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NON-WOVEN PRODUCTS COMPOSED OF NON-UNIFORMLY DRAWN STAPLE FIBERS

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This invention relates to fibrous products made from cold drawable synthetic organic polymer filaments and it is particularly suitable for polyethylene terephthalate filaments.

The fibrous products are suitable for filters, heat and sound insulation, gaskets, packings, wicking felts and the like. They are also suitable for domestic and other textile applications such as carpet backing cloth, heavy curtaining and even some articles of clothing. They are of particular interest as paper makers and like felts requiring a high resistance to acids and chemicals.

A non-woven fibrous material which consists of filamentary material predominantly arranged in superimposed layers parallel to the faces of the material and a minor proportion oriented in the thickness direction of the material, the whole or a minor part of the filamentary material being composed of retractable synthetic filaments and the number and disposition of filaments oriented in the thickness direction being such that the material is held together, is known.

This non-woven fibrous material relies on a minor proportion of filamentary material oriented in the thickness direction, the whole or major part being composed of retractable synthetic filaments which hold the material together. The preparation of such retractable fibre is described in British patent specification 603,827 comprising continuously drawing filamentary material, e.g. between rolls and, if desired, using a snubbing pin and whilst being heated e.g. with steam before or during drawing.

According to our invention we provide a fibrous product made from cold drawable synthetic organic polymer filaments cut into staple lengths of e.g. one to six inches, predominantly lying in a parallelised condition and a proportion lying in a non-parallel position thereby interlacing a sufficient proportion of the parallelised fibres to form a self-supporting consolidatable structure, a proportion of the fibres having non-uniformly drawn, partially drawn and/or undrawn portions along the length of each fibre, the birefringence of each of said fibre varying by at least 25×10^{-3} .

Our invention is based on the observation that fibrous material with useful properties can be obtained without the recourse to autogenous bonding between undrawn polyester fibres, or similarly without recourse to continuous drawing and heating of polyester filamentary material, provided that at least a proportion of undrawn, but cold drawable fibres, which may be elongated to at least twice their length are parallelised e.g. by garnetting or carding in order to produce non-uniformly and partially drawn portions of fibres, which portions are randomly distributed along the length of the drawn or partially drawn fibres and which exhibit a high degree of shrinkage when heated.

If desired, the fibrous material, after cutting to the required lengths, can be made more self-supporting after carding and matting in the fashion customarily employed in the felting industry, e.g. by needle punching in a transverse direction followed, if desired, by further consolidating the material by a heat treatment at a temperature which causes high shrinkage, without fusing of the fibres and/or by compressing.

The cold drawable synthetic organic polymer filaments, particularly polyethylene terephthalate filament yarn waste, is cut into lengths of one to six inches, a batt or web

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from the cut fibres is formed on a garnetting and/or carding machine, the batt or web is further matted by needle punching in a transverse direction from top to bottom and the needle punched batt or web is steamed to cause retraction by 30 to 60%, thereby consolidating the fibrous structure.

It will be appreciated that any drawing of the cold drawable filaments which occurs in our process, is caused solely by the inter-action of the card wires or garnetting action. In order to obtain fibres having a high degree of shrinkage for the consolidating process it is necessary to operate at temperatures between -10°C . and 35°C . For best results, higher temperatures, particularly at, or above, the second order transition temperature should be avoided as this tends to give fibres which have a relatively low shrinkage resulting in loose non-coherent structures.

In the process of our invention a proportion of the fibres are cold drawn intermittently and non-continuously along their length, thus resulting in portions e.g. at the ends of the fibres, which are drawn less, or not at all. It will be appreciated that such non-uniformly drawn fibres will enhance the random properties of the parallelised drawn material which thereby becomes capable of yielding a self-supporting structure because of the random properties of the fibres which in turn enhance matting.

As stated, the filamentary material, prior to cutting to the appropriate length, need not be drawn at all, therefore "as spun" filaments are suitable and even "as spun" waste material may be used for our fibrous products. The known costly separate continuous drawing operation in the production of the filamentary material is thereby eliminated.

Cold drawable filamentary material which has been found suitable includes polyethylene terephthalate and stereo specific polypropylene. It is produced by melt spinning e.g. as described in the aforementioned British specification relating to polyethylene terephthalate.

The cold drawable polyethylene terephthalate undrawn filaments should preferably have a birefringence of up to 0.005, and a degree of crystallinity less than 50% of the maximum crystallisation obtainable at the outset of the process and they should be capable of being drawn at least twice their length at room temperature, before they break. Under these conditions partial drawing between twice and up to six times the length of the filaments when cut to the required lengths can be induced e.g. by setting the garnet or card wires sufficiently close together. It will be appreciated that this induced drawing is quite unlike the usual uniform drawing process between rolls since the fibres become drawn non-uniformly only at intervals, two to six times their length "as spun," depending on the setting of the card wires or garnet, the length of the fibres, their deniers and their frictional properties, whereas portions of the fibres will become drawn less or not at all, as stated earlier.

It will be appreciated that the fibrous material, after garnetting and/or carding, can if desired, be formed into slivers and worked up into spun yarns, e.g. on the cotton system. In that case, the fibres e.g. in the form of a sliver, may be subject to a stuffer box or gear crimping operation followed by heat setting to enhance fibre to fibre adhesion, as required e.g. in a yarn spun on the cotton system.

A proportion, preferably a minor proportion, of other fibres such as cotton or wool may be incorporated in the fibrous product.

Polyethylene terephthalate filaments and fibres which in their undrawn condition exhibiting a birefringence of 0.001 to 0.005 are suitable. In the case of stereo-specific polypropylene the undrawn filament or fibre birefringence should be about 0.0015 to 0.0035.

The birefringence of the proportion of fibres which

are cold drawable and which become drawn non-uniformly in our process is 0.10 to 0.16, in the case of polyethylene terephthalate and 0.03 in case of stereo-specific polypropylene.

In each case at least a short length of each fibre or filament will be drawn less than the stated amount, so that the difference in birefringence will be at least 25×10^{-3} . It will be appreciated that in the case of polyethylene terephthalate this difference may be much greater, namely at least 100×10^{-3} .

In the known drawing processes the aim is to draw the filaments uniformly and therefore, even under unfavourable conditions, any short term variation in birefringence will be less than that in our process.

The following example illustrates but does not limit our invention:

Example

Waste melt spun polyethylene terephthalate filament yarn is removed from melt spinning bobbins and cut into $1\frac{1}{2}$ inch lengths. The melt spun filaments on the bobbins have a birefringence of 0.005 and a denier of about 8.

The cut "as spun" fibres are passed through a garnetting machine at 18°C ., without allowing any heating to take place after melt spinning and prior to garnetting and ensuring that the fibres have only a low degree of crystallinity. Portions of the majority of the fibres become drawn non-uniformly at least twice their length, whereas other portions of the same fibre remain undrawn or drawn to a lesser degree. The birefringence of the drawn portions of the fibres is 0.15 or more, indicating a draw ratio greater than 1:3. The setting of the garnet and the rate of feeding of the fibre is so adjusted that the maximum number of fibres become non-uniformly drawn during one passage through the garnetting machine and so that induced heating of the fibres is kept to a minimum.

The garnetted non-uniformly drawn fibres in the form of a web are then passed through a carding engine where they become parallelised and 15 carded webs are assembled into a fleece about 4 inches thick. The fleece is needle punched through its entire thickness on a fine needle loom and simultaneously compressed to about $\frac{1}{2}$ — $\frac{3}{4}$ inch thick. Samples of the resulting felt about 1 square foot in size are shrunk by immersion in boiling water. The felt samples shrink 45% lengthwise and 48.5% in width. The shrunk felt samples while wet are given a finishing treatment in a hydraulic press, where they are compressed for 2-3 minutes at about 10 lb./sq. inch between fabric covered platens, heated to 120°C . The finished samples are quite flat and flexible. The dry weight before shrinking and after shrinking and fin-

ishing is 17.9 and 75.6 oz./sq. yard, respectively. From the shrunk felt samples, test strips are prepared for a flexing test on a De Matia machine and given 250 kilocycles of flexure. The tensile strength of one inch strips cut along the length of the felt is still 26.6 lb. compared with 39.2 lb. before flexing. The felts are very absorbent and can be sterilized by steaming or heating above 100°C , without substantial alteration in shape and physical properties. They are therefore suitable also for hospital and medical applications where sterilization is necessary.

What we claim is:

1. A fibrous product of synthetic organic polymer fibres having a staple length of one to six inches, predominantly lying in a parallelised condition and a minor proportion lying in a non-parallel position the non-parallel fibres thereby interlacing a proportion of the parallelised fibres to form a self-supporting consolidatable structure, a major proportion of the fibres having non-uniformly drawn portions along the length of each fibre, the birefringence of said fibre varying by at least 25×10^{-3} .

2. A fibrous product according to claim 1 in which at least a substantial proportion of the fibres are polyethylene terephthalate fibres having a birefringence of up to 0.005 and a degree of crystallinity less than 50%.

3. A fibrous product according to claim 1 in which at least a substantial proportion of the fibre are stereo-specific polypropylene fibres having a birefringence up to 0.003.

4. A fibrous product according to claim 1 in which at least a substantial proportion of the fibres consist of polyethylene terephthalate fibres having a birefringence between 0.001 and 0.16 and containing portions in which the difference in birefringence is about 100×10^{-3} between the stated values.

5. A fibrous product according to claim 1 in which at least a substantial proportion of the fibres consist of stereo-specific polypropylene fibres having a birefringence between 0.0015 and 0.03 and containing portions in which the difference in birefringence is about 25×10^{-3} between the stated values.

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