maintain the pH below about 7.5.

The acidic copolymer resin derived from 95 parts

vinyl acetate and 5 parts crotonic acid is preferred, although the polymerization products of from 90 to 98 parts of vinyl acetate and 10 to 2 parts of crotonic acid are useful. The copolymer resin may be prepared in accordance with the teaching of U. S. Patent 2,317,725.

China clay and titanium dioxide are used in the specific examples to impart stiffness to the dry bandage. Other inert fillers and pigments may be used as long as they are non-reactive with the resin, such as, e. g. barytes, finely divided silica, bentonite, mica and diatomaceous earth. The more reactive fillers, such as calcium carbonate, calcium sulfate and magnesium oxide, while useful, are not preferred since the coating is less cohesive than when completely inert fillers are used. In place of titanium dioxide other pigments, such as zinc oxide, antimony oxide, zinc sulfide, or colored pigments, may be used, as long as they are inert with respect to the copolymer resin. The minimum amount of loading of the coating with fillers and/or pigments to obtain the necessary stiffness is one-half part for each part of the copolymer resin. When the amount of filler and pigment is increased beyond 3 parts for each part of copolymer resin the cohesive property deteriorates to an undesirable extent.

In the claims the term "inert filler" is used to designate pigments and colorless fillers which are inert with respect to the copolymer resin.

The amount of coating on the fabric is not critical and may vary over a wide range. Satisfactory results have been obtained with 1.0 to 6.0 ounces of dry coating per square yard, depending on the type and construction of fabric. However, if more than 7 ounces of coating per square yard are employed there is no additional advantage in stiffness and there are disadvantages of longer drying and a greater tendency for the dry coating to powder off in handling the bandage material before wetting. If the fabric is an open weave fabric and not very absorbent, less coating will be required than if the fabric is closely woven and consists of absorbent fibers. In some cases the interstices may be completely filled, whereas in others they may remain open to permit easy passage of moisture during the drying of the bandage.

The type or construction of the supporting fabric is not critical, but a lightweight open weave fabric, similar to a leno weave, is preferred. Cotton fabrics are preferred for economic reasons, although fabrics made from synthetic fibers such as, e. g. polyacrylonitrile, polyethylene terephthalate, nylon, polyvinyl chloride and various copolymers thereof, and various cellulose derivatives, are satisfactory. The synthetic fibers which do not absorb water or are not softened by water dry faster than cotton fabric after the bandage has been wetted and put in place. Non-woven fabrics, such as those disclosed in copending application S. N. 232,245, filed June 18, 1951, by J. A. Piccard may be used in place of the woven fabrics disclosed in the examples. Certain papers may also be used.

Throughout the specification and claims "impregnating" and "coating" are used synonymously. In the case of coatings applied to gauze fabrics with wide interstices there is no fundamental difference between impregnation and coating. It is also immaterial whether the coating composition is applied directly to one or both sides of the fabric or whether the fabric is completely immersed in the coating. Useful products can be made by coating only one side even where the fabric is so tightly woven that the coating does not strike through the fabric.

The products of this invention are particularly useful for stiffening bandages to replace plaster casts on injured body members. It will be readily apparent to those skilled in the art that the products of this invention have other uses, where the coated fabric is used as a single ply. The process herein described, in which a water-insoluble resin is converted to a water-soluble salt in an aqueous medium and then applied to a fabric substrate, after which it is rendered water-insoluble by the in situ formation of a polyvalent metal salt, provides an economic advantage by avoiding costly organic solvents and their recovery. Fabrics coated with the water-insoluble polyvalent metal salt of the copolymer, properly pigmented, are useful as case coverings, bookbindings, window shades, luggage linings, etc.

It is apparent that many widely different embodiments of this invention may be made without departing from the spirit and scope thereof and, therefore, it is not intended to be limited except as indicated in the appended claims.

I claim:

1. A surgical cast comprising a plurality of convolutions, cohesively united, of a fabric having a coating of a water-insoluble salt of a polyvalent metal and a copolymer resin of 90–98 parts of vinyl acetate and 10–2 parts of crotonic acid, and 0.5 to 3 parts of inert filler per part of copolymer resin.

2. A surgical cast comprising a plurality of convolutions, cohesively united, of a fabric having a coating of a water-insoluble magnesium salt of an acidic copolymer resin of 90–98 parts vinyl acetate and 10–2 parts crotonic acid and 0.5 to 3 parts of inert filler per part of copolymer resin.

3. Process of preparing a surgical cast material which comprises coating a flexible fabric with an aqueous coating comprising a water-soluble Group I alkali metal salt of an acidic copolymer resin of 90–98 parts vinyl acetate and 10–2 parts crotonic acid and 0.5 to 3 parts of inert filler per each part of copolymer resin, drying the coated fabric, immersing the dry coated fabric in water to soften and activate the cohesive property of the salt, wrapping a plurality of convolutions around a member to be bandaged, converting the water-soluble coating to a water-insoluble coating by treating the wet bandage with an aqueous solution of a polyvalent metal compound, and allowing the water to evaporate.

4. The process of claim 3 in which the copolymer resin comprises 95 parts vinyl acetate and 5 parts crotonic acid.

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