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**Datasheet for the decision
of 20 November 2009**

Case Number: T 1614/07 - 3.3.03

Application Number: 01305417.6

Publication Number: 1170318

IPC: C08G 61/12

Language of the proceedings: EN

Title of invention:

Melt processible polyether ether ketone polymer

Patentee:

SOLVAY SPECIALITIES INDIA PRIVATE LIMITED

Opponent:

Victrex Manufacturing Limited

Headword:

-

Relevant legal provisions:

EPC Art. 56, 83, 114(2), 123(2)

Relevant legal provisions (EPC 1973):

-

Keyword:

"Late submitted material not admitted by first instance -
correct exercise of discretion - (yes)"

"Amendment - added subject-matter - (no)"

"Disclosure - sufficiency - (yes)"

"Inventive step - (yes)"

Decisions cited:

G 0007/93, T 0014/83, T 0229/85, T 0640/91, T 1002/92,
T 1008/96

Catchword:

-



Case Number: T 1614/07 - 3.3.03

D E C I S I O N
of the Technical Board of Appeal 3.3.03
of 20 November 2009

Appellant:
(Opponent)

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Decision under appeal:

Interlocutory decision of the Opposition
Division of the European Patent Office dated
20 June 2007 and posted 23 July 2007 concerning
maintenance of European patent No. 1170318 in
amended form.

Composition of the Board:

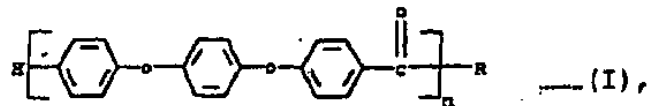
Chairman: R. Young
Members: M. C. Gordon
C. Vallet

Summary of Facts and Submissions

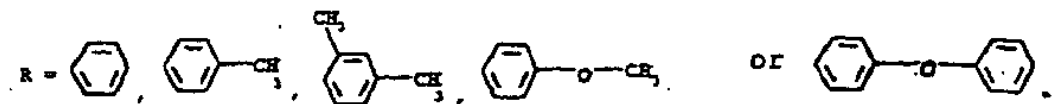
I. Mention of the grant of European Patent No. 1 170 318 in the name of Gharda Chemicals Limited, later Solvay Specialities India Private Limited, in respect of European patent application No. 01305417.6 filed on 22 June 2001, published on 9 January 2002 and claiming a priority date of 6 July 2000 from GB 0016527 was announced on 21 July 2004 (Bulletin 2004/30) on the basis of 21 claims.

Independent claim 1 read as follows:

1. A process for the production of a melt processible polyether ether ketone polymer (PEEK), containing a reduced concentration of any reactive end-groups on its backbone and having predominantly the following repeat units (I) with suitably modified end groups, i.e., -OR



wherein



comprising the steps of electrophilically polymerising phenoxy phenoxy benzoic acid (PPBA) using an alkane sulfonic acid as a solvent in the presence of a condensing agent and an optionally a diluent, in the temperature range of 40° to 160°C, precipitating the PEEK produced in water after it has achieved the desired Inh.V., including the step of end-capping the PEEK polymer, removing the acid residues produced by treatments with water and later with an organic solvent, such as DMAc or DMF, or with a bicarbonate solution, and then filtering and drying the PEEK produced to give melt processible PEEK.

Claims 2-21 were dependent claims.

II. A notice of opposition to the patent was filed on 20 April 2005 by Victrex Manufacturing Limited. The opponent invoked the grounds of opposition pursuant to Art. 100(a) EPC (lack of novelty, lack of inventive step), Art. 100(b) EPC (insufficiency of disclosure) and Art. 100(c) EPC (extension of the subject-matter of the patent beyond the content of the application as filed).

The following documents were cited together with the Notice of Opposition in support of the opposition:

- D1: Ueda, M. and Oda, M., "Synthesis of Aromatic Poly(ether ketone)s in Phosphorus Pentoxide/Methanesulfonic Acid", Polymer Journal Vol 21, No 9, Pages 673-679 (1989);
- D2: Colquhoun, H.M. and Lewis, D.F., "Synthesis of aromatic polyetherketones in trifluoromethanesulphonic acid", Polymer, 1988, Vol 29, October, pp. 1902-1908;
- D3: GB-A-2 116 990
- * no document D4 was cited in the notice of opposition*
- D5: GB-A-1,109,842
- D6: US-A-4,247,682
- D7: US-A-3,953,400
- D8: EP 0 414 009 B1
- D9: US-A-5,212,276
- D10: WO-A-88/08010
- D11: Lakshmana Rao, V., "Polyether Ketones" J.M.S.-REV-MACROMOL. CHEM. PHYS., C35(4), (1995) pages 661, 674 and 675
- D12: EP 1 454 891 A1
- D13: Material Safety Data Sheet "Gatone™ PEEK CF", Issue date 3 January 2000, Rev No. 001 - Revision date 18-09-2004 (Gharda Chemicals Ltd)
- D14: Material Safety Data Sheet "Gatone™ PEEK", Issue date 3 January 2000, Rev No. 001 - Revision date 18-09-2004 (Gharda Chemicals Ltd)
- D15: Material Safety Data Sheet "Gatone™ PEEK GF", Issue date 3 January 2000, Rev No. 001 - Revision date 18-09-2004 (Gharda Chemicals Ltd)
- D16: "New Developments in Gatone™ PEEK" Public Presentation given by Dr. U.M. Vakil at the

"Engineering Thermoplastics World Congress" Zurich,
Switzerland 6-8 June 2000

Together with a letter dated 20 April 2007 the opponent
cited further documents, *inter alia*:

D19: Witness Statement dated 20 April 2007, signed by
Dr. Brian Wilson of the opponent.

- III. By an interlocutory decision dated 20 June 2007 and
issued in writing on 23 July 2007 the opposition
division held that the patent in suit could be
maintained in amended form on the basis of a set of
21 claims whereby claim 1, filed on 2 December 2005 had
been amended, compared to claim 1 of the patent as
granted by amendment of the definition of the modifying
group in line 3 of the claim from "-OR" to "-R".
Claims 2-21 were identical to the correspondingly
numbered claims of the patent as granted.
The decision held that the amendment made to operative
claim 1 was allowable pursuant of R. 88 EPC 1973.
- (a) It was held that D19, filed after the expiry of
the nine month opposition period (see section II,
above), had not been filed in response to a new
issue or argument raised during the opposition
proceedings. Further D19 either taken alone or in
combination with D13-D16 did not provide a
disclosure of the process parameters specified in
operative claim 1. Consequently D19 could not be
considered as being *prima facie* relevant to the
assessment of novelty or inventive step. Pursuant
to Art. 114(2) EPC, D19 was not admitted to the
proceedings.
- (b) With respect to Art. 100(c)/123(2) EPC and the
end-capping step in claim 1 the opposition

division *inter alia* held that the passage of the original specification (page 9, paragraph 3, corresponding to paragraph [0031] of the A-specification) referring to "...and subsequently end capping it using an end capping agent" was not considered to be a limiting statement specifying when the end-capping step had to be performed but merely stated that the end-capping was performed at all. Accordingly this feature did not constitute an "undue broadening" of the subject-matter of the claim.

- (c) With respect to Art. 100(b)/83 EPC it was, *inter alia* held with respect to the specification in operative claim 1 of treatment with an organic solvent such as DMAc or DMF and an objection by the opponent that these would decompose at melt processing temperatures forming decomposition products which would interact with the polymer, that there was no indication in the patent as granted or in the prior art that this would take place.

With respect to an objection relating to the term "predominantly" in claim 1 the opposition division held that the evidence and documents in the proceedings failed to support the assertion of the opponent concerning the impossibility of preparing PEEK copolymers by the claimed process, nor was it considered that the term "predominantly" was unclear, having regard to the information contained in the patent specification.

- (d) Novelty of the subject-matter of claim 1, which had been challenged on the basis of an alleged public prior use supported by documents D13-D16,

was recognised because none of these documents disclosed the specified process parameters.

- (e) With regard to inventive step it was held that D1 represented the closest prior art. This document disclosed the preparation of PEEK using 4-(4'-phenoxy phenoxy) benzoic acid (PPBA) in the presence of phosphorous pentoxide and methane sulphonic acid under conditions similar to those of the patent in suit. Melt processable polymers were obtained for which thermal resistance behaviour was reported (D1, page 679, Table VII). The subject matter of claim 1 differed from the disclosure of D1 due to the feature of end-capping the PEEK polymers.

In view of the evidence of example 3 compared to example 4 and example 13 compared to examples 14-17 of the patent in suit it was concluded that the end-capping resulted in PEEK with improved thermal resistance. Consequently the objective technical problem was the provision of PEEK polymers with improved thermal or melt stability.

D1 did not specifically disclose the inclusion of end-cappers. Of the other documents cited, D5, D8 and D9 related to end-capping of different types of polymers, namely polyarylsulphones, polyesters and polyimides respectively. The structures and properties of these polymers were so different from PEEK that it did not appear obvious to apply the teaching of these documents to PEEK.

D6 related to double end-capping of specific polymers, namely polyarylsulphones and polyarylsulphones which resulted from a different preparation route (benzoyl chloride in the presence of HF). The end-capped polymers were

stated in D6 to have excellent high temperature stability properties and to be melt processable. There was however no indication in D6 that end-capping in general would lead to these advantageous properties for specific PEEKs. Similarly D7 related to the end-capping of PEK (Polyetherketones) obtained by polymerisation of phenoxybenzoic acid (PBA) with HF and contained no indication that end-capping of PEEK could be performed according to the same protocol as employed for PEK.

D10 pertained to the preparation of PEKs usable in moulding processes. It was taught (pages 9-10) that an aromatic end-capper, different from that specified in operative claim 1 might improve the thermal stability of PEKs. However PEEK was not referred to in this respect. Further there was no clear indication in D10 that this teaching could be applied to PEEK.

D2 pertained explicitly to the end-capping of PEK and PEEK. It was indicated that some end-capping agents, e.g. 1,4-diphenoxybenzene might lead to molecular weight control of PEKs, whereas others, e.g. 4,4'-diphenoxybiphenyl, might not. D2 also suggested that monomer design was decisive for viscosity control of polymers obtained from self polymerisation of the monomers. D2 did not provide any information on the beneficial effect of the end-capping of PEEK on the melt properties or thermal stabilities of these polymers.

D11 disclosed in general words and very briefly the end-capping of PEK obtained from the Friedel-Crafts reaction and did not mention the thermal

properties, nor give any hint that end-capping might improve the melt properties of the polymers.

Consequently it was concluded that there was no teaching in the prior art to perform the end-capping of the PEEK polymers of D1 in order to solve the objective technical problem. Further, it was considered that the teaching of D7, i.e. improvement of the thermal stability of PEK by the introduction of end-cappers could not be applied to other polymers such as the PEEK of the patent in suit as the chemistries of PEK and PEEK were shown to be very different in the prior art, reference being made to D1 and D2.

(f) Consequently it was held that the patent could be maintained in amended form.

IV. A notice of appeal against the decision was filed on 24 September 2007 by the opponent, the prescribed fee being paid on the same day.

V. The statement of grounds of appeal was received on 3 December 2007.

(a) With respect to the decision of the opposition division not to admit D19 to the procedure as it had been held to be late filed (see section III.(a), above), the appellant/opponent submitted that this had been filed in response to the submissions of the patent proprietor in the rejoinder to the notice of opposition. Specifically, it had been argued by the patent proprietor that the opponent had not submitted any evidence to support the argument, based on D13-D16, that PEEK made as described in the patent in suit

had been available before the priority date. D19 was provided in order to further substantiate these arguments of the opponent and hence did not represent a completely new ground of opposition or a new piece of prior art.

- (b) With respect to the question of end-capping (an objection raised pursuant to Art. 123(2)/100(c) EPC - see section III.(b), above) it was argued that the amendment from the wording of paragraph [0031] of the application as filed "subsequently end capping" to the wording "including the step of end-capping" in operative claim 1 extended the protection beyond that of the specification as filed. An argument by the patent proprietor (made at the oral proceedings before the opposition division) that the term "subsequently" should be interpreted in the light of the examples was challenged in view of the clear meaning of this term. Even if such interpretation were permitted, the amendment - to refer simply to the step of "including" end-capping went far beyond the interpretation of the word "subsequently" derivable from the examples. In particular it covered process steps which were not contemplated either in the specification nor the examples as originally filed.
- (c) With respect to Art. 83/100(b) EPC and the question of whether DMF/DMAc decomposed at high temperature (see section III.(c), above) it was submitted that filtering the polymer after washing with such a solvent meant inevitably that significant levels of solvent would be present in the polymer. DMF and DMAc were unstable and would decompose at high temperatures, e.g. during melt

processing. These decomposition products would interact with the polymer, making it susceptible to crosslinking and chain scission. Hence it could not be seen how the process of claim 1, which would inevitably result in the polymer being contaminated with organic solvent would result in "a reduced concentration of any reactive end groups", or lead to production of a polymer with improved thermal stability.

The statement at paragraph [0025] of the patent that the polymer produced had to be made "completely free" of solvent, effectively confirmed the position of the appellant/opponent. Further claim 1 was not limited in this respect and covered processes which could be clearly contaminated with solvent. Further the omission of such an essential feature appeared to be contrary to the arguments of the patent proprietor with respect to inventive step which were apparently based on an unobvious use of specified end-cappers to improve thermal stability. The presence of any organic solvent would result in an unstable product.

With respect to the term "predominantly", it was submitted that this term appeared to have two different interpretations - either this applied to the nature of the end groups and repeat units, or this meant a polymer having a "mainly" linear structure, meaning that the "width" of claim 1 was impossible to determine, which had ramifications for the consideration of inventive step.

- (d) The finding of the decision under appeal with respect to novelty (Art. 54 EPC) was not challenged.

(e) With respect to inventive step it was submitted that the examples of the patent in suit did not demonstrate any improvement arising from end-capping since the relative change in properties, measured as the increase in viscosity on exposure to elevated temperature was greater for the polymers with end-capping than for those without. It was further submitted that the effect of a polymer's end groups on thermal stability was well known, and hence it was known to manipulate end groups to produce polymers having improved thermal stability.

Reference in this respect was made to D5, relating to polysulphone polymers, D6, relating to PEK end-capped with diphenylether, D7 relating to PEK with e.g. benzene, biphenyl and diphenyl ether end-capping agents, D8, relating to polyesters wherein the free carboxyl end groups were capped and D9, relating to polyimides (not "polyamides" as stated in the statement of grounds of appeal).

D10, related to the preparation of PEEK, envisaged the use of PPBA as the monomer and disclosed end-capping, *inter alia* with diphenyl ether or biphenyl. This latter agent was less reactive than those end-capping agents specified in operative claim 1.

The problem which the patent in suit addressed was to provide PEEK polymers with improved melt stability. The solution, to end-cap PEEK using specified end groups, was provided by D10, which even instructed the skilled person to improve the thermal stability by the use of end-cappers such as diphenyl ether and biphenyl. In view of the disclosure of D10 the other end-capping agents

specified in claim 1 were obvious, and in any case their use in the polymer did not confer the advantages alluded to in the patent in suit. Hence the subject matter of operative claim 1 was obvious with respect to the teaching of D10. With regard to D7 it was submitted that the only significant difference was that the patent in suit related to the preparation of end-capped PEEK whereas D7 related to PEK. The skilled person seeking to improve PEEK would as a matter of course modify the teaching of D7 by using PPBA instead of *p*-phenoxy benzoic acid so to prepare PEEK rather than PEK. Further the end-cappers of D7 would be selected.

With respect to D2 it was submitted that although this did not disclose the temperature range of the operative claim, it was trivial to carry out a reaction at this temperature instead of at room temperature. Further although the end-cappers of claim 1 were not disclosed in D2, similar end-cappers were disclosed. There was nothing inventive in the selection of the end-cappers of operative claim 1, especially in view of their apparent poor performance.

D11 taught, in the context of PEK, that melt stability could be improved by the use of capping agents and further specifically envisaged capping agents of the type specified in operative claim 1. Hence the skilled person faced with the problem of preparing PEEK with improved thermal stability was instructed by D11 to end-cap the polymer, and in particular which endcapping agents to use (biphenyl or diphenyl ether). Hence the features of operative claim 1 would be arrived at in an

obvious manner by a combination of the disclosure of D11 and general knowledge with respect to polyether ketone.

D1 related to the preparation of melt processable PEEK using PPBA, but did not specifically disclose the inclusion of end-cappers. However the solution to improving the melt stability of polymers prepared as described was provided by any of D2 or D5 to D11. Further the skilled person understood in general the importance of end-capping groups, and hence would be motivated to end-cap the PEEK polymer prepared. The specified end-capping agents were obvious, being specifically disclosed in D5-D7 and D11, and in any case did not result in any surprising technical effect.

D3 related to the production of PEEK using PPBA. Analogously to the arguments with respect to D1, it would be obvious to modify the teaching of D3 and so arrive at the subject matter of the operative claim.

It was obvious that a polymer having reactive end-groups would be unstable. To improve stability it would be necessary to remove or mask these groups. PEEK as prepared from PPBA had carboxyl end-groups, which could undergo further reaction during processing. Hence it was intuitively obvious to remove or mask these groups. Further, end-capping had been extensively used before the priority date to solve precisely this problem and was part of the common general knowledge of the skilled person. In any case end-capping was obvious over D1 in combination with any of the other cited documents. It was submitted that according to the minutes of

the oral proceedings (section 5.3) the opposition division appeared to have acknowledged that there were some suggestions, e.g. in D10 to use capping agents to improve the melt stability and control the molecular weight, but considered that the choice of end-cappers and reaction conditions was not trivial. The question of reaction conditions was however irrelevant since D1 provided all the necessary information, and there had been no suggestion that any other features of the reaction made any contribution to the invention.

It was submitted that comparison of example 3 and comparative example 4 of the patent in suit was not valid since comparative example 4 did not include a step for removal of the solvents (DMAc), the presence of which would account for the poor stability measured.

It was further submitted that the claims were not limited to the details of the examples but covered a much wider range of polymers. In particular claim 1 was not limited to a situation wherein substantially all PEEK chains were end-capped, since claim 1 required only a "reduced concentration" of any reactive end-groups, and hence covered e.g. a 1% reduction which would show negligible advantage. Hence there was no inventive step across the whole scope of claim 1.

It was submitted that the finding of the decision under appeal that there was no teaching in the prior art to perform end-capping of the polymers of D1 to solve the technical problem was unsupportable since many prior art documents provided such a teaching, reference being made to D5-D9. With reference to the findings of the

decision that the teaching of D7 was not applicable since PEK and PEEK were very different (see section III.(e), above), it was submitted that this finding was not supported by the prior art which often discussed PEK and PEEK together. Since the melt stability of PEEK, PEK and all other polymers discussed in the cited prior art was due to reactive end groups, the solution to the problem of poor melt stability for un-end-capped polymer was to end-cap the material, thus removing the end groups and preventing them from reacting. This concept had been acknowledged numerous times in the prior art for a wide range of polymers and its application to PEEK was non-inventive.

VI. The patent proprietor, now the respondent, replied with a letter dated 15 April 2008.

- (a) It was disputed that the witness statement D19 (see sections III.(a) and V.(a), above) had been submitted in response to submissions made by the patent proprietor. Instead this appeared to be an attempt to rectify deficiencies in the original case presented by the opponent. Further it was submitted that D19 was inadequate to form the basis of a *prima facie* case of public prior use, reference being made to the findings of T 472/92 (OJ EPO 1998, 161).
- (b) With regard to the objection pursuant to Art. 123(2) EPC concerning the end-capping step (see sections III.(b) and V.(b), above) it was submitted that the specification gave examples teaching how to prepare the polymer using end-capping agents at different stages in the process

(examples 1, 10 and 12). It was nowhere stated that the particular point in the process at which end-capping was done was critical, and it was clearly within the scope of the process of the claims of the application as filed that the polymer could be end-capped at any time. In paragraphs [0015] and [0031] of the application as filed the word "involves" was employed, indicating that the inventive process was being described in general terms rather than specific steps. If paragraph [0031] were to be interpreted literally, the consequence would be that examples 10, 11 and 14-17 would no longer fall within the scope of the invention. Although the major teaching of the examples lay in the contrast of using an end-capping agent as against not using an end-capping agent, the examples as a whole also showed that an end-capping agent could be added at different stages of the overall process. The opponent had provided no evidence that the point in time of carrying out the end-capping was critical. It was also stated that in general the end-capping reactions were slow relative to the polymerisation process, and hence polymerisation could proceed whilst end-capping took place.

- (c) With regard to the objection raised pursuant to Art 83 EPC concerning the presence of DMAc or DMF (see sections III.(c) and V.(c), above) it was argued that the appellant/opponent had advanced no evidence or information about the manner in which these compounds decomposed and at what temperatures (beyond a passing reference to melt processing) when in the presence of polymers such as PEEK. Further the use of such solvents was not

essential since the use of a bicarbonate solution was an alternative.

Example 1 of the patent in suit described the use of DMAc and reported that the polymer had excellent thermal stability. Thus contrary to the assertions of the opponent there appeared to be no difficulty in practice regarding the use of the specified solvents. In the absence of any evidence from the appellant/opponent, it could be speculated that when heating PEEK polymer up to the extrusion temperature (360-400°C as stated in paragraph [0001] of the patent in suit), the solvent would tend to evaporate away, since these boiled at 165°C (DMAc) and 153°C (DMF).

Regarding the objection with respect to the term "predominantly" (see sections III.(c) and V.(c), above) it was submitted that any ambiguity perceived was artificial. In any case, ambiguity was not a valid ground of opposition.

It was clear from the specification that the polymer should mainly have the described structure, which did not exclude the possibility of some end-groups not being those specifically recited, some units in addition to the recited repeat units and some branching. The patent described the preferred polymers, i.e. those with exclusively the specified end-groups and repeat units. The patent also described how alternative end-groups could arise and it was easily within the skill of the appropriate worker to devise co-polymerisation processes if so required.

- (d) Submissions with respect to Art. 54 EPC (novelty) were not made.

- (e) With respect to Art. 56 EPC (inventive step) (see also sections III.(e) and V.(e), above) it was submitted with reference to paragraph [0014] of the patent in suit that the claimed process as well as producing a "thermally stable and melt processable" PEEK, could readily be used in manufacturing due to its lower temperature of polymerisation, use of recyclable reagents, use of water and overall ease of processing. Accordingly in assessing the validity of the claims the properties of the PEEK produced was not the only criterion for assessment. The appropriate comparison was provided by examples 3 and 4 of the patent in suit (end-capping/no end-capping respectively). The work up/purification of the polymers in these two examples was the same. Further the polymer of (comparative) example 4 was "dried", which would remove any residual solvent. The evidence was that the non-end-capped polymer of example 4 had significantly poorer properties (rougher surface, lower initial melt flow, more susceptible to heat degradation) than the end-capped polymer of example 3. It was further submitted that the absolute values for the melt flow were important, not the percentage change. The appellant/opponent had disregarded the poor absolute values of the comparative examples, concentrating instead on the relative change. It was submitted, with respect to examples 13-17 of the patent in suit that these polymers originated from the same batch and hence were of similar weight. The un-end-capped polymer showed high torque values after only 10 minutes which was a result of rapid cross-linking. There was no additional cross-linking after 10 minutes and consequently a smaller rise in

torque. The end-capped samples of PEEK showed small rises in torque, but none was anywhere near the value reached by the non-end-capped sample. This showed that the end-capped samples of PEEK were thermally stable and melt processable, showing a significant improvement over the non-end-capped polymer.

D5 described the use of diphenyl ether as an end-capping agent for polysulphone polymers. This was unrelated to the claimed process for the production of PEEK.

D6 and D7 related to processes for the production of polyether ketones using Friedel-Crafts polymerisations, which processes were clearly different from the process of the patent in suit.

D8 and D9 related to polyesters and polyamides respectively and thus were both equally irrelevant to the present patent.

With respect to D10, it was acknowledged that one of the many reactions described was the self-polymerisation of PPBA, to form PEEK.

D10 disclosed in the passage bridging pages 9 and 10 that benzoic acid and biphenyl - neither of which was covered by claim 1 of the patent in suit - were suitable as end-capping groups. Further D10 taught that preferably the end-capping agent was one of the aromatic compounds used in the polymerisation. With respect to diphenyl ether, mentioned explicitly by the appellant/opponent in the statement of grounds of appeal (see section V.(e), above) it was submitted that this had been employed in D10 only in processes for the preparation of polyketones by reaction of diphenyl ether with a dicarboxylic acid,

but was not used in the production of PEEK - achievable by self-condensation of PPBA. Consequently the skilled person was not taught by D10 to employ diphenyl ether as an end-capping agent and in particular not in order to obtain PEEK having improved properties.

With regard to D1 the submission by the appellant/opponent that the skilled person would arrive at the process of operative claim 1 by combining the teaching thereof with that of D2 or any of D5 to D11 was disputed. The data given in D1 (page 679) suggested that the PEEK polymers disclosed therein had good thermal stability. There was nothing in the data of D1 which would encourage the skilled person to seek ways of improving the thermal stability of these polymers.

It would not have been considered by the skilled person that any perceived reduced thermal stability of uncapped PEEK could be cured by end-capping. It was known that there were many variables which could affect the decomposition of a polymer (e.g. defect structures, degree of branching) and there was also a broad range of possible solutions, primarily the addition of a thermal stabiliser. There was no motivation to concentrate on end-capping, and consequently no motivation to select the specific end-capping groups of the operative claims.

These considerations applied also to the teachings of D3.

Regarding the submissions of the opponent concerning to the findings of the decision under appeal with respect to the obviousness of end-capping it was firstly submitted that whilst this was an essential

feature, it had to be recalled that a process for the production of a **melt processable** PEEK had been developed (respondent's emphasis). Even if the skilled person had considered the possibility of employing end-capping agents it would not be immediately apparent that the resulting polymers would be melt-processable. Uncapped PEEK prepared using conventional processes was not heat stable under shear and consequently not melt-processable. There was no teaching in any of the cited prior art that melt processability of PEEK would be increased - or even maintained - after end-capping. These arguments hence depended on hindsight.

Even if it were admitted that end-capping of PEEK polymers was obvious to try, the selection of end-capping agents to leave the specific end groups of operative claim 1 was not obvious. Whilst these end-capping agents might be known in other fields, for other types of polymers (D5, D6, D7, D10 and D11) these had not been known in the field of PEEK prior to the patent in suit.

It was disputed that D13-D16 provided evidence of public availability before the priority date of polymer made in accordance with the process of the patent in suit. D13-D15 bore a date of "18-09-2004", and hence had only been made available in September 2004.

Regarding the presentation D16 it was submitted that the existence of a presentation describing the properties of a polymer did not establish that the polymer had been publicly available. In any case there was no evidence in D16 as to the manner in which the polymer had been prepared. It was also

disputed that even if the polymer had been in the public domain, it would have been possible to analyse it and so reveal the manufacturing process employed.

- VII. On 7 September 2009 the Board issued a summons to attend oral proceedings.
- VIII. With a letter dated 20 October 2009 the respondent/patent proprietor filed eight sets of claims forming a first to an eighth auxiliary request. The wording of these requests is however not of importance for this decision. Further the attendance of Mr Henri Massillon as a technical expert was announced. It was requested that he be permitted to address the Board.
- IX. With a letter dated 3 November 2009 the respondent/patent proprietor submitted a revised set of claims for each of the auxiliary requests.
- X. With a letter dated 13 November 2009 the appellant/opponent stated that it would not attend the oral proceedings. A written submission was however included.
- (a) With respect to D19 it was emphasised that this had been filed in response to arguments of the patent proprietor, and simply supplemented previously made arguments. D19 established that the patent proprietor had made relevant material available before the priority date of the patent in suit.
- It was submitted, with respect to the decision T 472/92 that since in this case the opponent was

alleging prior use by the patent proprietor the onus was on the patent proprietor to provide evidence to support its contention that such material had not been made available.

Further the previously advanced arguments with respect to D13-D16 were reiterated.

- (b) With respect to Art. 123(2) EPC it was submitted that the fact that the originally filed claims were silent with respect to end-capping did not mean that the patent proprietor was at liberty to introduce into the claim any generalised statement concerning end-capping. It was submitted that although the application as filed did contain examples in which the end-capping agent was added at different stages there was no generic disclosure to support the amendment of claim 1. With regard to the submission of the respondent/patent proprietor that the appellant/opponent had provided no evidence to support its contention that the point in time at which the end-capping was carried out was critical (see section VI.(b), above) it was submitted that no evidence was necessary - the matter could be assessed simply on the basis of the wording of the A and B specifications. It was not necessary or appropriate for the appellant/opponent to attempt to provide evidence that end-capping at a particular point in the process would never give rise to a polymer of improved properties.
- (c) With respect to Art. 83 EPC and the aspect of decomposition of DMAc or DMF, the previous arguments were maintained. It was considered that the statements by the respondent/patent proprietor in this respect indicated that there was no

problem with such residual solvents remaining in the PEEK since they would simply evaporate away. This was however in contradiction with the disclosure in paragraph [0025] of the patent in suit according to which it was part of the invention that the PEEK produced was to be made completely free of solvents.

With respect to example 10, employing washing with sodium bicarbonate solution followed by "several washes", it was submitted that this example was silent as to the nature of the "washes" and it was far-fetched and not supported by the example to imply that such sodium bicarbonate treatment was sufficient.

With respect to the term "predominantly" in claim 1 the previous submissions were referred to. Regarding the submission of the respondent/patent proprietor that it was clear from the specification that polymer produced in the claimed process should "mainly" have the described structure it was argued that this term had now been introduced to paraphrase "predominantly". It was noted that the respondent/patent proprietor had acknowledged that the polymer might contain some end groups not being those specifically recited, some other repeat units and some branching. Hence the claim could not be said to solve the problem of providing thermally stable PEEK if it covered such variations in structure. It was likely that a very large number of polymers which fell within the scope of claim 1 would show very poor thermal stability and consequently did

not solve the problem set out in the patent in suit.

- (d) No submissions were made with respect to novelty.
- (e) With respect to obviousness, reference was made to the submissions in the statement of grounds of appeal(see section V.(e), above).

It was argued that the scope of the claims went beyond that which had been exemplified and covered an infinite number of products - including those with different end-groups, chain units and branching - which would not show any improvement over the prior art. Thus it was denied that claim 1 included an inventive step over its entire scope.

It was clear from the prior art in the proceedings that the effect of a polymer's end groups on the thermal stability was well known and it was well known to manipulate the end-groups in order to improve thermal stability.

The statement by the respondent/patent proprietor (see section VI.(e), above) that the skilled person would not think that any reduced thermal stability of uncapped PEEK could be remedied by end-capping was completely unsupported - there were numerous disclosures in the prior art relating to end-groups and the effect thereof on thermal stability.

Regarding the submissions of the patent proprietor with respect to the influence of defect structures and branching on thermal stability it was recalled that the operative claims did not exclude polymers which contained such structural features which could reduce the thermal stability thereof.

With regard to D10, it was acknowledged that the

groups disclosed therein as end-cappers, i.e. benzoic acid and biphenyl were not encompassed by operative claim 1. Those specified in the operative claims were however obvious alternatives in view of their similarity. No data comparing these different end-cappers had been provided by the patent proprietor. Since the scope of the claim extended to other copolymers with other end-groups and branched materials the problem with respect to D10 was simply to provide alternative end-cappers; those specified in claim 1 were obvious alternatives.

Similarly with respect to D2 it was argued that the end-cappers therein disclosed were similar to those specified in the operative claims, which were thus merely obvious alternatives.

With respect to D11 it was submitted that PEK and PEEK were extremely similar polymers, and further that since the operative claims covered copolymers, would also encompass copolymers of these. Further D11 showed end-capping of PEK by end-capping agents which fell within the scope of operative claim 1. It was noted that the respondent/patent proprietor had failed to advance any arguments why a skilled person would not apply teachings relating to PEK and its use of end-groups to PEEK. Regarding D1 and the argument of the patent proprietor regarding the question of whether the PEEK produced by the process of D1 was less thermally stable than that produced according to the process of the patent in suit it was submitted that if the stability of the D1 polymers was no different from those according to the patent in suit then the problem addressed could only be to

provide alternative polymers. End-capped polymers were an obvious alternative since many examples of the prior art referred to such polymers. It was incorrect to argue, as the respondent/patent proprietor had, that the skilled person would not have thought that any perceived reduced thermal stability of uncapped PEEK could be cured by end-capping the polymer.

A number of approaches with respect to the problem-solution approach were reiterated: Based on D2 or D10 the problem was to provide alternative end-cappers. Those specified in claim 1 were however obvious alternatives, being very similar in structure and there was no comparative data to suggest any advantage of those specified in operative claim 1.

With respect to D1 it was submitted that the problem addressed was to improve melt stability. The solution, i.e. to end-cap the polymers was provided by any of D2 or D5 to D11.

- XI. Oral proceedings were held on 20 November 2009, attended only by the respondent/patent proprietor (cf letter of the appellant/opponent dated 13 November 2009, section X, above).
- (a) The respondent/patent proprietor maintained the request that D19 not be admitted to the proceedings. Analysis of a sample of polymer would not reveal the process by which it had been made because the purification steps would remove all residues which could provide information about the process. It would not be possible on the basis of a commercial sample even to ascertain in general

terms whether a nucleophilic or electrophilic process had been employed.

After deliberation the Board announced that D19 was not admitted to the proceedings.

- (b) With respect to Art. 123(2) EPC the respondent/patentee disputed the statement of the appellant/opponent that the A-specification had been silent with regard to end-capping and was broad enough to cover end-capping at any point in the process. Claim 4 thereof was directed to a process for production of the PEEK according to claims 1-3 which related to a PEEK having a reduced concentration of end-groups, i.e. having end-caps. Claims 13-15 of the A-specification recited end-capping agents. Paragraphs [0051] and [0053] (i.e. example 12) showed that end-capping agent could be added either at the start of the reaction or after the reaction has terminated. The inclusion of the end-capping step in operative claim 1 was merely the consequence of amending original process claim 4 to be an independent claim. The end-capping was an additional step within the overall process and was not restricted to any particular point.

The technical expert confirmed that the end-capping had to be of the end-groups of the polymer, not of the starting monomer, i.e. that this had to be understood as occurring subsequent to the polymerisation taking place.

- (c) With respect to Art. 83 EPC and the objection relating to the purification step (removal of DMF/DMAc), it was submitted that there were different degrees of melt processability. Claim 1 set out the essential steps to achieve a melt

processable polymer. There was no restriction on the extent of melt processability defined in the claim, and hence no "benchmark" for measuring the extent of drying or washing, i.e. removal of the solvent.

With respect to the objection relating to the term "predominantly" the respondent/patent proprietor emphasised that the claim was directed to the process, not to the polymer. The only property which was of importance was whether the polymer was melt processable - if it was then it would be covered by the claim. Had more been understood about the reaction then it might have been possible to give a more complete definition of the structure of the polymer - this was however not the case.

It was disputed that the claim covered an infinite range of polymer structures - it was restricted to PEEK. It was submitted that the concentration of reactive end groups was reduced by end-capping, the reduction being with respect to the non-end-capped variant. The examples showed that when the end-capping was omitted, the required polymer was not obtained.

- (d) With respect to inventive step, reference was made to D1, mentioned in the specification of the patent in suit, and to example 3/comparative example 4 and comparative example 13/examples 14-17 of the patent in suit as demonstrating the effect of the end-capping. Regarding the submissions of the appellant/opponent that PEK and PEEK were very similar (see section X.(e), above) the respondent/patent proprietor referred to D1, page 677 which showed that when attempting to

prepare PEK using the method employed for PEEK, only a low molecular weight product was obtained. According to D3, col. 1, line 42 it was not possible to apply the techniques employed for the preparation of polyether sulphones to prepare aromatic polyetherketones. It was emphasised that simply because polymers had a similar structure did not mean that the technology regarding preparation and end-capping could readily be transferred from one to the other. Further the physical and mechanical properties were different meaning that these two classes of polymers had different end use profiles.

From D10 it was known that the selection of the end-capping agent was dependent on the polymer under consideration. In the process of D10 end-capping was effected by employing excess monomer, i.e. not a true end-capping agent. In contrast in D6 the end-capping agent employed was an agent designed to alter the end groups and make them less reactive.

It was also submitted that the appellant/opponent had ignored the remaining essential features of the claim, i.e. the cleaning up aspects. It was only by means of these cleaning up steps that it was possible to obtain a melt processable product. Thus the end-capping was not the only aspect of the claims which was of importance for achieving melt processable polymers. Reference was made to D10 which did concern end-capping but failed to appreciate the importance of the purification steps claimed.

It was also stressed that the possibility of recycling reagents - provided by the claimed

process - was another important aspect which had been disregarded by the appellant/opponent in its submissions.

With respect to D1 and the thermal stability results reported therein the respondent/patent proprietor submitted that these related to ultimate breakdown temperature. In contrast the measurements in the patent in suit, in particular the Haake test related to the gradual degradation/breakdown of structure - i.e. how quickly the polymer broke down to the extent that it could no longer be processed/used. This test was more representative for the use properties of the polymer than the ultimate breakdown temperature.

XII. The appellant/opponent requested that the decision under appeal be set aside and that the European patent no. 1 170 318 be revoked.

The respondent/patent proprietor requested that the appeal be dismissed.

In the alternative, that the patent be maintained in amended form on the basis of one of the sets of claims according to the first to the eighth auxiliary request submitted with the letter of 3 November 2009 in that order.

Reasons for the Decision

1. The appeal is admissible.

2. *Status of D19*

2.1 D19, entitled "Witness Statement", was submitted by the opponent with a letter of 20 April 2007, i.e. after expiry of the nine month opposition period. Accordingly this document was not filed in due time (Art. 99(1) EPC).

2.2 The opposition division exercised its discretion pursuant to Art. 114(2) EPC not to admit this document to the procedure (see section III.(a), above). The question to be considered by the Board is whether the Opposition division exercised its discretion correctly, i.e. in a reasonable way and according to the right principles (cf G 7/93 (OJ EPO 1994, 775), reasons 2.6 and T 640/91 29 September 1993, not published in the OJ EPO, reasons 6.3, last sentence). However it is not the function of the Board to review all the facts and circumstances of the case as if it were in the place of the opposition division (see above cited G 7/93, T 640/91 and also T 1008/96 of 25 June 2003, not published in the OJ EPO Reasons 2.3 and 2.4).

2.3 As follows from the extensive body of case law developed in this respect (e.g. decision T 1002/92, OJ EPO 1995, 605), an essential condition to be met is whether the late submission was (*prima facie*) highly relevant or not. The opposition division considered this in sections II.1.2.ii and II.1.2.iii of the decision under appeal and came to the conclusion, after a detailed analysis of witness statement D19 that this condition was not met. Since the failure to meet an essential condition is sufficient to preclude admission of the late filed

document D19 into the proceedings, the Board cannot see any incorrect application of the discretion.

2.4 Accordingly the opposition division exercised its discretion not to admit D19 to the procedure according to the correct principles and in view of their detailed analysis in a reasonable manner. As a consequence D19 is not admitted to the proceedings.

3. *Art 123(2) EPC*

The objection pursuant to Art. 123(2) EPC as maintained during the appeal procedure related to the specification of the end-capping step (see sections III.(b), V.(b), VI.(b), X.(b) and XI.(b), above).

3.1 Claim 1 of the application as filed was directed to a polymer having "suitably modified end-groups" and specified as end-groups those specified in operative claim 1.

The first process claim in the application as filed was claim 4 which was directed to a process for the production of the PEEK of claims 1-3, i.e. a polymer having end-groups in place. Claim 4 however did not specify any step which would result in end-capping. Originally filed (process) claims 13-15 specified various compounds as an end-capping agent, which would result in the end-groups specified in claim 1 of the application.

3.2 Operative claim 1 specifies as part of the claimed process "including the step of end-capping the PEEK polymer".

- 3.3 The appellant/opponent has objected that this constitutes an extension of subject-matter compared to the disclosure of in particular paragraphs [0015] and [0031] of the application as filed which each specify the step of reacting PPBA and "subsequently" end-capping it with/using a suitable end-capping agent". As the term "subsequently" is not present in operative claim 1 the appellant/opponent submits that the end-capping can, according to the operative claim, be carried out at any time, which is perceived to constitute an extension of subject matter beyond the content of the application as filed (see sections V.(b) and X.(b), above).
- 3.4 Since operative claim 1 includes the step of "end-capping the PEEK **polymer**" (emphasis of the Board) it is a feature of the claim that the step of end-capping takes place only under the condition that there is polymer present, i.e. subsequent to polymerisation having occurred. Accordingly the subject-matter of the claim does not extend beyond that which is disclosed in the indicated passages of the description of the application as filed.
- 3.5 This conclusion and interpretation is not challenged by the disclosure of example 12 of the application and the patent. According to this example a portion of the end-capping agent was added at the onset of the polymerisation stage. A second portion of end-capping agent was added after the polymerisation stage "to complete the end-capping". As however explained by the respondent/patent proprietor (see section VI.(b) above), the end-capping reaction is slow compared to the polymerisation reaction and consequently polymerisation

could occur while end-capping took place. Thus in this example as well, the presence of an initial portion of end-capping agent notwithstanding it was the polymer which was end-capped, i.e. the end-capping took place subsequent to polymerisation.

3.6 Accordingly claim 1 and paragraphs [0015] and [0031] of the description both specify that end-capping is applied to the polymer, i.e. happens subsequent to polymerisation and therefore these are of the same scope with respect to this feature.

3.7 Accordingly the operative claims satisfy the requirements of Art. 123(2) EPC.

4. *Art. 83 EPC*

Two objections were maintained under this ground during the appeal proceedings (see sections V.(c) and X.(c), above):

- The aspect of removal of solvents DMAc and DMF
- The meaning of the term "predominantly".

4.1 *Removal of solvents DMAc and DMF*

4.1.1 Operative claim 1 encompasses, as one of two alternative work up processes, treatment with an organic solvent such as DMAc or DMF. Such treatment is, according to the claim, followed by filtering and drying the polymer produced. This treatment is discussed in paragraph [0024] of the patent in suit. In the following paragraph it is stated that the polymer has to be made completely free of the solvent. In example 1 it is disclosed that the polymer after

precipitation and repeated extraction with water to neutral pH was treated with DMAc and then with water followed by drying.

- 4.1.2 The objection of the appellant/opponent is essentially that the claims do not specify how the DMF/DMAc is to be removed. This is however the wrong criterion for deciding upon sufficiency of disclosure. As held in part 3 of the reasons of T 14/83 (OJ EPO 1984, 105), the question of sufficiency of disclosure is not to be decided solely on the basis of the claims.
- 4.1.3 As explained in section 4.1.1 above, the description and examples of the patent in suit include further information with respect to this aspect of the claimed subject-matter. The appellant/opponent has not argued, let alone shown that this information is in some manner deficient such that following these teachings would not allow the skilled person to arrive at the results promised by the patent in suit, i.e. a melt stable polymer.
- 4.1.4 Accordingly the appellant/opponent has failed to show that the aspect of treatment of the polymer with DMAc or DMF is not sufficiently disclosed.
- 4.2 *The term "predominantly"*
- 4.2.1 Claim 1 specifies that the process claimed is for the production of a polymer defined as having "predominantly" specified repeat units with suitably modified end-groups.

4.2.2 The phrase including the term "predominantly" was already present in the claims of the patent as granted and has not been modified by any amendment undertaken by the patent proprietor during the opposition procedure.

4.2.3 The objection of the appellant/opponent related to how this term was to be understood, i.e. to the clarity of this term, and hence to the clarity of the claim containing it.

4.2.4 Clarity is however a matter which is governed by Art. 84 EPC, not Art. 83 EPC. Art. 84 EPC, unlike Art. 83 EPC is however not one of the grounds for opposition specified in Art. 100 EPC.

4.2.5 Since, as explained above, this term was in the claims of the patent as granted an objection with respect to the clarity of this term is not available to the appellant/opponent.

4.3 It is therefore concluded that the requirements of Art. 83 EPC are satisfied.

5. *Art. 54 EPC*

Novelty objections were not raised at the appeal stage. The Board is also satisfied that none of the documents cited disclose a process as specified in operative claim 1.

Accordingly novelty is acknowledged.

6. *The patent in suit - the technical problem*

6.1 As explained in paragraph [0001] of the patent in suit PEEK polymers have melting points in excess of 330°C, continuous use temperatures of 260°C or more and high mechanical strengths. They have significant utility e.g. as composites with glass/carbon/Kevlar fibres, especially for applications in aerospace and general engineering industries. They are processed using extruders and injection moulding machines at temperatures of 360-400°C, and so require extremely high thermal stability.

It is explained that there exist two major processes for the production of these polymers - nucleophilic and electrophilic.

The commercially used process, based on a nucleophilic reaction, has a number of drawbacks in that it employs expensive raw materials (fluorine and potassium products), the by-products from which have to be separated from the polymer. The process also requires very high temperatures (300°C or above), which leads to some charring of polymer requiring special melt filtration of the polymer. The solvent used - diphenyl sulphone - has a high melting point (129°C) making it inconvenient to process except at high temperatures. This solvent is also immiscible with water, necessitating the use of non-aqueous systems for precipitation of the polymer, making its removal from the reaction mass cumbersome (paragraphs [0002]-[0004]).

6.2 Hence it is desired to provide a PEEK manufacturing process which can be carried out at lower temperatures, where PEEK can be precipitated in water instead of non-aqueous non-solvents and where by-product recycling is feasible (paragraph [0005]).

A number of electrophilic processes are known, which

are discussed in paragraphs [0006]-[0011] of the patent in suit. In paragraph [0008] reference is made to a number of journal articles which report the use of methane sulphonic acid and phosphorous pentoxide at low temperatures (60°C). The polymers so produced however have high temperature instability and hence cannot be moulded or extruded without extensive cross-linking and degradation.

The patent in suit notes that there is no disclosure in the art of polymerisation of phenoxy phenoxy benzoic acid (PPBA) to yield a melt stable and thermally processable PEEK (paragraph [0012]).

The patent in suit states that it has now been found that not only the nature of the repeat unit but also the nature of the end-groups is critical for attaining the desired thermal stability (paragraph [0013]).

6.3 Accordingly the patent in suit aims to provide a low temperature process for the production of a melt stable and thermally processable PEEK, which problem is stated to be solved by the process of operative claim 1 (paragraph [0014]).

6.4 Certain of the examples relate specifically to the influence of the end-capping step. Thus example 3 and comparative example 4 are identical except that in the case of comparative example 4 the end-capping agent (diphenyl ether) was omitted. The properties of the resulting polymers were measured by determining the melt flow values at 400°C under a force of 2.16 kg. Two hold times were employed - 6 minutes and 60 minutes. In the case of example 3 (end-capped with diphenyl ether) the melt flow rates at 400°C under a force of

2.16 Kg reported were 29cc/10 minutes after 6 minutes hold time and 23 cc/10 minutes after 60 minutes hold time.

The corresponding values for the non-end-capped comparative polymer of comparative example 4 were 17 cc/10 minutes at 6 minutes hold time. After 60 minutes hold time the polymer had degraded into powder which did not flow.

Examples 13 (comparative) and 14-17 (according to the claims) show the effect of employing, with the same starting polymer, either no end-capping agent or different end-capping agents within the scope of claim 1, namely benzene, toluene, xylene and anisole. Specifically in these examples, based on a modification of the process of example 10, a non-end-capped polymer was prepared in a first step. 200g portions of this polymer were then redissolved in a mixture of methane sulphonic acid and phosphorous pentoxide and the end-capping agent added.

The heat stability properties of the resulting polymers was determined by measuring the torque in a Haake Rheocord. In this test 45g of the polymer was melted in a mixer bowl equipped with roller rotors. The melt stability was determined by the change in torque of the polymer under shear at 45 rpm and 380°C. The torque at 10 and 60 minutes are reported.

In the case of the non-end-capped sample of comparative example 13 the values reported were 7.5 N-m and 8.9 N-m at 10 minutes and 60 minutes respectively.

The examples employing end-capping agents had torques at 10 minutes of 2.6, 1.7, 2.5 and 2.2 N-m, rising to, respectively, 4.2, 2.3, 4.9 and 4.9 N-m at 60 minutes.

Although, as argued by the appellant/opponent (see section V.(e), above) the **relative** increases in torque (i.e. decreases in melt flowability) in the cases of the examples having end-capping were higher than in the case of the non-end-capped polymers, the **absolute** values are in all cases and at all times lower. In particular in the case of examples 13-17 it is observed that even after 60 minutes all of the end-capped samples exhibited a lower torque value than did the non-end-capped sample after only 10 minutes.

6.5 The conclusion is that the examples of the patent in suit show that the specified technical problem has been solved by the claimed measures.

6.6 *The closest prior art*

As explained in section III.(e), above the opposition division considered D1, relating to the preparation of PEEK by condensation of PPBA to represent the closest prior art.

Whilst the appellant/opponent in its statement of grounds of appeal refrained from committing itself unequivocally to another document as closest state of the art, it nevertheless referred to a number of individual documents as disclosures in the light of which the obviousness question might be negatively answered, specifically D2, D3, D7, D10 and D11 (see section V.(e), above). *Inter alia* the appellant/opponent took the position that teachings with respect to PEK could be applied equally to PEEK (see section V.(e), above), with the consequence that documents relating to polymers other than PEEK were considered as highly relevant prior art.

The Board will consider the various documents referred to as possible relevant starting points for the assessment of inventive step.

- 6.6.1 D1 - considered to be the closest prior art in the decision under appeal - relates to the production of PEEK by the self polymerisation of PPBA (designated monomer "2a", in D1- section "Polymer Synthesis") in phosphorous pentoxide/methane sulphonic acid. End-capping is not carried out. D1 reports the decomposition temperature of the polymer (Table VII). D1 in the first paragraph teaches *inter alia* that PEEK exhibits good thermoxidative stability and mechanical properties.
- 6.6.2 D2 relates to the synthesis of aromatic polyether ketones (PEK) in trifluoromethane sulphonic acid. Among the monomers employed is PPBA - designated "Monomer F". D2 discloses on page 1905, left-hand column the use of end-capping agents - either 1,4-diphenoxybenzene or 4,4'-diphenoxybiphenyl for the purpose of molecular weight control. Neither of these end-capping agents is within the scope of operative claim 1. Further the disclosed purpose of end-capping in D2 is different from that in the patent in suit, namely to provide molecular weight control (D2 page 1905, lh column).
In view of these differences, i.e.
- different polymer
 - different end-capping agents
 - different purpose of the end-capping
- with respect to the teachings of the patent in suit it is concluded that D2 is not a more appropriate starting point for the assessment of inventive step than D1.

6.6.3 D3 relates, according to the title to the production of PEK. Among the characteristics of the polymers mentioned in the second paragraph of this document are excellent mechanical properties at high temperatures and resistance to fire.

End-capping is not discussed. In example 1 PPBA is reacted in trifluoromethane sulphonic acid. The polymer can be formed at 400°C into films.

Hence as D3 relates to a different polymer and does not disclose end-capping it is concluded that D3 is not more relevant as a starting point than D1.

6.6.4 D7 is directed to PEK and methods for preparing this employing Friedel-Crafts chemistry. It is taught that PEK exhibit good resistance to thermal degradation (col. 1, line 37). Inherent viscosity, and hence melt processability are controlled according to D7 by the use of selected end-capping agents, which serve to terminate the polymerisation via Friedel-Crafts catalysed acylation reaction of with the active polymer chain (col. 3, lines 35-40). The capping agent is selected from non-aliphatic hydrocarbons whose rate of acetylation relative to benzene is greater than ca 150. Preferred capping agents are biphenyl and diphenyl ether, the latter being one of those specified in operative claim 1 (col. 4, lines 1-55, claims 7 and 8). Accordingly D7 relates to a different polymer prepared by a different chemistry from that specified in operative claim 1. Further, although end-capping is taught and one of the end-capping agents preferred is one of those specified in operative claim 1 (diphenyl ether) the purpose of the end-capping is a different one from that according to the patent in suit. Further

the chemical mechanism by which the end-capping agent is introduced into the polymer is a different one from that underlying the process of the patent in suit. Accordingly it is concluded that D7 is not more relevant as a starting point for the analysis of inventive step than D1.

6.6.5 D10 relates to a process for preparing polyketones in general by reaction of the monomers with perfluoroalkane sulphonic acid and a phosphorous oxide. Although PPBA is discussed as a monomer (page 5), there is no example employing this. On the contrary, the focus of D10, as shown by the examples, is on employing two different monomers each providing a different functional group. End-capping of the polymers is discussed in the final section of page 9. Benzoic acid and biphenyl are mentioned explicitly, neither of which is in the scope of the operative claims. According to page 9, line 35 to page 10, line 1, preferably the end-capping agent is one of the monomers employed for the polymerisation. This teaching would clearly be incompatible with the use of PPBA as the monomer since this compound has two different functional groups, i.e. reaction of this would lead to propagation of the polymerisation and not end-capping. Further, the purpose of end-capping according to D10 is to control the molecular weight and also to control the branching in the polymer (page 10, first section). Although it is taught in D10 (page 9, lines 31-34) that the end-capping "may" lead to improvements in thermal stability, it is not explained under which conditions this improvement "may" occur. Further this teaching is in respect of polyketones in general, but not specifically with reference to PEEK.

Further to the extent that D10 refers to a compound falling within the scope of the end-capping agents specified in operative claim 1 (diphenyl ether) this is taught as a monomer in a different polymerisation route (i.e. not involving PPBA) but not as an end-capping agent (see examples 5 and 6 of D10).

It is therefore concluded that D10 does not relate to the problem addressed by the patent in suit and hence is also not more relevant than D1.

6.6.6 D11 relates to the production of PEK. It is taught that PEK having improved colour and melt stability and capable of elongation to 50% or more can be obtained by polycondensation of *p*-phenoxy benzoyl chloride.

Molecular weight and IV are controlled by inclusion of an end-capping agent, biphenyl and diphenyl ether being explicitly mentioned, the latter being one of those enumerated in operative claim 1 of the patent in suit. It is taught that further improvements in colour and "stability" and reduced scorching can be achieved by "double end-capping" in which a nucleophilic and an electrophilic agent are included (D11 page 674, 2nd paragraph). However it is not specified in which manner the "stability" is improved, i.e. D11 does not teach that melt stability can be improved by "double end-capping"

Accordingly D11 relates to a different polymer from that specified in claim 1 of the patent in suit, which is prepared by a different chemistry. Although D11 mentions end-capping, *inter alia* with one of the groups specified in operative claim 1 it does not teach that this step contributes to improvements in the melt stability of the resulting polymer.

Consequently it is concluded that this document is not more relevant as a starting point than D1.

6.6.7 The conclusion is that D1 is the only document to disclose a process for preparing PEEK by self polymerisation of PPBA employing an alkane sulphonic acid, i.e. as specified in operative claim 1. Further, D1 is the only document which refers explicitly to the thermoxidative stability of the resulting polymer. Accordingly it is concluded that that none of the documents relied upon by the appellant is more relevant than D1 and that D1 thus represents the closest state of the art.

6.7 *The objective technical problem with respect to D1*
As shown by the examples of the patent in suit the effect of the end-capping is to improve the thermal stability of the polymer, i.e. to minimise the increase in viscosity when the polymer is held under elevated temperature, possibly under shearing conditions. This corresponds to the technical problem set out in the patent in suit, which accordingly can be adopted as the objective technical problem.

With regard to the submissions of the appellant/opponent with respect to D2 and D10 as giving rise to a relevant technical problem, the technical problem proposed in relation to these documents, was to provide alternative end-cappers (see section X.(e), above).

However, and quite apart from the fact that neither of these documents can properly be regarded as the closest prior art (see sections 6.6.2 and 6.6.5, above) it is not, as is well established, permitted according to the

problem and solution approach to formulate the technical problem in terms which contain pointers to the solution (T 229/85, OJ EPO 1987, 237). Accordingly the technical problem formulated with respect to D2 and D10 is not a valid one, and cannot lead to a finding of obviousness in relation to those disclosures.

6.8 *Obviousness*

Whilst a number of documents (D5-D11) were advanced by the appellant as demonstrating the obviousness of end-capping (see section V.(e) and X.(e), above) these all relate to different classes of polymers from PEEK and hence can provide no teaching with respect to solving the technical problem addressed by the patent in suit.

- 6.8.1 D5 relates to polysulphones, not to PEEKs. At page 3, starting at line 19, it is taught that residual sulphonyl halide groups in the polymer chains may result in increasing viscosity when molten. Hence it is desirable to end-cap the polymer to increase stability in the molten state. As end-capping agents diphenyl ether or aniline are proposed. The first of these compounds is one of those specified in operative claim 1.

With respect to this document firstly it is observed that the reactive end-groups (sulphonyl halide) reported to be responsible for the undesired increase in viscosity do not arise in the reaction specified in the operative claims. Secondly the citing of this document presupposes that the behaviour of polysulphones and PEEKs is similar or even identical. The appellant has provided no evidence in support of

the validity of this assumption. In any case, other cited documents provide evidence this assumption is not valid. Thus in D3 at page 1, lines 44ff it is reported that an attempt to apply chemistry employed for the production of polyether sulphones to the production of analogous aromatic polyether ketones by polycondensation of the corresponding carboxylic acid analogue (instead of acyl halides) in general was unsuccessful due to the slow reaction of the carboxylic acid.

Accordingly D3 teaches that measures adopted for one class of aromatic polymers are not necessarily applicable to other classes of aromatic polymers and hence fails to teach to employ end-capping of PEEKs for any reason, let alone specifically to improve the melt stability.

The consequence is that it cannot be concluded that the measures disclosed in D5 to improve the melt stability of polysulphones (end-capping) would necessarily and inevitably be applicable to different classes of polymers, in particular PEEK.

Accordingly D5 does not render it obvious to modify the process of D1 by introducing specific end-capping agents in order to solve the problem underlying the patent in suit.

6.8.2 D6 relates to aromatic ketone and sulphone polymers. Examples 2 and 4 of this document report the polymerisation of p-phenoxy benzoyl chloride with hydrogen fluoride. End-capping agents are present in the polymerisation mixture.

According to example 2 end-capping the polymers by including 0.50 mole % of biphenyl during the reaction results in a gelatinous, insoluble polymer which could

not be filtered. If instead a combination of 0.50 mole % of biphenyl and 0.457 mole % of benzoic acid were employed as the end-capping agents - neither of which is in the scope of operative claim 1 - than polymer which could be filtered was applied. Similarly example 4 of D6 shows that when end-capping was accomplished by means of 0.50 mole % of each of diphenyl ether and 1,4-diphenoxy benzophenone - the first of these being in the scope of operative claim 1 - a processable polymer was also obtained.

The evidence of this document is thus that when both end-capping agents are present the variation in viscosity as a function of reaction time is reduced. However, firstly this document relates to a different polymer, prepared by different chemistry from that of the operative claims. Secondly the reported reduction in variability in viscosity applies to the step of preparing the polymer, but, in contrast to the results reported in the patent in suit, is not disclosed with respect to the behaviour of the final polymer under elevated temperature conditions, i.e. such conditions as would occur when the polymer was employed in melt processing.

Accordingly D6 does not provide any teaching with respect to the obviousness of end-capping PEEK polymers in order to address the technical problem underlying the patent in suit.

- 6.8.3 D7 relates, as explained in section 6.6.4, above, to a different polymer, prepared by different chemistry. The end-capping agents are similarly introduced via a different chemistry and have the purpose of terminating the polymerisation reaction, i.e. a different purpose to that in the patent in suit. Accordingly there is no

discussion in D7 of employing the end-caps in order to improve the melt stability of the polymers disclosed therein (PEK).

Thus D7 does not provide any information useful in solving the technical problem with respect to D1.

6.8.4 D8 relates to polyesters, which are end-capped with dialkyl oxalate. The aim of this end-capping is to reduce the acidity of the polyesters (D8, title, col. 1, lines 15-19 and 24-27). It is stated that the presence of pendant carboxylic groups is "detrimental" (col. 1, line 19). However it is not explained in which respect this is so.

Accordingly D8 does not relate to the polymers prepared by the process of the patent in suit, but relates to unrelated polymers prepared by a different chemistry. The purpose of end-capping the polymers in D8 is not explained beyond being to reduce the amount of unwanted terminal groups. In particular no connection is made between the removal of acidity and increasing melt stability and thermal processability.

Accordingly D8 also can provide no pointers to the solution of the technical problem with respect to D1.

6.8.5 D9 relates to polyimides. Reactive end-groups are end-capped to provide improved thermal stability (col. 2, lines 4-10). D9 discusses improvement of moulding properties, in particular in the context of improving the melt flow by reducing molecular weight and narrowing the molecular weight distribution (col. 1, lines 44-46). Two measures are taught in D9 to achieve this: reduction of molecular weight by offsetting monomer stoichiometry (col. 1, lines 43ff) and the afore-mentioned end-capping to render the reduced

molecular weight polyimide more thermally stable (col. 2, lines 7-10).

The resulting polymers are reported to exhibit improved moulding properties, permitting lower processing pressures and temperatures to be employed and also to exhibit improved melt stability (col. 2, lines 39-45). Accordingly D9 also relates to different polymers, prepared by a different chemistry than that specified in the operative claims of the patent in suit. Although it is taught that these polymers exhibit improved melt stability, this effect is stated to arise as the consequence of a combination of measures, one of which is end-capping. There is no statement, express or implied that end-capping alone would, in the case of the specific polyimides of D9, give rise to an improvement in melt stability, let alone any hint that such a measure might be applicable to other unrelated polymers.

6.8.6 D10, discussed in section 6.6.5 above relates *inter alia* to PEEK. Although end-capping is discussed (page 9 line 27ff) and is stated to - potentially - improve the thermal stability of the polymer, this teaching is not presented with respect to PEEK and in any case, as explained above, different end-capping agents are employed.

Thus D10 does not contain any teaching which when combined with that of D1 would lead to a solution to the objective technical problem.

6.8.7 D11 relates, as explained in section 6.6.6, above to a different polymer, prepared by a different chemistry from that specified in operative claim 1 and

- consequently does not provide any pointers to the claimed solution to the technical problem.
- 6.8.8 The conclusion is that insofar as D5, D6, D7, D8, D9, D10 and D11 relate to end-capping this is either in the context of polymers different from those prepared according to the patent in suit, and employing a different chemistry (all mentioned documents except D10) or, insofar as they relate *inter alia* to the polymer having the units specified in operative claim 1 (i.e. D10) fail to disclose the end-capping agents as required and fail to teach that end-capping serves to improve specifically the melt stability of the polymers.
- 6.8.9 Further it follows from the foregoing that there is no document which supports the position of the appellant/opponent that teachings relating to PEK applied equally to PEEK (cf. sections V.(e) and 7.6, above). On the contrary to the extent that the cited documents even address the aspect of transferability of teachings between different classes of polymers the teachings are that processes applicable for one class of polymer cannot automatically be applied to other classes of polymer (see in particular D3 as discussed in section 6.8.1 above in connection with D5).
- 6.8.10 In view of the foregoing it is concluded that none of the cited prior art documents provides a hint to solve the problem underlying the patent in suit, namely to improve the melt stability of polymers produced by the method e.g. of D1 by end-capping these with groups as specified in operative claim 1.

6.8.11 Accordingly it is concluded that the subject matter of operative claim 1 is not obvious.

6.8.12 Since the remaining claims are dependent on claim 1 this conclusion applies *mutatis mutandis* to the subject matter thereof.

6.9 It is therefore concluded that the subject matter of the operative claims meets the requirements of Art. 56 EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

P. Cremona

R. Young