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�54 **High twist polyester multi-filament yarn and fabric made therefrom.**

�57 A high twist polyester multifilament yarn having a twist of a twist multiplier K within a range between 15,000 and 25,000, made from polyester filaments consisting essentially of a copolymer of two or more monomers selected from the group consisting of ethylene terephthalate, trimethylene terephthalate and tetramethylene terephthalate and/or a blend of two or more polymers of the respective monomers and having a breaking elongation of not more than 60% and shrinkage in boiling water of not more than 6%. A woven or knitted crepe fabric obtained by employing such a high twist yarn has a desirable pebble configuration.

HIGH TWIST POLYESTER MULTIFILAMENT YARN
AND FABRIC MADE THEREFROM

The invention relates to a high twist polyester multi-
filament yarn, a crepe fabric made therefrom, and a process
for preparing a crepe fabric.

Generally, woven or knitted crepe fabrics composed of
5   high twist yarns exhibit a unique hand and appearance when
processed into clothing products, and, therefore, are widely
used. Various types of woven or knitted crepe fabrics
composed of high twist yarns consisting of filaments of
thermoplastic synthetic polymers have been heretofore
10   proposed. In a typical method, the woven or knitted crepe
fabric are produced by highly twisting: polyester filament
yarns; treating the highly twisted yarns at a high temper-
ature so as to temporarily heat set the torque, thereby
attaining easy handling of the yarns in the preliminary
15   process for converting the yarns into a woven or knitted
fabric and in the process for making the woven or knitted
fabric; converting the resultant yarns into a woven or
knitted fabric; relaxing the resultant fabric in hot water
so as to release the temporarily set untwisting torque of
20   the highly twisted yarn, thereby producing the broken
appearance termed "pebble" on the surface of the fabric;
and drying, tentering, and setting the pebbled fabric.

However, this method cannot produce a woven or knitted
crepe fabric having the well-defined pebble and excellent
25   pebble configuration conventionally found in silk fabrics.
When high twist yarns of conventional polyester filaments
are twist set at a low temperature, the temporary heat
setting of the high twist yarns is not satisfactory. As a
result, the handling of the resultant yarns in the pre-
30   liminary process for conversion into a woven or knitted
fabric and in the process for making the woven or knitted
fabric becomes poor. Or, a large number of snarls are
generated during the process of making the woven or knitted

fabric, which may detract from the quality of the resultant woven or knitted fabric.

When the twist setting temperature is increased, the temporary heat setting of the high twist yarns becomes strong. In this case, however, heat deformation of the polyester filaments occurs. This heat deformation not only reduces the untwisting torque of the resultant woven or knitted fabric during the pebbling process, but also produces unevenness in twist setting in the internal and external layers of the twisted yarn bobbin during the twist setting procedure. This unevenness causes the resultant woven or knitted fabric to be uneven. For these reasons, it has been difficult to stably and efficiently produce a pebbled woven or knitted fabric having a satisfactory pebbling property and pebble configuration.

Various attempts have been made to overcome the above-mentioned problems. One attempt, disclosed in Japanese Patent Publication No. 56-8140, called for subjecting undrawn polyester filament yarns to high temperature treatment under relaxation or for subjecting polyester filament yarns to heat treatment under a constant length during the drawing procedure. This decreased the shrinkage of polyester filament yarns in boiling water to a satisfactory degree and, at the same time, raised the heat shrinkage stress at a high temperature of the polyester filament yarns to a level greater than that at a lower temperature, thereby improving the pebbling property of the polyester filament yarns. Although this method improved the pebbling property of the polyester filament yarns, it still required high temperature heat treatment during the twist setting procedure.

Another attempt, called for producing a woven or knitted crepe fabric by preparing high twist yarns consisting of polybutylene terephthalate filaments, heat treating the high twist yarns so as to twist set them, and converting the resultant yarns into a woven or knitted fabric. This method also, however, required high temperature treatment

for the twist setting of the high twist yarns.

The above-mentioned methods were based on the discovery that high temperature twist setting does not significantly reduce pebble development during the pebbling procedure for

5   the resultant woven or knitted fabric, therefore enabiling superior pebbling property of the fabric to conventional woven or knitted fabric. Therefore, these methods did not solve the problem of the high temperature treatment for twist setting causing the resultant fabric to exhibit

10   decreased ability to develop pebble in proportion to the temperature increase and causing an unevenness in twist setting.

Our extensive studies have shown that the above-
-mentioned problems can be solved by the use of a high

15   twist yarn capable of being twist set at a relatively low temperature.

The present invention provides a high twist polyester multifilament yarn having a twist of a twist multiplier K within a range between 15,000 and 25,000; made from

20   polyester filaments consisting essentially of a copolymer of two or more monomers selected from the group consisting of ethylene terephthalate, trimethylene terephthalate, and tetramethylene terephthalate and/or a blend of two or more polymers of the monomers; and having a breaking elongation

25   of not more than 60% and a shrinkage in boiling water of not more than 6%.

The polyester filaments useful for the high twist yarn according to the present invention may be obtained by melt spinning a copolymer of two or more monomers selected from

30   the group consisting of ethylene terephthalate, trimethylene terephthalate, and tetramethylene terephthalate and/or a blend of two or more polymers of the monomers. The alkylene terephthalate polymers and copolymers used in the present invention are highly compatible with each other because of

35   the similarity in chemical structure, and, thus, any combination of the alkylene terephthalate polymers and copolymers in any proportion may be employed in the melt

spinning. However, the polyester filaments preferably
consist of the copolymer or a combination of the copolymer
and the blend. The copolymer or the combination of the
copolymer and the blend is preferably comprised of, based

5   on the total weight, 20% to 90% by weight of ethylene
terephthalate units, i.e., copolymerized ethylene
terephthalate units in the copolymer and polyethylene
terephthalate in the blend, and 80% to 10% by weight of
trimethylene terephthalate units, i.e., copolymerized

10 trimethylene terephthalate units in the copolymer and
polytrimethylene terephthalate in the blend, and/or
tetramethylene terephthalate units, i.e., copolymerized
tetramethylene terephthalate units in the copolymer and
polytetramethylene terephthalate in the blend.

15   The polyester filament yarn used for the raw material
of the high twist yarn of the present invention should have
a breaking elongation of not more than 60% and a shrinkage
in boiling water of not more than 6%. If the breaking
elongation is more than 60%, the yarn may have poor handling

20 in the weaving or knitting step and in the preparatory step
thereof. Also, if the breaking elongation is more than 60%
or the shrinkage in boiling water is more than 6%, satis-
factory pebbling effect may not be attained due to the
thermally unstable configuration of the filaments of the

25 yarn.
       The polyester filaments usable for the present
invention consist essentially of the hereinbefore mentioned
alkylene terephthalate polymers and/or copolymers. The
filaments may further contain high molecular weight or low

30 molecular weight organic or inorganic substances for
various purposes, copolymerized or blended, in an amount of
not more than 5% of the total weight.
       The polyester filament yarn is then subjected to
twisting to impart a high a twist multiplier K within a

35 range between 15,000 and 25,000. The twist multiplier K is
represented by the following equation:

   K = (Number of twist per meter) x $\sqrt{\text{denier}}$

The polyester filament yarn may be sized prior to the
twisting procedure. The application of sizing may be
determined depending on the intended pebble configuration.
In order to obtain a deeper and larger pebble configuration,
5 it is preferable to apply sizing process to the polyester
filament yarns. The sizing agent usable for the present
invention may be selected from conventional sizing agents.
Preferable sizing agents for the present invention are
starch-based sizing agents, polyvinyl alcohol-based sizing
10 agents, acryl-based sizing agents, and combinations thereof.
The high twist yarns are then subjected to a twist
setting procedure. The polyester filament yarns according
to the present invention may be twist set at a relatively
low temperature. Usually, the twist setting procedure is
15 carried out by wet heat setting at a temperature of from
70°C to 130°C or by dry heat setting at a temperature of
from 70°C to 180°C. That is to say, in accordance with the
present invention, a high twist setting effect can be
obtained by carrying out the twist setting procedure at a
20 relatively low temperature.
For example, a blend of 50% by weight of polyethylene
terephthalate chips having an intrinsic viscosity of 0.64
with 50% by weight of polytetramethylene terephthalate
chips having an intrinsic viscosity of 0.86 was melted at a
25 temperature of 290°C to prepare a dope solution. The dope
solution was extruded through a spinneret under a usual
condition. After the extruded filaments were cooled and
oiled, they were wound up at a speed of 1,000 m/minute.
The resultant undrawn filaments were drawn at a speed of
30 800 m/minute to prepare a polyester filament yarn of
50 denier/36 filaments having a density of 1.332 g/cm^3 and
breaking elongation of 35.8%.
The polyester filament yarn was then highly twisted so
as to provide a twist of 3,000 turns/m of the yarn. The
35 highly twisted yarn was subjected to a twist setting
process at various wet heat temperatures for 30 minutes.
After the twist setting process was completed, the double

twist number of the resultant yarn was determined as the
untwisting torque of the resultant yarn.

Measurement of double twist number:

A load of 2 mg/de was suspended from the middle
portion of a high twist yarn having a length of 100 cm
which had been twist set. The ends of the yarn were joined
together and the double twist number (turns/50 cm) occurred
in the yarn was measured. The double twist number is one
type of second twist which is developed due to the un-
twisting torque of the high twist yarn. The higher the
untwisting torque, the higher the double twist number.

As a comparison, a filament yarn consisting of
polyethylene terephthalate alone and having a count of
50 denier/36 filament was subjected to the same twisting
and twist setting processes as those mentioned above.
After the twist setting process was completed, the double
twist number of the resultant yarn was measured. The
relationship between the twist setting temperature and the
double twist number is shown in Fig. 1. In Fig. 1, the
symbol I indicates the polyester filament yarn according to
the present invention, while the symbol II indicates a
conventional polyethylene terephthalate yarn.

It is apparent from Fig. 1 that with the conventional
polyethylene terephthalate filament yarn, the twist setting
effect is obtained at a wet heat temperature of 90°C or
more. With the polyester filament yarn of the present
invention, a wet heat temperature of 60°C can provide the
twist setting effect. This fact indicates that the present
invention allows a low temperature twist setting procedure
which could not have been heretofore realized because such
a low temperature twist setting reduced the handling of the
twist set yarn in the weaving or knitting process.

The reason why the polyester filament yarn according
to the present invention can be temporarily twist set at
such a low temperature is believed to be as follows: The
polyester filament yarn according to the present invention
may have an excellent twist setting ability, because ester

interchange-copolymerization occurs to some degree between
ethylene terephthalate-tetramethylene terephthalate,
ethylene terephthalate-trimethylene terephthalate, and
tetramethylene terephthalate-trimethylene terephthalate, or
5   each polyester molecular chain is in a mobile state in the
boundary between the blended polymers. Particularly, the
behavior of the noncrystalline portions of each polyester
is considered to be effective for providing such an
excellent twist setting ability.

10   In order that the polyester filament yarn has a more
excellent twist setting ability in a high twist yarn or a
higher pebbling effect in a fabric, it is preferable that
the polyester filament yarn have a temperature (T_f) of 220°C
to 255°C at which, on a shrinkage stress-temperature curve,
15   the shrinkage stress of the filaments becomes equal to zero
due to the fusion.

Furthermore, it is preferable that the polyester
filament yarn have a density of 1.300 g/cm^3 or more. Such
polyester filament yarn can be obtained by subjecting spun
20   filaments to a drawing procedure or by carrying out a high
speed melt spinning at a speed of from 3,000 to 3,500 m/min
or more. Where the density of the polyester filament yarn
is lower than 1.300 g/cm^2, the resultant woven or knitted
fabric may have a poor pebbling property.

25   It has further been found that if the polyester
filament yarn is comprised of 3% to 15% by weight of a
noncrystalline polymer, the resulting yarn can have a very
excellent twist setting ability. Thus, the present
invention also provides a high twist polyester multi-
30   filament yarn having a twist of a twist multiplier K within
a range between 15,000 and 25,000; made from polyester
filaments consisting of a composition of a copolymer of two
or more monomers selected from the group consisting of
ethylene terephthalate, trimethylene terephthalate, and
35   tetramethylene terephthalate and/or a blend of two or more
polymers of said monomers blended with 3 to 15% by weight,
based on the weight of said copolymer and/or blend, of a

noncrystalline polymer, and having a breaking elongation of
not more than 60% and a shrinkage in boiling water of not
more than 6%.

As the noncrystalline polymer, there may preferably be
employed those having a glass transition temperature of 70°C
to 110°C, more preferably styrene polymers and methacrylate
polymers.

The present invention further provides a woven or
knitted crepe fabric consisting of or comprising a high
twist polyester multifilament yarn having a twist of a
twist multiplier K within a range between 15,000 and
25,000, made from polyester filaments consisting essen-
tially of a copolymer of two or more monomers selected from
the group consisting of ethylene terephthalate, tri-
methylene terephthalate, and tetramethylene terephthalate
and/or a blend of two or more polymers of the respective
monomers.

According to a preferred embodiment of the present
invention, such a woven or knitted crepe fabric may
advantageously be prepared by a process comprising the
steps of:

subjecting a copolymer of two or more monomers
selected from the group consisting of ethylene tere-
phthalate, trimethylene terephthalate, and tetramethylene
terephthalate and/or a blend of two or more polymers of the
respective monomers to spinning and drawing to obtain a
yarn of polyester filaments having a shrinkage in boiling
water of not more than 6%, a density of not less than
1.300 g/cm^3, and a breaking elongation of not more than
60%;

subjecting the polyester multifilament yarn to
twisting to apply a twist of a twist multiplier K within a
range between 15,000 and 25,000 to the yarn;

subjecting the high twist yarn to twist setting;

preparing a woven or knitted fabric consisting of
or comprising the high twist yarn using said high twist
yarn; and then,

subjecting the woven or knitted fabric to pebbling.

The high twist yarn of the present invention exhibiting an excellent twist setting property at a low temperature
5   is converted into a woven or knitted fabric in the same manner as mentioned above. The woven or knitted fabric is subsequently subjected to a pebbling treatment in hot water at a temperature of from 80°C to 100°C, in a wet heating atmosphere at a temperature of from 80°C to 150°C, or in a
10 dry heating atmosphere at a temperature of from 100°C to 200°C. After the pebbling treatment is completed, an excellent woven or knitted crepe fabric is obtained.

That is, in accordance with the present invention, use of the polyester filament yarn exhibiting an excellent
15 twist setting property enables a woven or knitted fabric having an excellent pebble which has not been obtained hitherto for. As described above, the excellent twist setting property is considered to be due to the copolymerized portion of the yarn or the behavior of the molecular
20 chain in the boundary between the blended polymers of the yarn. On the other hand, the excellent pebbling property is considered to be due to the elastic property of polytetramethylene terephthalate and polytrimethylene terephthalate.
25 As is described above, in accordance with the present invention, the polyester filament yarn of the present invention can be twist set at a low temperature while it is in highly twisted state, such a low temperature twist setting being impossible with conventional polyester
30 filament yarn. The twist set yarn exhibits satisfactory handling. The woven or knitted fabric prepared from the twist set yarn exhibits no unevenness in width and in pebble and exhibits a satisfactory pebbling property producing a high reduction in width. Particularly, the
35 capability to carry out the twist setting treatment at a low temperature makes it possible to avoid a reduction in the pebble developing ability of the fabric when the fabric

is subjected to the pebbling procedure. Thus, a woven or
knitted crepe fabric having an excellent pebble configu-
ration is obtained.

In a specific embodiment of the present invention, a
woven crepe fabric may also be prepared by a process com-
prising the steps of:

weaving a mixed fabric employing (A) a polyester
multifilament yarn having a shrinkage in boiling water of
not more than 8% and a birefringence Δn of 0.05 to 0.11 and
(B) a high twist polyester multifilament yarn having a
twist of a twist multiplier K within a range between 15,000
and 25,000, made from polyester filaments consisting
essentially of a copolymer of two of more monomers selected
from the group consisting of ethylene terephthalate, tri-
methylene terephthalate, and tetramethylene terephthalate
and/or a blend of two or more polymers of the respective
monomers and having a shrinkage in boiling water of not
more than 6%, a density of not less than 1.300 g/cm^3 and a
breaking elongation of not more than 60%; and then,

subjecting the woven fabric to pebbling.

It has further been found that the use of a yarn of
the type (A) above as a warp or filling and yarn of the
type (B) above as a filling or warp, respectively, enables
an excellent woven crepe fabric, such as crepe, striped
crepe, or oriental crepe, having the excellent pebble
configuration as appears on a silk crepe fabric. That is
to say, a woven crepe fabric having an excellent pebbling
property and pebble configuration can be prepared, accord-
ing to the above-mentioned process of the present invention,
by reducing the restricting force of the warp or filling of
the type (A) yarn with respect to the filling or warp of
the type (B) yarn so that the torque of the type (B) yarn
can easily be developed.

If the shrinkage in boiling water of the type (A) yarn
is more than 8%, the shrinkage of the type (A) yarn may
become large and increase the restricting force with
respect to the type (B) yarn. If the birefringence is less

than 0.05, the shrinkage in boiling water is too high and the type (A) yarn has the same drawback as mentioned above. On the other hand, if the birefringence is larger than 0.11, the type (A) yarn may have a too high flexural

5   stiffness and prevent the type (B) yarn from satisfactorily developing the torque.

The yarn of the type (A) may be obtained by various methods which may be easily understood by a person with ordinary skill in the art.

10   For example, the yarn can be prepared by taking up spun filaments of a polyethylene terephthalate having an intrinsic viscosity of 0.5 to 0.8 at a speed of not less than 4,500 m/min. However, the optimum taking up speed may vary largely depending on the molecular weight of the

15   polyethylene terephthalate, the catalyst, additive or third component contained in the polymer, or the like.

The yarn can also be prepared by cooling the spun filaments below a glass transition temperature, then heating them to 100°C to 250°C, and finally taking them up at a

20   speed of 1,500 to 4,500 m/min. The yarn can be prepared by another method wherein a yarn of undrawn filaments taken up at a speed of 2,500 to 4,000 m/min is subjected to thermal relaxation by 2% to 8% at a temperature of not lower than 150°C and then subjected to low temperature drawing at a

25   draw ratio of 1.2 to 1.5. The yarn can be prepared by a further method wherein a yarn of undrawn filaments taken up at a speed of 1,000 to 2,500 m/min is drawn at a ratio of about 2.0, thermally relaxed by 2% to 8% at a temperature of not lower than 150°C, and then drawn at a low temper-

30   ature at a ratio of 1.2 to 1.5.

The present invention will further be illustrated by the following nonlimitative examples.

Example 1

Blends of polyethylene terephthalate chips having an

35   intrinsic viscosity of 0.64 with polytetramethylene terephthalate chips having an intrinsic viscosity of 0.86 at various proportions were prepared. Each blend was

melted at a temperature of from 285°C to 295°C to prepare a
dope solution. The dope solution was extruded through a
spinneret having 72 holes.

The extruded filaments were cooled and oiled under
5   usual conditions, after which the resultant filaments were
wound up at a speed of 1,000 m/min. The undrawn filaments
were drawn and wound up at a speed of 800 m/min by means of
a usual method. The resultant drawn yarn of 100 denier/72
filaments was twisted by means of an Italian twisting
10   machine to provide a twisted yarn having a twist of
S2500 turns/m. Then, the twisted yarn was subjected to a
twist setting treatment at a temperature of 70°C for
30 minutes by means of a vacuum setter.

The physical properties of the drawn yarn, the double
15   twist number of the resultant high twist yarn after the
twist setting procedure, and the double twist number of the
twist set yarn when immersed in boiling water are shown in
Table 1. The double twist number (T/50 cm) in boiling
water was determined by suspending a load of 2 mg/de from
20   the middle portion of the high twist yarn having a length
of 100 cm, by joining together the ends of the yarn, and by
immersing the yarn in boiling water.

Moreover, the yarn was evaluated for weaving property
(handling in the preliminary process for converting the
25   yarn into a woven fabric and in the process for weaving)
and pebbling property. The results are indicated in
Table 1.

Table 1

No.	Blending proportions		Physical properties of drawn yarn		Untwisting torque (double twist number) of high twist yarn		Properties of fabric		Remark
	Polyethylene terephthalate (% by weight)	Polytetramethylene terephthalate (% by weight)	Density (g/cm³)	Elongation (%)	After twist setting (T/50 cm)	In boiling water (T/50 cm)	Weaving property	Pebbling property	
1	100	0	1.372	27	84	330	poor	good	Comparative Example
2	95	5	1.369	29	76	315	good	good	Example
3	90	10	1.363	28	48	285	good	good	do
4	70	30	1.349	37	44	280	good	good	do
5	50	50	1.332	36	21	280	good	good	do
6	20	80	1.314	31	32	320	good	good	do
7	10	90	1.306	34	80	340	good	good	do
8	0	100	1.298	28	340	410	very poor	good	Comparative Example

Example 2

Each of the drawn yarns as prepared in Example 1 was highly twisted to provide a high twist yarn having a twist of 2,800 turns/m. The twisted yarn was subjected to a twist setting procedure. The twist setting procedure was carried out for 30 minutes by means of a vacuum setter at a temperature such that the untwisting torque of the twisted yarn was 50 turns/50 cm or less, which temperature had been preliminarily determined in a laboratory.

The weaving property and the pebbling property of the high twist yarn were determined in accordance with the same manner as that described in Example 1. The results are shown in Table 2.

Table 2

No.	Blending proportions		Untwisting torque of high twist yarn			Properties of fabric			Remark
	Polyethylene terephthalate (% by weight)	Polytetra-methylene terephthalate (% by weight)	Twist setting temperature (°C)	After twist setting (T/50 cm)	In boiling water (T/50 cm)	Weaving property	Pebbling property	Width reduction percentage (%)	
1	100	0	95	52	195	good	poor	23	Comparative Example
2	95	5	90	55	205	good	good	26	Example
3	90	10	70	51	295	good	good	67	do
4	70	30	70	45	280	good	good	65	do
5	50	50	65	32	290	good	good	71	do
6	20	80	70	41	330	good	good	74	do
7	10	90	100	48	220	good	good	30	do
8	0	100	105	53	210	good	poor	28	Comparative Example

The width reduction percentage after the pebbling as shown in Table 2 was determined according to the following equation. The higher the width reduction percentage, the better the pebbling property.

5   Width reduction percentage

$$= \frac{\left(\begin{array}{c}\text{Width in cm}\\\text{of gray fabric}\end{array}\right) - \left(\begin{array}{c}\text{Width in cm of woven fabric}\\\text{after pebbling procedure}\end{array}\right)}{\text{(Width in cm of gray fabric)}} \times 100$$

The difference between the untwisting torque developed
10   in boiling water and the untwisting torque after the twist setting, as shown in Table 2, indicates an ability to form a pebble on the fabric surface, that is, a pebble developing ability.

Example 3

15   A blend of 50% by weight of polyethylene terephthalate chips having an intrinsic viscosity of 0.64 with 50% by weight of polytetramethylene terephthalate having an intrinsic viscosity of 0.86 was prepared. The blend was melted at a temperature of 290°C to prepare a dope solution.
20   The dope solution was extruded through a spinneret having 24 holes.

The extruded filaments were cooled and oiled under usual conditions, after which the resultant filaments were taken up at a speed of 1,000 cm/min.

25   The undrawn filaments were drawn at various draw ratio to prepare yarns Nos. 1, 2, 3, and 5, each having a different density.

Separately, a blend consisting of 50% by weight of polyethylene terephthalate chips having an intrinsic
30   viscosity of 0.64, 25% by weight of polytetramethylene terephthalate chips having an intrinsic viscosity of 0.86 and 25% by weight of polytrimethylene terephthalate chips having an intrinsic viscosity of 0.96, was prepared. The blend was melted at a temperature of 285°C to prepare a
35   dope solution. The dope solution was extruded in a similar manner to that described above. Then, the undrawn filaments were drawn to prepare yarns Nos. 4 and 6, each having a

different density.

Each of the resultant drawn yarns having a count of 50 denier/24 filaments was subjected to a high twisting procedure (S and Z twist) to provide twisted yarns each having a twist of 3,000 turns/m. The high twist yarns were heat treated at a wet heat temperature of 70°C for 30 minutes to temporarily set the twists of the yarn. The yarns were converted into a plain weave fabric having a warp density of 32/cm of a weft density of 37/cm and comprising two S twist yarns and two Z twist yarns alternately. The acting reed width was 120 cm, the warping length was 55 m, and the fabric length was 50 m.

Then, the resultant gray fabric was subjected to a pebbling procedure in hot water at a temperature of 98°C for 30 minutes by means of a rotary washer in accordance with a usual method. The width reduction percentage after the pebbling procedure and the pebbling property of the fabric are indicated in Table 3.

Table 3

No.	Polymer — Type	Ratio (%)	Density g/cm³	Breaking elongation (%)	Width reduction percentage (%)	Pebbling property	Remark
1	Polyethylene terephthalate / Polytetramethylene terephthalate	50 / 50	1.289	38	32		Example
2	Polyethylene terephthalate / Polytetramethylene terephthalate	50 / 50	1.293	37	34		Example
3	Polyethylene terephthalate / Polytetramethylene terephthalate	50 / 50	1.308	37	63	good	Example
4	Polyethylene terephthalate / Polytetramethylene terephthalate / Polytrimethylene terephthalate	50 / 25 / 25	1.316	38	67	good	Example
5	Polyethylene terephthalate / Polytetramethylene terephthalate	50 / 50	1.334	34	77	very good	Example
6	Polyethylene terephthalate / Polytetramethylene terephthalate / Polytrimethylene terephthalate	50 / 25 / 25	1.341	32	79	very good	Example

Example 4

Blends of polyethylene terephthalate chips (dried at 160°C for 4 hours) having an intrinsic viscosity of 0.64 containing 0.05% by weight of TiO_2 as flatting agent with
5 polytetramethylene terephthalate chips (dried at 120°C for 6 hours) having an intrinsic viscosity of 0.86 at various proportions were prepared. Each blend was melted at a temperature of from 285°C to 295°C to prepare a dope solution. The dope solution was extruded through a spin-
10 neret having 72 holes of a circular cross-section of 0.3 mm diameter.

The extruded filaments were cooled and oiled under usual conditions, after which the resultant filaments were wound up at a speed of 1,000 m/min. The undrawn filaments
15 were drawn and heat set on a hot roller at 180°C. The resultant drawn yarn of 100 denier/72 filaments was twisted by means of an Italian twisting machine to provide a twisted yarn having a twist of S2500 turns/m. Then, the twisted yarn was subjected to a twist setting treatment at a tem-
20 perature of 90°C by means of a vacuum steam setter.

The physical properties of the drawn yarn, the un-twisting torque of the resultant high twist yarn after the twist setting procedure, and the untwisting torque of the twist set yarn when immersed in boiling water are shown in
25 Table 4.

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Table 4

No.	Blending proportions		Physical properties of drawn yarn			Untwisting torque (double twist number) of high twist yarn		Remark
	Polyethylene terephthalate (% by weight)	Polytetramethylene terephthalate (% by weight)	Elongation (%)	Shrinkage in boiling water (%)	T_f (°C)	After twist setting (T/50 cm)	In boiling water (T/50 cm)	
1	100	0	25	1.6	260	160	435	Comparative Example
2	95	5	27	1.9	258	140	420	Example
3	90	10	26	2.8	255	125	410	do
4	70	30	34	3.4	246	75	385	do
5	50	50	33	4.5	235	45	390	do
6	20	80	30	5.1	227	60	445	do
7	10	90	30	4.7	229	150	480	do
8	0	100	25	3.2	233	370	515	Comparative Example

Example 5

A fabric was woven on a water jet loom (Nissan WJL
LW-41) at 360 rpm using as filling each of the high twist
yarns as prepared in Example 4 and as warp a polyethylene
terephthalate multifilament yarn of 50 denier/36 filaments.
The fabric was scored with a weak alkali and pebbled on a
rotary washer at boil for 20 min.

The results are shown in Table 5.

Table 5

No.	Weaving property	Pebbling property	Remark
1	X	o	Comparative Example
2		o	Example
3	△	o	do.
4	o – △	o – ◎	do.
5	o	o – ◎	do.
6	o	o	do.
7		o	do.
8	XX	–	Comparative Example

Weaving Property

XX: Weaving is impossible

X: Weaving is somewhat difficult

△:   Weaving is possible

o: Weaving is easy

Pebbling Property

o: Good

◎:   Very good

Example 6

Blends of polyethylene terephthalate chips (dried at
160°C for 4 hours) having an intrinsic viscosity of 0.64
containing 0.05% by weight of TiO_2 and polytrimethylene
5   terephthalate chips (dried at 120°C for 6 hours) having an
intrinsic viscosity of 0.65 were converted into drawn yarns
and, then, high twist yarns, as described in Example 4.

The physical properties of the drawn yarns and the
untwisting torques of the high twist yarns are shown in
10   Table 6.

Table 6

No.	Blending proportions		Physical properties of drawn yarn			Untwisting torque of high twist yarn		Remark
	Polyethylene terephthalate (% by weight)	Polytri-methylene terephthalate (% by weight)	Elon-gation (%)	Shrinkage in boiling water (%)	T_f (°C)	After twist setting (T/50 cm)	In boiling water (T/50 cm)	
1	100	0	26	1.6	260	160	435	Comparative Example
2	95	5	30	2.1	256	140	426	Example
3	90	10	29	2.7	253	120	422	do
4	70	30	31	3.4	240	85	408	do
5	50	50	32	4.6	228	60	412	do
6	20	80	30	5.5	220	80	483	do
7	10	90	30	5.0	221	210	517	do
8	0	100	28	3.5	225	460	552	Comparative Example

Example 7

Blends of polyethylene terephthalate chips having an intrinsic viscosity of 0.64, polytetramethylene terephthalate chips having an instrinsic viscosity of 0.85 at
5   various proportions, and polystyrene (Styrone 679, by Asahi Dow Co.) were prepared. Each blend was melted at a temperature of from 285°C to 295°C to prepare a dope solution. The dope solution was extruded through a spinneret having 72 holes of a circular cross-section of a 0.25 mm diameter.
10   The extruded filaments were cooled and oiled under usual conditions, after which the resultant filaments were wound up at a speed of 1,000 m/min.

The undrawn filaments were drawn at a preheating temperature of 80°C and heat set on a hot roller at 180°C
15   by rapping the filaments on the roller 8 times. The resultant drawn yarn was twisted to provide a twisted yarn having a twist of 2,500 turns/m. Then, the twisted yarn was subjected to a twist setting treatment at a temperature of 90°C by means of a steam bath.
20   The physical properties of the drawn yarn and the untwisting torques of the resultant high twist yarn are shown in Table 7.

Table 7

No.	Blending proportions			Physical properties of drawn yarn				Untwisting torque of high twist yarn		Remark
	Polyethylene terephthalate (%)	Polytetramethylene terephthalate (%)	Polystyrene (%)	de/fil	Elongation (%)	Shrinkage in boiling water (%)	T_f (°C)	After twist setting (T/50 cm)	In boiling water (T/50 cm)	
1	100	0	0	49/36	28	1.9	260	160	430	Comparative Example
2	0	100	0	52/36	26	3.2	233	365	515	do
3	95	0	5	50/36	26	2.3	259	110	405	do
4	0	95	5	50/36	29	3.0	231	215	480	do
5	76	19	5	51/36	33	3.1	251	70	385	Example
6	69.6	17.4	13	48/36	28	3.3	249	45	370	do
7	66.4	16.6	17	49/36	27	3.3	248	40	350	Comparative Example
8	78.4	19.6	2	52/36	28	2.9	252	105	395	do
9	47.5	47.5	5	50/36	30	4.6	232	30	380	Example
10	19	76	5	50/36	32	5.5	226	70	440	do

Example 8

A fabric was woven on a water jet loom (Nissan WJL LW-41) at 360 rpm using as filling each of the high twist yarns (except for No. 7 yarn) as prepared in Example 7 and as warp a polyethylene terephthalate multifilament yarn of 50 denier/36 filaments. The fabric was scored with a weak alkali and pebbled on a rotary washer at boil for 20 min.

The results are shown in Table 8.

Table 8

No.	Weaving property	Pebbling property	Remark
1	X	-	Comparative Example
2	XX	-	do
3	X - △	o	do
4	X	-	do
5	△ - o	o	Example
6	o	o	do
8	X - △	o	Comparative Example
9	o	o	Example
10	△ - o	o	do

Example 9

Blends of polyethylene terephthalate chips having an intrinsic viscosity of 0.64 with polytetramethylene terephthalate chips having an intrinsic viscosity of 0.86 at various proportions were prepared. Each blend was melted at a temperature of from 285°C to 295°C to prepare a dope solution. The dope solution was extruded through a spinneret having 72 holes.

The extruded filaments were cooled and oiled under
usual conditions, after which the resultant filaments were
wound up at a speed of 1,000 m/min. The undrawn filaments
were drawn between a feed roller at 80°C and a drawing
5   roller at 180°C at a draw ratio of 3.0, heat treated at
200°C, and wound up at a speed of 800 m/min by means of a
usual method. The resultant drawn yarn of 100 denier/72
filaments was twisted by means of an Italian twisting
machine to provide a twisted yarn having a twist of
10   S2500 turns/m. Then, the twisted yarn was subjected to a
twist setting treatment at a temperature of 70°C for
30 minutes by means of a vacuum setter.

The physical properties of the drawn yarn, the un-
twisting torques of the resultant high twist yarn and the
15   properties of the resultant fabric are shown in Table 9.

Table 9

No.	Blending proportions		Physical properties of drawn yarn		Untwisting torque of high twist yarn		Properties of fabric		Remark
	Polyethylene terephthalate (% by weight)	Polytetramethylene terephthalate (% by weight)	Elongation (%)	Shrinkage in boiling water (%)	After twist setting (T/50 cm)	In boiling water (T/50 cm)	Weaving property	Pebbling property	
1	100	0	25	1.6	168	441	poor	good	Comparative Example
2	95	5	27	1.9	142	426	good	good	Example
3	90	10	26	2.8	118	408	good	good	do
4	70	30	34	3.4	70	380	good	good	do
5	50	50	33	4.5	43	394	good	good	do
6	20	80	30	5.1	62	448	good	good	do
7	10	90	30	4.7	152	484	good	good	do
8	0	100	25	3.2	378	517	poor	good	Comparative Example

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Example 10

A blend of 50% by weight of polyethylene terephthalate chips having an intrinsic viscosity of 0.64 with 50% by weight of polytetramethylene terephthalate having an
5 intrinsic viscosity of 0.86 was prepared. The blend was melted at a temperature of 296°C to prepare a dope solution. The dope solution was extended through a spinneret having 24 holes.

The extruded filaments were cooled and oiled under
10 usual conditions, after which the resistant filaments were taken up at a speed of 1000 cm/min.

The undrawn filaments were drawn at various draw ratios to prepare yarns Nos. 1, 3, 5, and 7, each having a different density and shrinkage in boiling water.

15 Separately, a blend consisting of 50% by weight of polyethylene terephthalate chips having an intrinsic vis-cosity of 0.64, 25% by weight of polytetramethylene terepthalate chips having an intrinsic viscosity of 0.36, and 25% by weight of polytrimethylene terephthalate chips
20 having an intrinsic viscosity of 0.96 was prepared. The blend was melted at a temperature of 285°C to prepare a dope solution. The dope solution was extruded in a similar manner to that described above. Then, the undrawn filaments were drawn to prepare yarns Nos. 2, 4, and 6, each having a
25 different density and shrinkage in boiling water.

Each of the resultant drawn yarns having a count of 50 denier/24 filaments was subjected to a high twisting pro-cedure (S and Z twist) to provide a twisted yarn, each having a twist of 3000 turns/m. The high twist yarns were
30 heat treated at a wet heat temperature of 70°C for 30 minutes to temporarily set the twists of the yarn. The yarns were converted into a plain weave fabric having a warp density of 32/cm and a weft density of 37/cm and comprising two S twist yarns and two Z twist yarns
35 alternately. The acting reed width was 120 cm, the warping length was 55 m, and the fabric length was 50 m.

Then, the resultant gray fabric was subjected to a

pebbling procedure in hot water at a temperature of 98°C
for 30 minutes by means of a rotary washer in accordance
with the usual method. The width reduction percentage
after the pebbling procedure and the pebbling property of
5   the fabric are shown in Table 10.

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Table 10

No.	Polymer		Density (g/cm³)	Shrinkage in boiling water (%)	Width reduction percentage (%)	Pebbling property	Remark
	Type	Ratio (%)					
1	Polyethylene terephthalate	50					
	Polytetramethylene terephthalate	50	1.289	9.2	12		Example
2	Polyethylene terephthalate	50					
	Polytetramethylene terephthalate	25	1.294	5.5	27		Example
	Polytrimethylene terephthalate	25					
3	polyethylene terephthalate	50					
	Polytetramethylene terephthalate	50	1.305	8.4	40		Example
4	Polyethylene terephthalate	50					
	Polytetramethylene terephthalate	25	1.314	9.0			
	Polytrimethylene terephthalate	25			43		Example
5	Polyethylene terephthalate	50					
	Polytetramethylene terephthalate	50	1.307	3.5	64	good	Example
6	Polyethylene terephthalate	50					
	Polytetramethylene terephthalate	25					
	Polytrimethylene terephthalate	25	1.318	4.3	67	good	Example
7	Polyethylene terephthalate	50					Example
	Polytetramethylene terephthalate	50	1.348	3.8	87		

Example 11

A polyethylene terephthalate of an intrinsic viscosity
of 0.64 was melt spun at 290°C through a spinneret of
24 holes, and the spun filaments were taken up at a speed
5   of 5,000 m/min. The resultant polyester filament yarn (A)
of 75 denier/24 filaments was then twisted at a low twist
of S300 turns/m and warped at a warp density of 50/cm.

A blend of 50% by weight of polyethylene terephtha-
late chips having an intrinsic viscosity of 0.64 with 50%
10   by weight of polytetramethylene terephthalate having an
intrinsic viscosity of 0.86 was prepared. The blend was
melted at a temperature of 290°C to prepare a dope solution.
The dope solution was extruded through a spinneret having
24 holes.

15   The extruded filaments were cooled and oiled under
usual conditions, after which the resultant filaments were
taken up at a speed of 1000 cm/min.

The resultant undrawn yarn was drawn at a draw ratio
of 3.0 between a feed roller at 80°C and a drawing roller
20   at 180°C, heat treated at 200°C, and taken up at 800 m/min.

The drawn yarn of 75 denier/24 filament was twisted at
S2500 turns/m and subjected to wet heat twist setting
at 80°C for 30 min.

Using the high twist yarn (B) as filling at a density
25   of 33/cm, a plain woven fabric was prepared. The fabric
was then subjected to pebbling in hot water at 98°C on a
rotary washer for 20 min. or by a continuous pebbling
procedure for 5 min.

For comparison, a polyethylene terephthalate of an
30   intrinsic viscosity of 0.64 was melt spun at 290°C through
a spinneret of 24 holes and the spun filaments were taken
up at a speed of 1,200 m/min. The resultant undrawn yarn
was drawn at draw ratio of 3.3 on a draw pin at 90°C at a
speed of 500 m/min and taken up after bringing it in touch
35   with a hot plate of a 30 cm length at 180°C. The drawn
yarn of 75 denier/24 filaments was twisted at a low twist
of S300 turns/m and warped at a warp density of 50/cm.

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Then, a plain fabric was prepared and treated, as mentioned above.

The results are shown in Table 11.

Table 11

	Properties	Example	Comparative Example
Warp	Shrinkage in boiling water (%)	5.5	2.5
	Birefringence	0.099	0.167
	Young's modulus (kg/mm^2)	745	1280
Fabric	Width reduction percentage	82.4	14.5
	Pebbling in rotary washer	Possible	Pebble unevenness
	Continuous pebbling	Possible	Impossible
	Pebble configuration	Fine, deep and even	Fine but uneven

CLAIMS

1.   A high twist polyester multifilament yarn having
a twist of a twist multiplier K within a range between
15,000 and 25,000, made from polyester filaments consisting
essentially of a copolymer of two or more monomers selected
5   from the group consisting of ethylene terephthalate, tri-
methylene terephthalate, and tetramethylene terephthalate
and/or a blend of two or more polymers of the respective
monomers and having a breaking elongation of not more
than 60% and a shrinkage in boiling water of not more
10   than 6%.

2.   A high twist yarn as claimed in claim 1, wherein
said polyester filaments consist of said copolymer or a
combination of said copolymer and said blend, comprised of,
based on the total weight, 20% to 90% by weight of ethylene
15   terephthalate units and 80% to 10% by weight of trimethylene
terephthalate and/or tetramethylene terephthalate units.

3.   A high twist yarn as claimed in claim 1 or 2,
wherein said polyester filaments have a temperature of 220°C
to 255°C at which, on a shrinkage stress-temperature curve,
20   the shrinkage stress of the filaments becomes equal to zero
due to the fusion.

4.   A high twist polyester multifilament yarn having
a twist of a twist multiplier K within a range between
15,000 and 25,000, made from polyester filaments consisting
25   essentially of a composition of a copolymer of two or more
monomers.selected from the group consisting of ethylene
terephthalate, trimethylene terephthalate and tetramethylene
terephthalate and/or a blend of two or more polymers of the
respective monomers blended with 3% to 15% by weight, based
30   on the weight of said copolymer and/or blend, of a non-
crystalline polymer and having a breaking elongation of not
more than 60% and a shrinkage in boiling water of not more
than 6%.

5.   A high twist yarn as claimed in claim 4, wherein
35   said noncrystalline polymer is a styrene polymer or a
methacrylate polymer.

6.   A woven or knitted crepe fabric consisting of or
comprising a high twist polyester multifilament yarn having
a twist of a twist multiplier K within a range between
15,000 and 25,000, made from polyester filaments consisting
5 essentially of a copolymer of two or more monomers selected
from the group consisting of ethylene terephthalate, tri-
methylene terephthalate, and tetramethylene terephthalate
and/or a blend of two or more polymers of the respective
monomers.

10   7.   A process for preparing a woven or knitted crepe
fabric, comprising the steps of:
                subjecting a copolymer of two or more
monomers selected from the group consisting of ethylene
terephthalate, trimethylene terephthalate, and tetrame-
15 thylene terephthalate and/or a blend of two or more polymers
of the respective monomers to spinning and drawing to
obtain a yarn of polyester filaments having a shrinkage in
boiling water of not more than 6%, a density of not less
than 1.300 g/cm^3, and a breaking elongation of not more
20 than 60%;
                subjecting the polyester multifilament yarn
to twisting to apply a twist of a twist multiplier K within
a range between 15,000 and 25,000 to the yarn;
                subjecting the high twist yarn to twist
25 setting;
                preparing a woven or knitted fabric consist-
ing of or comprising the high twist yarn using said high
twist yarn; and then,
                subjecting the woven or knitted fabric to
30 pebbling.

8.   A process as claimed in claim 7, wherein said
twist setting is wet heat setting at a temperature of 70°C
to 130°C.

9.   A process as claimed in claim 7, wherein said
35 twist setting is dry heat setting at a temperature of
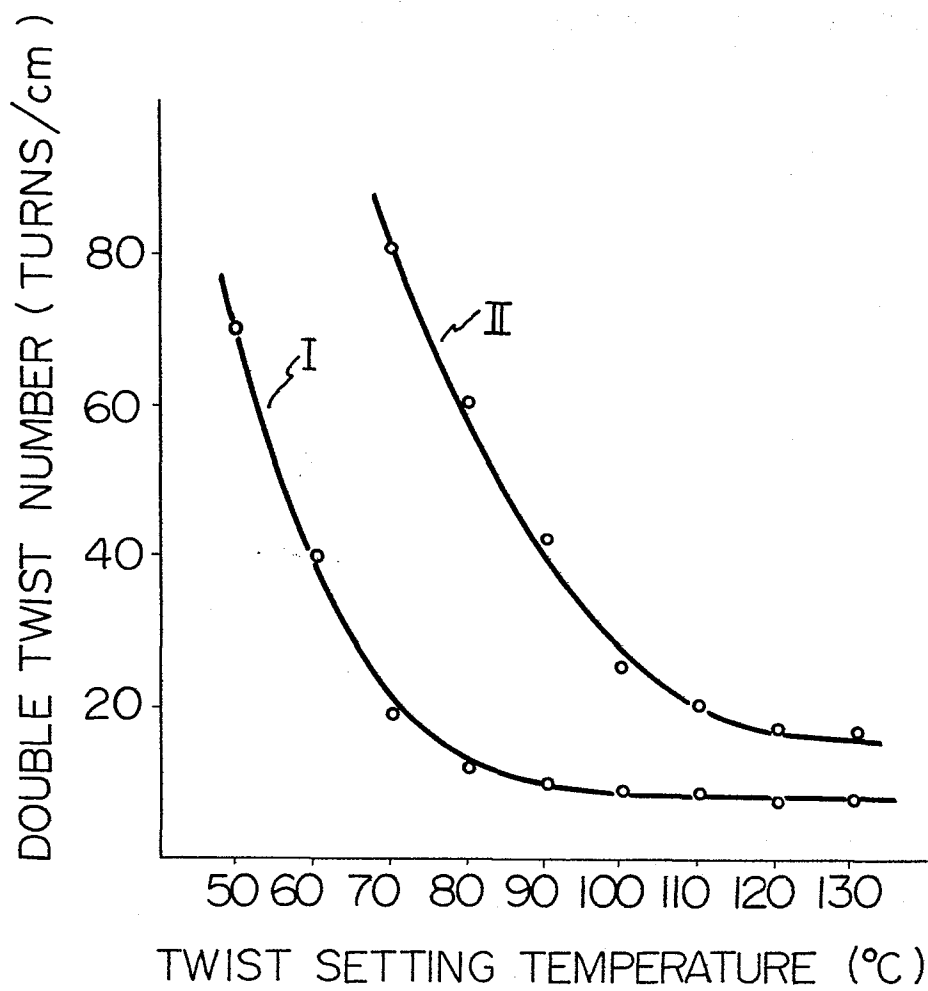70°C to 180°C.

10.   A process for preparing a woven crepe fabric,

comprising the steps of:

weaving a mixed fabric employing (A) a
polyester multifilament yarn having a shrinkage in boiling
water of not more than 8% and a birefringence Δn of 0.05
5   to 0.11 and (B) a high twist polyester multifilament yarn
having a twist of a twist multiplier K within a range
between 15,000 and 25,000, made from polyester filaments
consisting essentially of a copolymer of two or more
monomers selected from the group consisting of ethylene
10   terephthalate, trimethylene terephthalate and tetramethylene
terephthalate and/or a blend of two or more polymers of the
respective monomers and having a shrinkage in boiling water
of not more than 6%, a density of not less than 1.300 g/cm^3
and a breaking elongation of not more than 60%; and then,
15   subjecting the woven fabric to pebbling.

Fig. I

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
X,Y	US-A-4 164 116 (TEIJIN) * Claims 1-3; column 4, lines 7-67; column 3, lines 63-68 *	1,7-9	D 02 G 3/30 D 03 D 15/00
Y	US-A-3 977 175 (TEIJIN) * Claims 1,2; column 5, lines 44-63 *	1,2,7	
Y	US-A-4 164 114 (TEIJIN) * Claims 1-3; columns 7,8, example 1, table 1 *	1	
Y	GB-A-1 458 561 (MITSUBISHI) * Claim 1; page 2, lines 78-111; example 1, table 1 *	1,2	

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)

D 02 G
D 03 D
D 01 F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	04-02-1983	CATTOIRE V.A.