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3,323,978

ARTIFICIAL TEXTILE FIBRES AND THEIR PRODUCTION

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Fig. 1

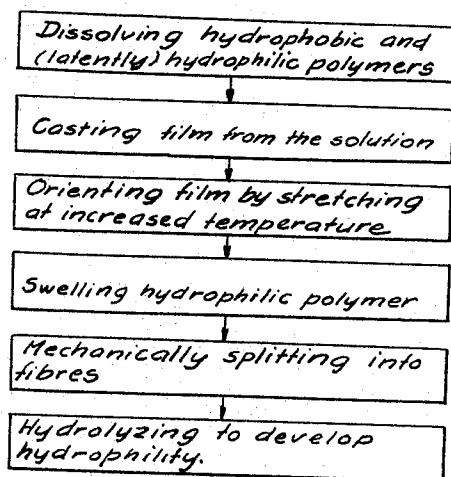


Fig. 2

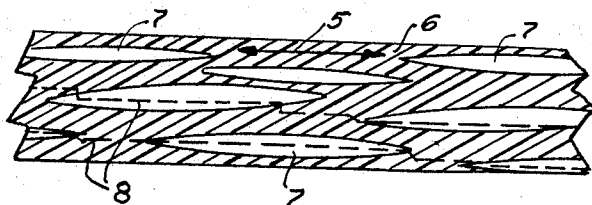
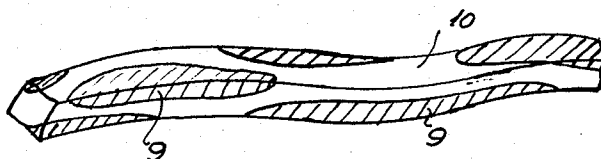


Fig. 3



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1

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7 Claims. (Cl. 161-169)

The invention relates to artificial textile fibres having a hydrophilic surface, and to methods for their production from an oriented film material.

It is an object of the invention to provide for artificial textile fibres combining the advantages of the hydrophobic synthetic fibres with the capability of the hydrophilic fibres, e.g. several natural fibres, to absorb clamminess of the body, to resist electrostatic charging, and to be easily dyed. The advantages as referred to here of the hydrophobic synthetic fibres are particularly their ability of resisting shrinkage on washing in hot water, and their independence upon the humidity of the surroundings in regard of strength and elasticity.

It has been suggested to combine the said properties by providing hydrophobic fibres with a coating of a hydrophilic polymer substance, for example by coating nylon fibres with polyvinyl alcohol, but a satisfying connection between the two substances could not be obtained so that the coating was too easily worn off.

In experiments preceding the present invention use has been made of a splitting process in order to provide for a relatively hydrophilic coating upon fibres of certain selected crystalline polymers, for example polycaprolactam. In these experiments, at first a film of the polymer was produced which was then oriented, after which the polymer was swelled and, finally, a splitting was carried out, for example by means of ultra-sound, while the polymer was still under the influence of the swelling agent. Since substances of the nature of polycaprolactam consist of crystalline and amorphous parts, and since it is mainly the amorphous parts that are attacked by the swelling agent, the splitting occurs mainly in the latter parts. Thereby, the surface of the fibres produced by the splitting becomes substantially more amorphous than do the remaining parts of the fibre material, and since polycaprolactam is substantially more hydrophilic in amorphous form than in crystalline form, fibres are obtained having in a manner of speaking a hydrophilic coating intimately connected with a relatively hydrophobic core. This method of producing a predominantly hydrophilic surface on predominantly hydrophobic fibres, however, can be used only in substances, such as polycaprolactam, which are intermediates between the hydrophilic and the hydrophobic polymers, and which are having incidentally a partly crystalline structure.

The fibres of the present invention are of the type called splitfibres, i.e. individual fibres or a network of fibres produced by subjecting an oriented organic synthetic polymer material to a splitting process.

The fibres of the invention are characterized in that the material of the fibres is of a two-phase structure with parts of an oriented distinctly hydrophobic polymer alternating with parts of another polymer of distinctly hydrophilic, or latently hydrophilic, character, the fibres having a predominantly hydrophobic core and an ac-

2

cumulation of the distinctly hydrophilic, or latently hydrophilic, polymer in spots on the surface.

The said two-phase structure can be obtained, for example, by producing a solution of the two polymers and casting a film from this solution, whereby during the drying first one polymer is precipitated, forming a gel structure in the solution, after which the other polymer is precipitated by the continued drying.

Other manners of obtaining the two-phase structure is by extruding a mixture of the two polymers, or by casting a film from a mixture of suspensions of the two polymers.

A preferred method of producing the fibres of the invention is characterized in that a film material is first produced, consisting of a synthetic polymer material comprising a distinctly hydrophobic component and a distinctly hydrophilic component, if desired with latent hydrophilicity, after which the said film material is treated with a strong-acting swelling agent for the distinctly hydrophilic component, the swelled product being subsequently split in known manner into individual fibres or into a coherent network of fibres and, if the hydrophilicity is latent, subjected to a treatment to develop the hydrophilicity.

It has been found that after strong orienting, the film material of the said kind comprising a distinctly hydrophobic and a distinctly hydrophilic component, forms a fibrillar two-phase microstructure. By swelling, the material of the hydrophilic fibrils is weakened, and the surfaces of the splits resulting from the subsequent splitting process will therefore mainly be in the hydrophilic substance so that the fibres will have an accumulation of hydrophilic substance at the surfaces. In this manner a very desirable combination is obtained of the said advantages of the hydrophilic and of the hydrophobic fibres, respectively.

As stated, orienting and splitting is carried out by well known methods. As regards the splitting process it will generally be advantageous to start with producing microscopic splits by incorporating in the material particles which are made to expand. If desired, this can take place before the treatment with the swelling agent. The resulting loosening of the structure facilitates the subsequent mechanical splitting. Advantageously, the splitting is started in known manner by sandwiching the film material between two rubber plates or endless rubber belts and stretching the latter at a right angle to the direction of orientation of the material, continuing the splitting treatment, for example, by ultrasonic means in a bath of liquid.

Often, it will be advantageous to make the said fibrillar two-phase structure more pronounced by means of a heat treatment before the swelling.

In an embodiment of carrying out the present invention, the film material is produced by mixing a hydrophobic synthetic polymer with a smaller amount of a hydrophilic polymer, and adding a graft or block polymer which on account of its surface-active effect improves and strengthens the connection between the said two components.

Examples of polymers of distinct hydrophilicity are polyoxyethylene, polyvinyl alcohol, and co-polymerisates on the basis of acrylic acid or methacrylic acid.

As stated, however, the hydrophilicity may be latent, a component being used which is not in itself particularly

hydrophilic, but which can be transformed so as to become distinctly hydrophilic without the hydrophobic substance being substantially attacked simultaneously, the said transformation then being made after the splitting has been carried out. The advantage of this is that the mixing process and the swelling are both facilitated. Briefly stated, the hydrophilic groups are masked during the said processes. Among others, esters of polyacids, such as polyacrylates or polymethacrylates, or esters or acetals of polyalcohols, such as polyvinyl esters, polyallyl esters, and polyvinylacetal can be used, the swelling being carried out by means of non-aqueous liquid being able to easily penetrate the hydrophobic component, the hydrophilicity being developed by total or partial hydrolysis or alcoholysis after the splitting. It will often be advantageous according to the invention to proceed in the manner that the film material is produced from a hydrophobic synthetic polymer and a graft or block polymer containing groups which give or can be made to give the latter polymer a distinct hydrophilicity.

The distinctly hydrophobic polymer component can advantageously be polyethylene with a high specific weight, crystalline polypropylene or polyvinylidene chloride, including co-polymerisates of the latter substance, but besides any distinctly hydrophobic synthetic polymer can be used. The said three polymers are all very cheap, especially polyethylene, and thus the present invention brings a solution of the problem how to produce refined textile fibres from these compounds by cheap methods and means.

As known, polyvinylidene chloride has the specific advantage of being self-extinguishing, but has not hitherto been used to any greater extent for proper textile purposes owing to the failing capacity of absorbing the clamminess of the body. As known, polypropylene has a particularly good tensile strength and also good textile properties in other respects. However, also the use of this substance for textile purposes has hitherto been inhibited owing to the failing capacity of adsorbing the clamminess of the body.

As regards the graft or block polymer to be used, the skilled artisan can easily make his choice on the basis of the comprehensive scientific literature which exists concerning the production and properties of the said substances. Generally, substances of the said kind are chosen, one component of which is identical with or closely related to the hydrophobic component which is used. In case the film to be split is produced using a graft or block polymer, a cheap substance of the said kind is preferably chosen, and it should be noted that graft polymerisates based upon polypropylene are both cheap and in other ways well suited for the purpose.

Example

A 0.06 mm. thick film is cast from a 20% solution in hot xylene of high density polyethylene and polyvinyl acetate in the proportions of 3:1 by weight. On drying the solution, the polyethylene first precipitates in gel form in the solution containing dissolved polyvinyl acetate. The dry film, being very fragile at room temperature, is oriented by stretching at 110° C. in the ratio of 10:1; thus acquiring a high tensile strength and ability to split.

The film is placed in an acetone bath for 1-2 minutes, causing the polyvinyl acetate, but not the polyethylene, to swell.

After drying the surfaces, the swelled film is split up to a coherent network of fibres by sandwiching the film between a pair of continuous rubber belts which are being kept together by means of water pressure at 5 atmospheres. By gradually laterally distending the travelling rubber belts enclosing the oriented film, the splitting of the latter is accomplished.

In order to keep the film in the swelled state during the

splitting, a paste of pulverized silica gel in acetone is applied to the rubber belts.

Finally, the network of fibres is passed through a hot acid-bath in order to develop the hydrophilicity of the fibre surfaces by partly hydrolyzing the spots of polyvinyl acetate to polyvinyl alcohol.

Since the hydrophilic parts are easily dyed, contrary to the hydrophobic parts, a dyeing process can be used for proving the two-phase structure of the fibres, and the accumulation of the hydrophilic component on the surface of the individual fibres. A direct cotton dye as normally used is suitable for the said dyeing.

The invention is further illustrated by the accompanying drawing in which

FIG. 1 is a flow sheet illustrating a method of producing the fibres,

FIG. 2 is an enlarged section through part of a stretched film, and

FIG. 3 is an enlarged part of an individual fibre.

In FIG. 2, an arrow 5 represents the stretching direction. The film consists of a hydrophobic polymer 6 having embedded therein oblong parts 7 of a hydrophobic polymer. Upon mechanical splitting, the clefts proceed mainly through the hydrophilic parts as illustrated by dashed lines 8 to give fibres as the one illustrated in FIG. 3 showing spots 9 of the hydrophilic polymer on the surface of a mainly hydrophobic core 10.

I claim:

1. A fibrous product of organic synthetic material comprising a two-phase structure including a continuous core portion of an oriented, normally crystalline, predominantly hydrophobic polymer, and a discontinuous surface portion of a different distinctly hydrophilic polymer.

2. A fibrous product of organic synthetic material comprising a plurality of fibres in a coherent network in which each fibre element has a two-phase structure including a continuous core portion of an oriented, normally crystalline, predominantly hydrophobic polymer selected from the group consisting of polyethylene, polypropylene and polyvinylidene chloride, and a discontinuous surface portion of a different distinctly hydrophilic polymer selected from the group consisting of polyvinyl alcohol, polyoxyethylene, copolymerizates of acrylic acid and of methacrylic acid, and hydrolyzed polymers selected from the group consisting of esters of polyacids, esters of polyalcohols and acetals of polyalcohols.

3. A method of making a synthetic fibrous product which comprises blending a normally crystalline, predominantly hydrophobic polymer with a smaller amount of a different polymer which is distinctly hydrophilic or potentially hydrophilic on hydrolysis, forming the resulting blend into a film, stretching said film so as to orient uniaxially the crystalline polymer component, treating the oriented film with a swelling agent for said hydrophilic polymer, and splitting said film into a fibrous structure.

4. The method of claim 3 wherein said fibrous structure is treated with a hydrolysis agent to hydrolyze any potentially hydrophilic polymer present at the surface of the fibres.

5. A method of making a synthetic fibrous product which comprises blending a normally crystalline, predominantly hydrophobic polymer selected from the group consisting of polyethylene, polypropylene and polyvinylidene chloride with a smaller amount of a different polymer which is distinctly hydrophilic or potentially hydrophilic on hydrolysis, selected from the group consisting of polyvinyl alcohol, polyoxyethylene, copolymerizates of acrylic acid and of methacrylic acid, and hydrolyzed polymers selected from the group consisting of esters of polyacids, esters of polyalcohols and acetals of polyalcohols, forming the resulting blend into a film, stretching said film so as to orient uniaxially the crystalline polymer component, treating the oriented film with a swelling agent for said hydrophilic polymer, and splitting said film into a fibrous structure.

5

6. Method according to claim 3 wherein the film material is produced by mixing a hydrophobic synthetic polymer with a smaller proportion of a hydrophilic polymer, and a graft or block polymer is added which on account of its surface-active effect brings about the connection between said two components.

7. Method according to claim 3 wherein the film material is produced from a hydrophobic synthetic polymer and a graft or block polymer containing groups which are giving or can be made to give the latter polymer a distinct hydrophilicity.

6

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