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D E C I S I O N
of 7 April 2005

Case Number: T 0608/01 - 3.3.7

Application Number: 92311348.4

Publication Number: 0546859

IPC: D01F 6/62

Language of the proceedings: EN

Title of invention:

Polyester filamentary yarn, polyester tire cord and production thereof

Patentee:

Kolon Industries, Inc.

Opponents:

01. Rhodia Filtec AG
02. Hoechst Trevira GmbH & Co. KG
03. Honeywell International Inc.

Headword:

-

Relevant legal provisions:

EPC Art. 83, 56

Keyword:

"Sufficiency of disclosure (yes)"
"Inventive step (yes) - problem and solution"

Decisions cited:

T 0219/83

Catchword:

-

Party as of right: Rhodia Filtec AG
(Opponent 01) Patent Abteilung MP
CH-6021 Emmenbrücke (CH)

Representative: Esson, Jean-Pierre
Rhodia Services
Direction de la Propriété Industrielle
Crit-Carières,
B.P. 62
F-69192 Saint-Fons Cédex (FR)

Decision under appeal: Interlocutory decision of the Opposition
Division of the European Patent Office posted
18 April 2001 concerning maintenance of
European patent No. 0546859 in amended form.

Composition of the Board:

Chairman: R. E. Teschemacher
Members: B. J. M. Struif
G. Santavicca

Summary of Facts and Submissions

I. The mention of the grant of European patent No. 0 546 859 with respect to European patent application No. 92 311 348.4 filed on 11 December 1992 was published on 16 July 1997. The granted patent included the following independent claims:

"1. A polyester filamentary yarn comprising at least 90 mol% polyethylene terephthalate and having a fineness of 0.01 to 6 tex (0.1 to 50 denier) per filament, and possessing a three-phase microstructure consisting of crystalline, amorphous and mesomorphous portions, wherein the said yarn has a crystallinity of 30-45 per cent by weight and the proportion of the mesomorphous portion is 5 to 15 percent based upon the total amount of crystalline, amorphous and mesomorphous portions."

"2. A polyester filamentary yarn comprising at least 90 mol% polyethylene terephthalate and having a fineness of 0.01 to 6 tex (0.1-50 denier) per filament, wherein said yarn has:

- i) a crystalline orientation function (f_c) of at most 0.94,
- ii) an amorphous orientation function (f_a) of at least 0.60,
- iii) a long period value of at most 15.5 nm,

and where said yarn is characterized in that $f_a(1-X_c) > 0.330$ where X_c is the percent crystallinity and is a value of 0.30-0.45."

"3. A polyester filamentary yarn comprising at least 90 mol% polyethylene terephthalate and having a fineness of 0.01 to 6 tex (0.1-50 denier) per filament, wherein said yarn has:

- i) a crystallinity of 30-45 percent by weight,
- ii) a crystallite size in the [(105) plane] of at most 6.5 nm,
- iii) a crystal volume of 50-154 nm³."

"6. A process for producing polyester filamentary yarn from a polyester resin comprising at least 90 mol% polyethylene terephthalate and having an intrinsic viscosity of at least 0.85, wherein the intrinsic viscosity (η) is calculated from the following equation by determining the relative viscosity (η_r) of a solution of 8 g of sample in 100 ml of ortho-chlorophenol at 25 °C using an Ostwald viscometer

$$\eta = 0.0242 \eta_r + 0.2634$$

where

$$\eta_r = t \times d / t_o \times d_o$$

and t = dropping time of solution (in seconds),
 t_o = dropping time of ortho-chlorophenol (in seconds),
 d = density of solution (in g/cc) and d_o = density of ortho-chlorophenol (in g/cc);
comprising the steps of melt-spinning, drawing, thermally treating and relaxing, wherein:

- 1) said polyester resin is spun at a spinning speed of 2,500 - 4,000 m/min and then solidified by quenching in air at a temperature of 25°C - the glass transition temperature T_g of the polymer to produce an undrawn yarn;
- 2) said undrawn yarn is drawn at a drawing temperature of the glass transition temperature T_g of the polymer - 120°C and a total draw ratio of 1.4:1 - 2.2:1,
- 3) the obtained drawn yarn is thermally treated at a temperature of 100-210°C; and
- 4) the thermally treated yarn is relaxed at a temperature < 140°C and at a relax ratio of 3 to 6 percent."

"14. A tire cord formed from a polyester filamentary yarn comprising at least 90 mol% polyethylene terephthalate, wherein said cord has:

- i) a strength at 10% elongation of at least 100 Newtons,
- ii) a shrinkage, S , of at most 3.5% obtained upon dry heat treatment at 177°C during 2 minutes under a dead weight loading of 20 g,
- iii) a strength at 10% elongation after the treatment in ii) above, L , of at least 65 Newtons, and
- iv) a coefficient of dimensional stability, L/S , of at least 20, wherein L and S are as defined above."

"16. A process for producing an improved tire cord wherein:

- 1) a polyester filamentary yarn is produced by means of a process according to any of claim 6 to 13,
- 2) the filamentary yarn is subjected in sequence to dipping in a rubber solution, drying, thermal treatment under a tension in the range of 0.2 to 0.5 dN/tex (0.2 to 0.6 g/d) and at a temperature in the range of 220 to 250°C, and normalizing to obtain a tire cord."

"17. A tire comprising a rubber matrix and the polyester tire cord defined in claim 15 imbedded in the rubber matrix."

II. Three notices of opposition have been filed against the granted patent, in which revocation of the patent in its entirety was requested with respect to lack of novelty, lack of an inventive step and insufficient disclosure, on the grounds of Article 100, paragraphs (a) and (b), EPC, respectively. The oppositions were *inter alia* supported by the following documents:

D1: J. Shimizu et al., Sen-i Gakkaishi, vol. 40 (1984), pages 1 to 16 (translation into English)

D3: US-A-4 851 172

D9: EP-A-0 456 496

D10: EP-A-0 295 147

D11: EP-A-0 169 415

D12: A. Ziabicki & H. Kawai: "High-Speed Fiber Spinning" (1985), p. 228, 345, 351, 365, 406, 425, 429-434, 437, 349, 440

D16: WO-A-90/07592

D19: Brandrup et al.: "Polymer Handbook", 4th. ed. (1999), p. V/114

III. In an interlocutory decision notified by post on 18 April 2001, the opposition division held that the patent based on a set of amended claims 1 to 16 submitted by letter dated 13 February 2001 as the sole request fulfilled the requirements of the EPC. Independent claims 1, 2 and 14 had the following version:

"1. A polyester filamentary yarn made from a polyester resin comprising at least 90 mol% polyethylene terephthalate and having an intrinsic viscosity of at least 0.85, said yarn having a fineness of 0.01 to 6 tex (0.1 to 50 denier) per filament, and possessing a three-phase microstructure consisting of crystalline, amorphous and mesomorphous portions, wherein the said yarn has a crystallinity of 30-45 per cent by weight and the proportion of the mesomorphous portion is 5 to 15 percent based upon the total amount of crystalline, amorphous and mesomorphous portions, and wherein said yarn has a crystalline orientation function (fc) of at most 0.94."

"2. A polyester filamentary yarn made from a polyester resin comprising at least 90 mol% polyethylene

terephthalate and having an intrinsic viscosity of at least 0.85, said yarn having a fineness of 0.01 to 6 tex (0.1 - 50 denier) per filament, wherein said yarn has:

- i) a crystalline orientation function (f_c) of at most 0.94,
- ii) an amorphous orientation function (f_a) of at least 0.60,
- iii) a long period value of at most 15.5 nm,
- iv) a shrinkage of 8-15% in an oven at 150°C during 30 minutes under zero tension,

and where said yarn is characterized in that $f_a(1-X_c) > 0.330$ where X_c is the percent crystallinity and is a value of 0.30 - 0.45."

"14. A tire cord formed from a polyester filamentary yarn as defined in any of claims 1 to 5, wherein said cord has:

- i) a strength at 10% elongation of at least 100 Newtons,
- ii) a shrinkage S of at most 3.5% obtained upon dry heat treatment at 177°C during 2 minutes under a dead weight loading of 20 g,
- iii) a strength at 10% elongation after the treatment in ii) above, L , of at least 65 Newtons, and
- iv) a coefficient of dimensional stability, L/S , of at least 20, wherein L and S are as defined above."

Independent granted claim 3 was replaced by an amended claim 3 dependent on claim 1. Independent claim 6 as granted remained unamended.

IV. According to the reasons of the interlocutory decision the opposition division held that:

- (a) D16 was *inter alia* admitted into the proceedings.
- (b) The amendments to the patent were in compliance with the requirements of Article 123, paragraphs (2) and (3), EPC.
- (c) As regards sufficiency of disclosure, the mesomorphous portion of the polyester yarn could be determined by using the formula and the peak intensity values from a X-ray diffractogram as taught in the description. Figure 1 of the patent in suit showed a real diffractogram, which could be used to determine peak values. Hence, the skilled person had no difficulty to reliably determine the mesophase portion from an X-ray diffractogram.
- (d) The glass transition temperature (T_g) of polyethylene terephthalate (PET) mentioned in claim 6 was, for the purposes of the patent in suit, 80°C. Consequently, the skilled person had no difficulty in setting the drawing temperature. The parameters of the tire cord according to claim 14 referred to filaments having a total fineness of 111 tex so that the missing indication in that claim could not be seen as an issue under Article 83 EPC.

Consequently, the requirements of Article 83 EPC were fulfilled.

- (e) As regards novelty, run 12 of Example 3 in D11 disclosed a relaxation step having a relax ratio within the claimed range of 3 to 6% and a drawing step through a gas bath at 325°C. However, D11 did not disclose a relaxation temperature of at most 140°C nor a heat-treatment separate from the drawing and relaxing step as claimed.

In Examples 1 to 4 of D16, a two stage drawing and a relaxation step were used, but they did not disclose a separate heat treatment step nor a relaxation step at 140°C or less.

Although in some examples of D9 a polyester having an intrinsic viscosity (IV) as claimed could be used, D9 did not disclose the claimed portion of the mesomorphous phase. Furthermore, the examples of D9 showed long period values as claimed only when using polyesters having a low intrinsic viscosity. Thus, novelty over D9, D11 and D16 was acknowledged.

- (f) As regards inventive step, the problem to be solved by the patent in suit was to provide polyester filamentary yarns, which showed improved fatigue resistance and strength conversion efficiency after having been subjected to a cord conversion process and incorporated into a rubber matrix. Claim 6 differed from D9 as starting point in that a specific relaxation step was used, which provided a high strength conversion efficiency. Since D16 did not disclose the specific relaxation temperature as claimed nor its technical effect,

there was no suggestion in D16 to modify the teaching of D9 in the direction of the claimed invention.

Although D3 and D17 disclosed that a higher relaxation ratio led to a lower shrinkage, they did not disclose the influence of the relaxation ratio or of the temperature on the strength conversion efficiency during the dipping process.

Run 12 in Example 3 of D11 disclosed a relaxation ratio below 6 % but not in relation to a relaxation temperature as claimed.

- (g) When using D16 as closest state of the art, the subject-matter of claim 6 differed therefrom in that a separate heat treatment step (3) and a specific relaxation step (4) were used. The heat treatment step (3) contributed to maintain the desired strength during the dipping process and the separate relaxation step was not suggested by the cited prior art. Furthermore, there was no incentive in the prior art on how to modify and arrive at yarns defined in claims 1 and 2.
- (h) The subject-matter of claim 6 differed from D11 as starting point in that a separate heat treatment step (3) was used. There was no incentive in the prior art to modify D11 and arrive at process claim 6 or at the yarns of claims 1 and 2.
- (i) Since independent claims 14 to 16 made directly or indirectly reference to claims 1, 2 or 6 the same conclusion could be drawn for these claims.

(j) Thus, the claimed subject-matter involved an inventive step.

V. On 29 May 2001, opponent 02 (appellant 01) lodged an appeal against the above decision, the prescribed fee being paid on the same day. On 20 June 2001, opponent 03 (appellant 02) lodged an appeal against the above decision, the prescribed fee being paid on the same day. The statements setting out the grounds of appeal of appellants 01 and 02 were filed on 21 and 24 August 2001, respectively.

Opponent 01 did not file an appeal and thus is a party as of right.

VI. In a communication dated 11 January 2005, the board addressed the points to be discussed at the oral proceedings.

VII. With a letter dated 7 March 2005 the respondent submitted six sets of amended claims as auxiliary requests I to VI.

VIII. The oral proceedings were held on 7 April 2005, appellant 02 being absent as communicated in its letter dated 5 April 2005 and opponent 01 being absent, as communicated in its letter dated 3 March 2005. The oral proceedings were continued in the absence of the above parties in accordance with Rule 71(2) EPC. The respondent submitted a set of claims 1 to 13 as main request and a set of claims 1 to 15 as auxiliary

request α . Claims 1 and 8 of the main request had the following contents:

"1. A process for producing polyester filamentary yarn from a polyester resin comprising at least 90 mol% polyethylene terephthalate and having an intrinsic viscosity of at least 0.85, wherein the intrinsic viscosity (η) is calculated from the following equation by determining the relative viscosity (η_r) of a solution of 8 g of sample in 100 ml of ortho-chlorophenol at 25°C using an Ostwald viscometer

$$\eta = 0.0242 \eta_r + 0.2634$$

where

$$\eta_r = t \times d / t_o \times d_o$$

and t = dropping time of solution (in seconds),
 t_o = dropping time of ortho-chlorophenol (in seconds),
 d = density of solution (in g/cc) and d_o = density of ortho-chlorophenol (in g/cc)

comprising the steps of melt-spinning, drawing, thermally treating and relaxing, wherein:

1) said polyester resin is spun at a spinning speed of 2,500 - 4,000 m/min and then solidified by quenching in air at a temperature of 25°C - 60°C to produce an undrawn yarn;

2) said undrawn yarn is drawn at a drawing temperature of 80°C - 120°C and a total draw ratio of 1.4:1 - 2.2:1,

3) the obtained drawn yarn is thermally treated at a temperature of 160°C - 210°C; and

4) the thermally treated yarn is relaxed at a temperature $\leq 140^{\circ}\text{C}$ and at a relax ratio of 3 to 6 percent."

"8. A polyester filamentary yarn obtainable by the process according to any of claims 1 - 7, said yarn having a fineness of 0.01 to 6 tex (0.1 - 50 denier) per filament, wherein said yarn has:

i) a crystalline orientation function (fc) of at most 0.94,

ii) an amorphous orientation function (fa) of at least 0.60,

iii) a long period value of at most 15.5 nm,

iv) a shrinkage of 8 - 15% in an oven at 150°C during 30 minutes under zero tension,

and where said yarn is characterized in that $fa(1-Xc) > 0.330$ where Xc is the percent crystallinity and is a value of 0.30 - 0.45."

Amended claim 11 corresponded to a combination of claims 14 and 15 as granted with a reference back to claims 8 to 10. Granted claim 16 remained as amended claim 12 with reference back to claims 1 to 7.

IX. The arguments of appellant 01 and those of appellant 02 submitted in writing, as far as relevant to the amended main request, can be summarized as follows:

(a) No formal objections to admissibility of the amended claims of the main request were raised.

(b) No objections to insufficiency were raised by appellant 01 with respect to amended claim 8. Also appellant 02 had raised no objections under

Article 100(b) EPC with respect to granted claim 2, on which amended claim 8 was based.

- (c) As regards insufficiency of disclosure of amended claim 1, the temperature window, at which the yarn was drawn, could refer to the temperature of the yarn itself, the heated rolls, the heating plates or heated air. In order to reproduce the heat treating of a fast moving yarn it was necessary to define exactly the method of heating and of measuring the temperature used. Since the heating conditions were unknown, it was not possible for the skilled person without undue burden to find out, whether within a preferred drawing temperature window of for example 80 to 90°C satisfactory yarn properties were obtained. Thus, the disclosure of the patent in suit was insufficient in that respect.
- (d) The strength of the cord defined in claim 11 had no concrete meaning, since the total fineness of the cord was not defined. Thus, claim 11 was insufficiently disclosed.
- (e) As regards process claim 1, the novelty objection of appellant 01 based on D16 was not maintained. Appellant 02 had argued that former process claim 6 was not novel over D11.
- (f) As regards product claim 8, appellant 01 did not raise any novelty objections. According to appellant 02 former product claim 2 was anticipated by D9 which disclosed polyester fibres having a long period value of 10 to 25 nm and a

hot shrinkage value of 6 to 15% at 177°C. Although the amorphous orientation function (fa) was not explicitly mentioned, it could be learnt from D2, that typical values were 0.79 and 0.96.

Furthermore, it was self-evident from yarns according to D9 that feature $fa(1-X_c) > 0.330$ was also met.

- (g) As regards inventive step, appellant 02 only made reference to its statements in first instance proceedings.

According to appellant 01, D16 and D11 could be used as starting points for assessing inventive step of process claim 1. Examples 1 to 4 of D16 disclosed all claimed features. In particular, the drawing step at temperatures of 200 and 220°C involved a heat treatment similar to that of claimed process step 3). Furthermore, between rolls 2/3 and roll 5/6 a steam jet 4 was used which provided a drawing temperature within the claimed range. When combining the process features of Example 1 with those of Example 2, the skilled person would arrive at the claimed process.

Furthermore, there were no comparative examples on file showing that the argued difference from D16 provided any improved technical effect. The comparative examples of the patent in suit were carried out under unrealistic conditions and did not allow any reliable conclusions. The relaxation conditions of step 4) were not shown to be critical and the heat treatment temperature had no effect on the crystalline and amorphous

orientation of the fibres. The fibres in D16 had already a low shrinkage, which was also desired in the final tire cord so that it could not be inventive to first produce a yarn with a high shrinkage which was then lowered when incorporated into the tire cord. Furthermore, the prior art process included less steps than that of claim 1. Consequently, it was obvious to modify the teaching of D16 in the direction of the claimed invention.

- (h) Starting from D11 as the closest state of the art, a polyester having the claimed intrinsic viscosity (IV) was used. Run 12 of Example 3 disclosed a relaxation step at a relax ratio of 5%. Since in D11 the heat treatment occurred at a roll temperature of 130°C, a gas temperature of 330°C and the draw ratio in runs 3, 8, 9 and 10 was 1:1, a pure heat treatment without drawing was involved. That yarn provided an excellent thermal stress behaviour as demonstrated in Figure 2 of D11. No improvement could be seen when comparing the thermal stress at high temperatures of the claimed yarn with that of D11. Thus, the claimed process did not provide a yarn having any improved technical property. The crystal volume shown in D11 was not much different from that obtained by the claimed process. Furthermore, the known yarns had already a low shrinkage so that a further reduction in the tire cord process was not necessary.
- (i) As to inventive step of claim 8, D10 was considered as the closest state of the art. D10

disclosed a polyester yarn having an amorphous orientation function f_a , a crystallinity, and an intrinsic viscosity within the claimed range. Furthermore, the shrinkage of the yarn was at the lower limit of the claimed range. The long period value, the intrinsic viscosity and the shrinkage as claimed were obvious from D9. Furthermore, although yarn B had a shrinkage of lower than 8%, it showed the claimed long period spacing when using an intrinsic viscosity of 0.92. Thus, claim 8 did not involve an inventive step.

X. The respondent argued essentially as follows:

- (a) Steps 1) to 4) of the claimed process involved four separate steps. Heat treatment step 3) was a separate step, since the temperature was higher than that of drawing step 2) and relaxation step 4). The skilled person knew how to carry out such a process and that the thermal treatment in step 3) was carried out neither at the drawing conditions according to step 2) nor at relaxation conditions according to step 4). Thus, it was implicit that the rolls in the thermal treatment were run at the same speed so that a "draw ratio" of 1 : 1 was applied. Since spinning velocity was given in step 1), the velocity of the rolls in the further steps could be calculated from the draw ratios and the relaxation degree applied.
- (b) As regards insufficiency, since the "drawing temperature" could not be the temperature of the yarn itself, it referred to the temperature of a medium such as the drawing roller in contact with

the yarn in the drawing zone. The description of the patent in suit allowed the skilled person to find out, how to set the drawing temperature within a window of 80 to 120°C. The parameters of the tire cord according to claim 14 referred to a total fineness of the cord as specified in the description. Thus, the appellant's objections to insufficiency concerned clarity.

- (c) As regards novelty of claim 1, D11 did not clearly and unambiguously disclose a relaxation temperature of at most 140°C and a separate heat-treatment according to step 3) of claim 1. As regards novelty of claim 8, D9 did not disclose the long period value as claimed.

- (d) As regards inventive step of process claim 6, D16 used a two stage drawing and a relaxation step. In Examples 1 and 3 the drawing rolls were heated at 200°C and the relax rolls were maintained at 150°C. In Examples 2 to 4 the highly heated rolls were at 220°C. Furthermore, in the first drawing step, the rolls 2 and 3 were heated to 40 to 50°C outside the claimed drawing step and in the second drawing step, the heat rolls were at a too high temperature. A too high and a too low drawing temperature in D16 affected the crystallisation behaviour of the yarn before orientation.

On the other hand, a separate heat treatment led to a beneficial effect on the crystalline and amorphous portions of the yarn which were necessary in order to arrive at tire cords having improved properties as shown in tables 3 and 4.

When such a yarn having a relatively high shrinkage was incorporated into a rubber matrix, the mesomorphous phase disappeared and tire cords having excellent strength conversion efficiency, and fatigue resistance could be obtained. Thus, the problem to be solved over D16 was to provide a process for producing a yarn which, when incorporated into a tire cord, showed improved properties. D16 provided no incentive to modify its teaching in the direction of the claimed process.

- (e) Although some exemplified process conditions in D11 showed a draw ratio of 1:1, they did not use also a relaxation treatment at a temperature of at most 140°C. Furthermore, the drawing was not carried out between 80 to 120°C and no separate heat treatment was applied. The relax ratio according to D11 was generally in the range to 10 to 20% and only one run met the claimed relax ratio. Furthermore, D11 aimed at a yarn having low shrinkage whilst the claimed process should produce a yarn having high shrinkage and low thermal stress above 210°C. Thus, the skilled person had no motivation to consider a yarn having high shrinkage and to lower the shrinkage in the final tire cord. Thus, there was no incentive to modify D11 in the direction of the claimed invention.
- (f) As regards product claim 8, D10 did not suggest a long period value and a shrinkage as claimed and how a yarn with those features could be prepared, since the drawing conditions were very different.

In Examples I to III and VII of D9 a polyester having an intrinsic viscosity of 0.63 was used. The problem to be solved over D10 could be seen in providing a yarn having a high shrinkage and a three phase structure which, when incorporated into a tire cord, showed improved properties. Furthermore, the crystallinity specified in D9 referred to a polyester yarn as spun but not to the final filamentary yarn. As far as the filamentary yarns of Table VII referred to an intrinsic viscosity of 0.92, they provided a long period spacing outside the claimed range. In D2, the shrinkage of the yarn B was too low and sample C was a comparative example which the skilled person would not modify.

XI. After the closure of the debate and the deliberation by the board, the representative of appellant 01 requested to reopen the debate and to be given the opportunity to object to the term "normalizing" in claim 12 of the main request which had no clear meaning. That request was refused for the following reasons:

- (a) The term "normalising" in claim 12 was present in the corresponding claim 13 as granted, except its reference had been amended. Hence, it cannot be objected to under Article 84 EPC, which is no opposition ground (Case Law of the Boards of Appeal of the European Patent Office, 4th edition 2001, VII.C.10.1.2).
- (b) Furthermore, the parties had been given sufficient time and opportunity to comment on all relevant aspects before closing the debate.

- XII. Appellants 01 and 02 requested that the decision under appeal be set aside and that the European patent be revoked.
- XIII. The respondent requested that the appeal be dismissed and the patent be maintained on the basis of claims 1 to 13 submitted as the main request during the oral proceedings, alternatively with the claims, description and drawings underlying the decision under appeal, or on the basis of any of the requests indicated as auxiliary requests I to VI in the letter dated 7 March 2005, or on the basis of auxiliary request α submitted during the oral proceedings.

Reasons for the Decision

1. The appeal is admissible.

Amendments

2. Amended claims 1 and 8 go back to process claim 7 and product claim 2 as filed, respectively. Amended claim 8 has been made dependent on claim 1, so that the filamentary yarn is obtainable by the process steps of claims 1 to 7. Amended claim 11 is based on claims 16 and 17 as filed. Amended claim 12 corresponds to claim 18 as filed except for the amended reference back. The further amendments to claims 1 and 8 have a basis in the application as filed as follows:
 - claim 1, step 1): "60°C" (claim 11);
 - claim 1, step 2): "80°C - 120°C" (claim 12);

- claim 1, step 3): "160°C" (page 49, line 10);
- claim 8, feature iv): page 34, last three lines.

2.1 The amendments to the claims have not been objected to by the appellants. The board sees no reason to take a different position. Thus, the amended claims meet the requirements of Article 123, paragraphs (2) and (3), EPC.

Insufficiency of disclosure

3. The former main objections to insufficiency of disclosure were based on the calculation of the mesomorphous portion and the reference to the T_g. The first objection has been overcome by cancelling granted claim 1 and maintaining granted claim 2 as an alternative definition of the yarn produced by the claimed process. The second objection has been overcome by replacing the T_g in the process claim by specific temperature values. Consequently, those objections are overcome.

3.1 The appellants, however, argued that the temperature window for drawing the yarn was not clearly disclosed, since the patent specification did not indicate whether or not the drawing temperature referred to the temperature of the yarn itself, the heated rolls, the heating plates and/or hot air.

3.2 The question to be answered under Article 83 EPC is whether or not the claimed process can be reproduced by a person skilled in the art by taking into account the information in the patent in suit and common general knowledge.

3.2.1 According to amended claim 1, the quenching temperature in step 1) is 25 to 60°C, the temperature in step 2) is 80 to 120°C, the thermal heat treatment step 3) is effected at 160°C to 210°C and in step 4) the relaxation temperature is 140°C. Furthermore, it is specified that in step 2) said "undrawn yarn" is drawn, in step 3) that the "obtained drawn yarn" is thermally heat treated and in step 4) that the "thermally treated yarn" is relaxed.

3.2.2 As confirmed by the technical expert of appellant 01, the claimed process steps normally include rolls for spinning, drawing, thermal heating and relaxation similar to those as illustrated in Figure 2 of D9. According to Figure 2 of D9, after quenching of the filaments, the spun filament is drawn by a feeding roll 1 having a specified temperature, then passed over two pairs of rolls 2 and 3 both running at the same velocity but at a higher speed than roll 1. In that second (last) drawing step a pair of rolls 5 and 6 is used, which normally has the highest temperature of the rolls. In the final step, the rolls 7 and 8 run at a lower velocity so that a relaxation occurs. Appellant 01 agreed that the thermal heating step 3), which is neither a drawing step 2) nor a relaxation step 4), will be carried out with rolls running at the same velocity (draw ratio: 1:1).

3.2.3 Thus, from the above it follows that process steps 1) to 4) are quite separate process steps carried out at different process conditions and temperatures, which do not overlap.

- 3.2.4 The claimed process is illustrated in the patent in suit by twenty examples and ten comparative examples, in which detailed process conditions for steps 1) to 4) are specified, in particular spinning speed, drawing ratio, relaxation ratios and different temperatures to be used in those steps. In particular, the drawing is carried out in two steps, wherein the temperatures indicated refer to the "draw zone" (see tables 1 and 2). Since it is practically impossible to measure directly the temperature of a fast-running yarn as confirmed by D17 (page 11, lines 6 to 8), the drawing temperature cannot refer to the yarn itself.
- 3.2.5 According to the patent in suit, at a too high drawing temperature (above 120°C) fine crystals are formed before the orientation of the molecular chains and accordingly the drawability is degraded. At a too low temperature (below 80°C) the molecular chains lose their mobility whereby efficiency of drawing is low (page 11, lines 39 to 42). Thus, the skilled person will maintain the temperature of the medium in the draw zone within the claimed range so that these disadvantages are avoided.
- 3.2.6 Consequently, the skilled person gets sufficient information from the patent in suit as to how to set the temperature conditions of the medium in the drawing zone. On the other hand, the appellants have not provided any experimental evidence showing that the skilled person, with the guidance of the patent in suit and common general knowledge, would be unable to carry out the claimed process and to arrive at yarns having satisfactory properties. The onus of proof in this respect lies, however, with the opponents (appellants)

(T 219/83, OJ EPO 1986, 211), which they failed to discharge.

3.3 The appellants further argued that the strength of the cord defined in claim 11 had no concrete meaning, since the total fineness of the tire cord was not defined.

3.3.1 According to the patent in suit, filaments having a **total** fineness of 1000 denier (111 tex) (page 12, line 53) and a yarn with a fineness of 111 tex (1000 denier) (page 13, line 18) are used to produce a tire cord under specified process conditions (page 13, lines 23 to 31, tables 3 and 4). For that purpose the yarns are twisted 49 times/10cm in Z direction and then 49 times/10cm in S direction before doubling them together (page 13, lines 25 to 27). The properties of such tire cords are presented in Table 3, which reflect the properties of the tire cord according to claim 11. Hence, the skilled person is able to reproduce the tire cord for which the specific properties are indicated.

3.3.2 Furthermore, it has not been shown by experimental results that the skilled person was unable to reproduce such tire cords having the features i) to iv) as claimed. The onus of proof in this respect lies with the opponents (appellants) (T 219/83, *supra*), which they failed to discharge.

3.3.3 The question whether or not the cord fineness should be indicated in claim 11 concerns an objection of clarity under Article 84 EPC rather than an objection of insufficiency under Article 83 EPC. Since that objection did not arise out of any amendment made, the argued missing indication in the claim cannot be

objected to under Article 84 EPC, which is not a ground of opposition (Case Law, *supra*, VII.C.10.2).

Novelty

4. Appellant 01 did not raise any novelty objections, during oral proceedings, against the amended claims of the main request. The board sees no reason to take a different position. In addition, the novelty of the claimed subject-matter becomes apparent from the discussion of inventive step below.

Inventive step

Problem and solution

Process claim 1

5. The patent in suit *inter alia* concerns a process for the production of polyester filamentary yarn. Such processes are known from the prior art, in particular from D16 and D11, which the parties and the opposition division considered as an appropriate starting point for assessing inventive step of the claimed process. Since claim 1 concerns a process claim and since appellant 01 started from D16 as the closest state of the art, it is appropriate to start with D16 first.
 - 5.1 The patent in suit aims at a process for the production of a polyester filamentary yarn which exhibits excellent fatigue resistance and dimensional stability both before and after it has been incorporated in a rubber matrix even under the conditions where it is subjected to repeated fatigue behaviour at high temperatures (at least 210°C) (page 4, lines 16 to 19).

Starting point D16

5.2 D16 discloses a process for production of a dimensionally stable drawn polyethylene terephthalate multifilament yarn having filaments of at least 2.5 denier per filament comprising the steps of:

- (a) extruding a polyethylene terephthalate polymer melt through a spinnerette having a plurality of extrusion orifices to form filaments;
- (b) advancing the extruded multifilament yarn first through a delay zone then through a quenching zone to solidify the filaments in a controlled manner;
- (c) withdrawing the solidified multifilament yarn from the quenching zone at a desired spinning speed V ;;

whereby steps (a) through (c) are performed under conditions to form a partially-oriented multifilament yarn having an undrawn birefringence (Δn_u) of at least 0.020 and wherein $\Delta n_u = R_f V^{2.0} IV^{2.4}$ where IV is the intrinsic viscosity of the undrawn yarn and is at least 0.80 and R_f is at least 9.0×10^{-3} ; then

- (d) hot drawing the partially-oriented multifilament yarn (claim 1).

5.2.1 According to Examples 1 to 4 of D16, a two stage drawing step and a relaxation step are used. In Examples 1 and 3 a PET polymer is spun through a heated sleeve and quenched in a radial quench stack. The spun yarn is subsequently drawn on a panel similar to Figure 2 with a roll 1 maintained at 90°C. The yarn is drawn 1.5/1 to unheated rolls 2, 3 with a normal ambient temperature of 40-50°C, then drawn 1.6/1 from rolls 2, 3 to rolls 5, 6 maintained at 200°C and then the yarn is relaxed to rolls 7, 8 at 1 to 1.5 percent.

Rolls 7 and 8 have an operating temperature of 150°C. The drawn yarn is taken up at 2.98 km/min. The drawn yarn is 1004 denier and IV is 0.92 dl/g. In claimed step 4) the relaxation temperature (140°C) is lower and the relax ratio (3 to 6%) is higher than in the relaxation stage of D16.

5.2.2 In Examples 2 to 4, the spun yarn is first drawn 1.4/1 between rolls at 90°C and unheated rolls, then drawn 1.15/1 between these and rolls maintained at 220°C. The drawn yarn is then relaxed at 3% to rolls maintained at 135°C. The drawn yarn is taken up at 4.6 km/min. The drawn yarn is 924 denier and IV of the undrawn yarn is 0.92 dl/g. Since the relaxation conditions in Examples 2 and 4 cover those of claimed step 4), Examples 2 to 4 have more features in common with the claimed subject-matter than Examples 1 and 3. Hence, it is appropriate to use Examples 2 and 4 as starting point.

5.2.3 The drawing steps in Examples 2 and 4 of D16 cover temperatures of 90°C, 40 to 50°C and 220°C. In particular, in those examples the higher temperature of 220°C is specifically described as part of the drawing process, but not as separate thermal heat treatment different from the drawing and the relaxation conditions as claimed. Contrary to D16, the temperatures in drawing step 2) as claimed are limited to 80 to 120°C.

5.3 Since heated rolls 5 and 6 having a temperature of 220°C form part of the drawing step, they cannot be a thermal heating step 3) separate from a drawing step 2)

- and a relaxation step 4) in the sense of the steps of claim 1.
- 5.3.1 But even if the temperature of 220°C was interpreted as a kind of thermal treating step, that specific temperature would be outside the claimed range of 160 to 210°C.
- 5.4 The temperature of the thermal heating is one of the important factors to determine the structure of the yarn because in this thermal treatment a yarn with nearly completed orientation is treated. The temperature is required to be in the range of 160 to 210°C. When the temperature exceeds 210°C, which is the case in Examples 2 and 4 of D16, the network structure characteristic of the claimed invention i.e. the development of intermicrofibrillar tie molecules cannot be achieved and the orientation of the crystalline portions is greatly increased and the orientation of the amorphous region is decreased. Therefore, the lowering of strength due to abnormal crystal growth in the subsequent dipping process cannot be minimized (patent in suit, page 12, lines 17 to 21).
- 5.4.1 Examples 1 to 20 of the patent in suit illustrate the production of a yarn having a three phase microstructure, when using the above defined process steps 1) to 4) (Table 1, pages 15 to 17). This microstructure is evident from yarns having a crystalline orientation function (f_c) below 0.94 and an amorphous orientation function (f_a) of at least 0.60 as also specified in claim 8, since in those yarns besides the crystalline and amorphous portions a pseudo-crystalline portion of mesomorphous portion

exists (page 7, lines 29 to 31). Those yarns show in addition a crystal volume of 152 nm^3 or less (Example 16; claim 7). Furthermore, by those process conditions yarns having a relative high shrinkage of 8 to 15% and a maximum thermal stress of less than 0.5 g/d will be obtained (see tables 1 and 2). In particular, the yarns produced by the claimed process show a "decrease" in the thermal stress behaviour beyond 210°C .

5.4.2 On the other hand, comparative examples 1 to 10 illustrate yarns which do not achieve the above mentioned properties when process conditions outside the claimed range are used. In particular, when the temperature of the second drawing zone is 220°C and/or the heat treatment is above 210°C , the desired three phase microstructure, crystallite size and crystal volume cannot be achieved (see Table 2, page 20, in particular comparative examples 9 and 10). Furthermore, the shrinkage of the yarn produced by the comparative examples is lower than that obtained by the claimed process (see comparative examples 9 and 10 having a shrinkage of 5.9 and 5.6, respectively). In addition, in all yarns produced according to the comparative examples the thermal stress behaviour "increases" beyond 210°C .

5.4.3 When the exemplified yarns obtained by the claimed process are incorporated in the tire cord under the specified conditions of claim 12, a combination of (i) high strength at 10% elongation of at least 100 Newtons, (ii) low shrinkage S of at most 3.5% obtained upon dry heat treatment at 177°C during 2 minutes under a dead weight loading of 20 g, (iii) high strength at 10% elongation after the treatment in ii) above, L, of at

least 65 Newtons, and (iv) a coefficient of dimensional stability L/S, of at least 20, can be achieved (page 21, Table 3). Furthermore, the strength retention when tested on a tire before and after 48h rotation at an inner tube pressure of 3.5 kg/cm², rotation speed of 850 rpm and tube angle of 80°C is 94% or higher (see page 14, lines 6 to 8; Table 3). However, all exemplified comparative examples tested do not provide the above combination of tire cord properties and have in particular a strength retention of at most 90%.

5.4.4 From the results in tables 1 to 3 it can be gathered that yarns obtained by the claimed process have a distinct crystalline microstructure with the potential, when incorporated into a tire cord, to provide dimension stable products having low shrinkage at most 3.5% and maximum thermal stress of 0.06 to 0.09, although the starting yarns have a relative high shrinkage of above 10 (Example 9) to 12.4% (Example 12) and a maximum thermal stress of 0.28 (Example 9) to 0.48 (Example 1). In comparison thereto, tire cords according to comparative examples 15 to 20 which have been produced under the same dipping conditions do not show the desired combination of properties, in particular a lower fatigue resistance and strength retention efficiency although the lower starting shrinkage of the yarn of comparative examples 3, 5, 9 and 10 appears to be more promising in that respect than that of the yarns obtained by the claimed process.

5.5 Appellant 01 argued that the comparative examples have been carried out under unrealistic conditions and that no valid comparison to the state of the art has been made.

- 5.5.1 Comparative examples 9 and 10 use a temperature in the second drawing zone of 220°C and heat treatment temperature of 240°C and a high relax temperature of 180°C. The temperature of 220°C in the second drawing zone of Example 2 and 4 of D16 lies within that range. There are a lot of examples and comparative examples showing that the process conditions as claimed are critical for achieving the claimed effect in the final tire cord and that outside the claimed process condition these properties cannot be achieved. Hence, it has been made plausible that improved properties over the state of the art can be achieved, because in D16 the critical process conditions have not been met.
- 5.5.2 Whilst no direct comparison is on file which reproduces the exemplified process conditions of D16, there are, however, no process conditions disclosed in D16, under which the tire cords should be produced, making a direct comparison with the state of the art possible.
- 5.5.3 In this respect, appellants 01 and 02 have not shown by experimental evidence anything which might invalidate the plausible results shown in the patent in suit.
- 5.5.4 From the above it follows that the problem solved over D16 can be seen in providing a process for producing a yarn which, when incorporated into a tire cord shows an enhanced fatigue resistance and an improved strength retention.

Starting point D11

5.6 D11 discloses a polyester fibre composed of a polyester comprising ethylene terephthalate units as the main recurring units and having an intrinsic viscosity of at least 0.90, wherein the amorphous orientation degree is in the range of from 0.30 to 0.55 and the crystal melting point is at least 265°C (claim 1). The fibre has a crystal volume of at least $4.0 \times 10^5 \text{ \AA}^3$ (400 nm^3) a dry-heat shrinkage factor at 210°C of less than 6% and a long-period spacing is at least 160 Å (claims 2, 3 and 6).

5.6.1 The fibres according to D11 are produced at a take up speed of the undrawn fibre of 2000 to 6000 m/min (page 8, line 26), which is comparable to the claimed spinning speed. The cooling is effected by blowing air at room temperature (page 7, line 33). After spinning, the fibre is first drawn at a temperature in the range of $T_g + 15^\circ\text{C}$ to $T_g + 50^\circ\text{C}$ (page 9, lines 7 to 9), corresponding to 95 to 130°C, if T_g of PET is assumed to be 80°C. Thereafter, the fibre is subjected to a subsequent drawing stage. If a heat treatment is carried out, it is effected at a temperature in the range of (fusing temperature - 50°C) to (fusing temperature - 110°C) at a relax ratio to 10 to 20% (page 9, lines 17 to 24). The fusing temperature of PET is at least 265°C (D11, page 3, line 29) so that the temperature of that heat treatment is within the range of 155 to 215°C.

5.6.2 In Example 3 of D11 a melted polyester at about 300°C is extruded from a spinneret, spun at a spinning speed of 3500 to 6000 m/min (Table 2), cooled and solidified by blowing cooling air maintained at 25°C. The undrawn fiber is supplied to a roller heated at 85°C and

subjected to a first stage drawing between this roll and a take-up roll at a first draw ratio (DR1) and is then subjected to second stage drawing through a gas bath maintained at 325°C at a second draw ratio (DR2). Then, the fibre is subjected to a relax heat treatment at a third drawn ratio (DR3) by using a roller heated at 130°C and a gas bath at 330°C (page 18, lines 33 to page 19, line 5). The relax ratio in only one of fourteen runs is 5% (run 12), in all other runs 7% and above. In none of these exemplified runs is a heat treatment separate from the drawing and relaxation steps carried out. Furthermore, that relaxation step includes a gas bath having a temperature of 330°C which is far above the relaxation temperature used in step 4) as claimed.

5.6.3 According to Example 1 of D11, the draw ratio DR3 may be 1.00 (runs 3 and 8 to 10). This separate heat treatment is effected at a roller heated to 130°C and a gas bath maintained at 330°C. Even if in those runs a separate heat treatment is effected, the temperature thereof is above 210°C. Furthermore, in D11 there is no hint to a combination of steps 3) and 4) as claimed.

5.6.4 According to the patent in suit, when the relaxing temperature is greater than 140°C, the yarn will initiate the creation of defects in the crystalline structure or destruction of the same upon the application of heat in the subsequent dipping process. When the relax ratio is more than 6 percent, the strength efficiency may be decreased and the resulting lowering of shrinkage may be so small that the effect cannot remain in the dipped cord (page 12, lines 34 to 39).

- 5.6.5 A too high temperature of 220 to 240°C in the heat treatment and/or in the relaxation steps changes the microstructure of yarn considerably as shown by the crystalline and amorphous orientation function, the long period spacing and the crystal volume (patent in suit, Table 2, comparative examples 3, 5, 8 and 9). According to D11 the crystal volume of the yarns is preferably at least 400 nm³ to avoid that a degradation of the strength is readily caused (page 5, lines 4 to 9). Hence, the crystal volume of the yarns obtained by the claimed process (Table 1, pages 16 and Table 2, page 18) is more than two and a half times smaller than that of the yarns obtained by D11. Furthermore, the thermal stress behaviour of Example 3, run 12 of D11, "increases" beyond 210°C as shown by Figure 2, whilst in all exemplified yarns obtained according to the claimed process the thermal stress behaviour beyond 210°C shows the opposite effect (Table 1, pages 15 to 18).
- 5.6.6 From the above it follows that the process conditions in D11 are more distinct from the claimed process conditions than D16 and provide yarns having a crystal microstructure quite different from the claimed subject-matter. Furthermore, there are no examples in D11, which illustrate the behaviour of those yarns when incorporated into a tire cord under specific conditions.
- 5.6.7 Thus, considerations similar to those according to D16 (points 5.5 to 5.5.4 above) apply *mutatis mutandis* to D11 so that the problem to be solved over D11 can be formulated accordingly as outlined under point 5.5.4 above.

Product claim 8

5.7 D10 discloses a polyester yarn comprising primarily polyethylene terephthalate for use in reinforcing rubber goods and having the following properties:

- (a) an intrinsic viscosity of at least 0.91,
- (b) a tenacity of at least 8 g/d,
- (c) $E_{2.25}$ of 4.5 percent or less,
- (d) ΔH_{mf} of at least 11.5 cal/g,
- (e) $(T_{mf} - T_{mF})$ of at least 20°C, and
- (f) an amorphous orientation function of 0.75 or less,

wherein $E_{2.25}$ is the elongation under a load of 2.25 g/d, ΔH_{mf} is the amount of heat at the melting peak in differential scanning calorimeter (DSC), T_{mf} is the melting point measured by DSC under a tension of 0.05 g/d, and T_{mF} is the melting point measured by DSC under no tension (claim 1). The crystalline orientation function f_c of the yarn generally exhibits a value of about 0.94 (page 3, lines 49 and 50).

5.7.1 According to the example of D10, the spun yarn is cooled with air at 18°C and taken up at a speed of 2000 m/minute to a take-up roller which is heated to 85°C. The undrawn yarn is given a first stage drawing to a draw ratio of 1.45 between the heated take-up roller and an unheated No. 1 Nelson roller. Then, between the No. 1 Nelson roller and a No. 2 Nelson roller heated to 240°C, the yarn is passed through 400°C steam jet apparatus to effect a second stage drawing. Then, between the No. 2 Nelson roller and a conditioning roller which was heated to 100°C, the yarn is subjected to a relaxation ratio of 1.3 to 4.8

(Table 1). However, only one of the twelve examples (Example 11) shows a relaxation ratio between 3 and 6% as claimed.

5.7.2 D10 does not provide any indication of the claimed long period value and the shrinkage of the yarn. The long period value is a parameter reflecting the size of the crystal and amorphous regions so as to prevent the dimension deformation as such shrinkage by heat (patent in suit, page 8, lines 6 to 9).

5.7.3 Furthermore, the process conditions specified in the example of D10 are in many aspects different from those of the claimed process conditions. In particular, the exemplified spinning conditions of 2000 m/min at a quenching temperature of 18°C are outside the claimed range. Since the quenching temperature is less than 25°C, the filament is too quickly quenched and thus the tension at the solidification point may be decreased so that it may be difficult to obtain a highly oriented undrawn yarn (patent in suit, page 11, lines 23 to 30). Furthermore, in D10, the drawing conditions at very high temperatures by using rollers heated to 240°C and steam heated to 400°C cannot provide the microstructure of yarn as obtained by the claimed process as illustrated in the Examples 1 to 20 and comparative examples 3 and 5 of the patent in suit (tables 1 and 2). In particular, those comparative examples do not exhibit the crystalline microstructure as specified by the long period value, the crystallite size, the crystal volume and its shrinkage which characterize the yarn obtained by the claimed process. Thus, it has not been shown that the process conditions in D10 are suitable to provide a yarn showing a decrease in

thermal stress behaviour beyond 210°C as illustrated in tables 1 and 2 of the patent in suit.

5.7.4 Furthermore, although the conditions for measuring the shrinkage of the tire cord in D10 are not fully comparable to those of Table 3 of the patent in suit, they are measured at similar temperatures of 177 and 180°C respectively. Whilst the tire cord obtained by yarns according to D10 shows a heat shrinkage of 4.2 to 6.8% (Table 1, line N), the tire cord according to the patent in suit shows a shrinkage of less than 3.5% (Table 3; claim 11). The appellants have not shown anything to the contrary by experimental evidence.

5.7.5 From the above it is plausible that the claimed yarn exhibits a decrease in thermal stress behaviour above 210°C and provides, when incorporated into a tire cord, a lower shrinkage.

5.7.6 Thus, the problem solved over D10 can be seen in providing a polyester filamentary yarn which exhibits an improved fatigue resistance and dimensional stability when incorporated in a rubber matrix.

Obviousness

6. It remains to be decided whether or not the claimed subject-matter is obvious having regard to the documents on file.

Process claim

6.1 In D16, according to which a proper selection of process variables results in desired yarns exhibiting improved "dimensional stability" (page 9, lines 13

to 16), there is no hint to combine the teachings of Examples 1 and 3 with Examples 2 and 4. In particular, a simple lowering of the drawing temperature from 220°C according to Example 2 to 200°C according to Example 1 would not result in the claimed process, since those examples neither describe a drawing step within a temperature range of 80 to 120°C nor a separate heat treatment 3) as defined in claim 1. Thus, the claimed process steps for solving the technical problem are not made obvious from D16 alone.

6.2 Although in D11 four examples of Table 1 describe a thermal heat treatment without drawing and one example in Table 2 discloses a heat treatment under the claimed relaxation conditions, there is no incentive to combine these features in order to arrive at the claimed steps 3) and 4). Furthermore, the temperature conditions in all examples include a second drawing step comprising a heat roll at 130°C and a gas bath at 330°C resulting in temperatures at the drawing stage outside the claimed range. Having regard to the fact that the thermal stress increases at temperatures beyond 210°C as shown in Figure 2 of D11, whilst yarns obtained by the claimed process show an opposite behaviour under those conditions, there is no incentive in D11 to modify the process conditions in a direction as claimed. Furthermore, there is no indication in D11 for modifying the process steps of D16 in order to improve the fatigue resistance and retention of strength of the tire cord. Consequently, the claimed process is not made obvious when considering D16 and D11 in combination.

6.3 D9 discloses a process for spinning an organic synthetic melt spinnable polymer comprising the steps of extruding the polymer through a spinneret; passing the filaments from the spinneret through an elongated zone; maintaining the filaments at a temperature above the glass transition of the polymer over a distance of about 3 meters or greater within the zone; and thereafter converging the filaments (claim 1). The filaments have a spun denier per filament of 3-20 (claim 3). The filaments are quenched with a hot gas having a temperature no greater than 260°C, preferably 230°C (claims 5 and 6). The fibres of polyesters having an intrinsic viscosity of at least 0.85 (Examples IV, V and VII) were produced at a spinning speed of 3000 to 5800, preferably 3200 to 3800 m/min (page 6, lines 20 to 24) and have a crystalline portion of 10 to 43% (page 6, line 46). The draw ratio is about 1.65 for a spun yarn made at about 3800 m/min and the optimum draw roll temperature is 240 to 245°C (page 6, lines 58 to 58). In Example IV the draw rolls are maintained at a temperature of 180 to 255°C. In Example V, a single stage drawing by using an ambient feed roll and a 245°C draw roll are applied.

6.3.1 Since temperatures of 220°C and above in the drawing and/or heat treatment step result in yarns which show an increase in thermal stress behaviour beyond 210°C (see Table 2 of the patent in suit, comparative examples 3, 5, 9 and 10) and since nothing to the contrary has been shown, it is plausible that the exemplified yarns produced in accordance with D11 will show a similar effect. Furthermore, yarns of those comparative examples will not show the high strength retention and dimensional stability of the yarns

obtained by the claimed process when incorporated into tire cords (Tables 3 and 4).

- 6.4 Since D9 does not disclose any separate thermal heat and relaxation step and since the exemplified temperatures of the drawing step are quite outside the claimed range, there is no incentive in D9 to modify the teaching of D16 in a direction of the claimed process conditions in order to solve the problem posed.
- 6.5 D2 discloses a continuous melt-spin process for the simultaneous spin-drawing of high performance polyester multifilament yarn with an intrinsic viscosity of at least 0.90, a toughness of at least 0.40 grams per denier and a work loss of less than 0.04 inch-pounds when cycled between a stress of 0.6 gram per denier and 0.05 gram per denier at 150°C measured at a constant strain rate of 0.5 inch per minute in a 10-inch length of yarn normalized to that of a multifilament yarn of 1000 total denier, which comprises the steps of
- (a) feeding prepolymer to a first finisher vessel operated at 280°C or less for a period sufficient to increase the intrinsic viscosity to at least 0.4,
 - (b) transferring polymer from said first finisher vessel to a second finisher vessel while maintaining said polymer below about 280°C,
 - (c) maintaining said polymer in said second finisher vessel at 280°C or less for a period sufficient to achieve an intrinsic viscosity of at least 0.95,
 - (d) removing said polymer of intrinsic viscosity of at least 0.95 from said second finisher and supplying said polymer to an extrusion spinnerette at a temperature above the polymer melting point, maintaining said polymer at said spinnerette for a residence time no

greater than one and one-half minutes and at a temperature no greater than 325°C prior to spinning, then

(e) spinning the polymer under conditions to produce an undrawn yarn having a birefringence of at least 0.01 and drawing said yarn to produce said high performance polyester multifilament yarn (claim 1).

6.5.1 The process conditions of D2 mainly concern the spinning conditions and the drawing should be effected between rolls at temperatures above the glass transition temperature (i.e. 80°C) to with 85% of the maximum draw ratio (column 7, lines 4 to 6). However, D2 does not mention any process conditions specified in steps 3) and 4) as claimed. Thus, there cannot be any guidance in D2 to modify the teaching of D16 in the direction of the claimed process.

6.6 The process conditions according to D10 (see point 4.7) are quite different from those required by the claimed process and would not suggest the claimed subject-matter even when considering D10 and D16 in combination.

6.7 No other documents were referred to by appellant 01 at the oral proceedings when discussing inventive step. Since the further prior art documents cited during the proceedings are even more unrelated to the claimed subject-matter than those already discussed, they could not suggest the claimed subject-matter either. Thus, the board has no reason to go into more detail in that respect. Hence, when starting from D16 the claimed subject-matter of process claim 1 is not rendered obvious by the cited prior art.

6.8 When starting from D11, run 12 of Example 3 can be considered as the nearest starting point. However, the yarn in run 12, Example 3 of D11 shows a behaviour of the thermal stress at a temperature beyond 210°C opposite to that of the yarns produced according to the claimed process. Furthermore, the drawing step of D11 includes a gas bath maintained at 325°C and the relax treatment uses a roller heated at 130°C and a gas bath maintained at 330°C, which temperature conditions are different from the temperature conditions of claimed steps 2) and 4). Since also the other examples of D11 use high temperature conditions similar to those of run 12, they do not provide any incentive, to modify the conditions in a direction of the claimed process steps 2) to 4), let alone to its combination.

6.8.1 Having regard to D2, D9, D10 and D16 the same considerations as outlined above (Reasons, points 6.1, 6.3, 6.4 and 6.5) apply *mutatis mutandis* when starting from D11 as the closest state of the art. In particular, there is no incentive in those prior art documents to modify the teaching of D11 in the direction of the claimed process in order to solve the problem posed. Thus, the claimed subject-matter of the process claim is not obvious from the cited prior art documents and involves an inventive step.

Product claim 8

6.9 Having regard to product claim 8, D10 does not disclose or suggest how yarns having the claimed long period value and shrinkage may be produced to modify those yarns so that, when incorporated into a tire cord, improved shrinkage and dimensional stability may be

achieved. In particular, the exemplified process conditions in D10 at rollers heated to 240°C lead the skilled person in a direction opposite to the claimed subject-matter and do not provide yarns which show a decrease in the thermal stress behaviour beyond 210°C as illustrated in Table 1 and Figure 3 of the patent in suit.

- 6.9.1 Although D2 discloses a yarn B having a long period value of 11.8 within the claimed range, its crystal orientation function is 0.95 and its shrinkage at 177°C is 5.7% (tables I and II), both features being outside the claimed range. Furthermore, D2 does not disclose any specific heat treatment or relaxation conditions which, according to the patent in suit, are necessary to provide a yarn which, when incorporated into a tire cord, solves the problem posed. Consequently, the skilled person gets no incentive from D2 to modify the yarns according to D10 in a direction of the claimed product.
- 6.9.2 In D9, Example VII, yarns are produced which show a long period value within the claimed range (Table VII, runs 1 and 5 to 8). However, those yarns have been produced from PET having a low IV of 0.63, whilst yarns having an IV of 0.92 exhibit a long period value of 1.83 to 1.92 far outside the claimed range (Table VII, runs 9 to 11). There is no indication in D9, showing how yarns can be produced from high IV PET which exhibit a long period value as claimed, let alone in combination with the other claimed features, in order to solve the problem posed (see Reasons, point 6.4). Thus, D9 does not add anything to the disclosure of D10.

- 6.9.3 Since the product claims make reference to the process claims, the same considerations discussed in respect of D11 and D16 apply *mutatis mutandis* to the claimed yarns as outlined above (Reasons, points 6.1 and 6.2). Consequently, claim 8 is not rendered obvious when starting from D10 as the closest state of the art.
- 6.10 Since the tire cord according to claim 11 is referred back to product claims 8 to 10, since process claim 12 is dependent on process claims 1 to 7, and since the tire claim 13 is referred back to claim 11, the same considerations discussed in respect of the process and product claims 1 to 10 apply *mutatis mutandis* to claims 11 to 13 (Reasons, points 6.1 to 6.9 above).
- 6.11 From the above it follows that the appellants failed to show that claimed subject-matter is made obvious by the cited prior art. Hence, the claims according to the main request involve an inventive step.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to maintain the patent on the basis of claims 1 to 13 submitted during the oral proceedings as the main request and a description yet to be adapted.

The Registrar:

The Chairman:

C. Eickhoff

R. Teschemacher