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Datasheet for the decision of 26 September 2008

Case Number: T 0540/06 - 3.2.05

Application Number: 96917738.5

Publication Number: 0833742

IPC: B29C 70/50

Language of the proceedings: EN

Title of invention:
Ballistic-resistant moulded article and a process for the manufacture of the moulded article

Patentee:
DSM IP Assets B.V.

Opponents:
Teijin Twaron GmbH
Honeywell International Inc.

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56

Relevant legal provisions (EPC 1973):
-

Keyword:
"Novelty - yes"
"Inventive step - yes"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0540/06 - 3.2.05

D E C I S I O N
of the Technical Board of Appeal 3.2.05
of 26 September 2008

Appellant: (Opponent)
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Decision under appeal:
Interlocutory decision of the Opposition Division of the European Patent Office posted 31 January 2006 concerning maintenance of European patent No. 0833742 in amended form.

Composition of the Board:

Chairman: W. Zellhuber
Members: H. Schram
M. J. Vogel

Summary of Facts and Submissions

I. The appellant (opponent) lodged an appeal against the decision of the Opposition Division posted 31 January 2006 maintaining the European patent No. 0 833 742 in amended form on the basis of the main request of the respondent (patent proprietor) filed on 7 December 2005.

The Opposition Division held that the grounds of opposition under Article 100(a) EPC (lack of novelty, Article 54 EPC, and lack of inventive step, Article 56 EPC) did not prejudice the maintenance of the patent in amended form.

II. Oral proceedings were held before the Board of Appeal on 26 September 2008.

III. The appellant requested that the decision under appeal be set aside and that the patent in suit be revoked.

The respondent requested, as main request, that the appeal be dismissed, or, as an auxiliary measure, that the decision under appeal be set aside and that the patent in suit be maintained on the basis of the sets of claims submitted as first and second auxiliary requests on 25 August 2008.

IV. The following documents were *inter alia* referred to in the appeal proceedings:

D1 US-A 4,623,574

D2 US-A 3,743,561

D5 US-A 4,916,000

D17 US-A 4,457,985

V. Claims 1 and 7 of the main request of the respondent (ie the claims on the basis of which the Opposition Division intended to maintain the patent) read as follows:

"1. Ballistic-resistant moulded article containing a compressed stack of monolayers, with each monolayer containing unidirectionally oriented reinforcing fibres being high-drawn fibres of high-molecular-weight linear polyethylene and at most 20 wt.% of a plastic matrix material and with the fibre direction in each monolayer being rotated with respect to the fibre direction in an adjacent monolayer, the monolayers have a fiber weight between 25 and 150 gr/m^2, characterized in that the density (ρ_p) of the compressed stack is at least 98.0% of the theoretical maximum density."

"7. Process for manufacturing a ballistic-resistant moulded article in which a stack is made of crosswise-arranged monolayers, with each monolayer containing unidirectionally oriented reinforcing fibres being high-drawn fibres of high-molecular-weight linear polyethylene and at most 20 wt. % of a plastic matrix material and with the fibre direction in each monolayer being rotated with respect to the fibre direction in an adjacent monolayer, the monolayers having a fiber weight between 25 and 150 gr/m^2, which stack is compressed under pressure and at an elevated temperature and which stack is thereafter cooled under pressure, characterized in that the stack is compressed under a pressure of at least 13 MPa."

VI. The arguments of the appellant, in writing and during the oral proceedings, can be summarized as follows:

The subject-matter of claim 1 of the main request was not new with respect to document D1. This document disclosed (see Example 10 at column 10, lines 57 to 61, column 8, lines 41 to 60, and Table 6 at column 16, lines 43 to 60) a ballistic-resistant moulded article obtained by compressing a stack of prepreg sheets having undisputedly all the features of the preamble of claim 1 of the main request. However, also the characterizing feature of claim 1 of the main request, viz. *that the density (ρ_p) of the compressed stack is at least 98.0% of the theoretical maximum density*, was known from document D1 for the following reasons. Firstly, document D1 taught that in forming the prepreg sheets by consolidating and heat setting the coated yarns, the matrix material was caused to flow and occupy the remaining void spaces, see eg column 7, lines 33 to 37 and lines 53 to 60. Since the void spaces in the moulded article were eliminated, it had the theoretical maximum density. Secondly, since the pressure of 7,57 MPa (1100 psi) employed in molding the article of Example 10 (see document D1, column 10, line 52) was higher than the pressure of 7 MPa used to produce the panel according to Example I of the patent in suit having a relative density of 99% (see Table 1 in paragraph [0049] of the patent in suit), the moulded article of Example 10 had a relative density higher than 99%.

The ballistic-resistant moulded article known from document D1 represented the closest state of the art. The object of the invention with respect to document D1 was to provide an alternative ballistic-resistant moulded

article, rather than a better ballistic-resistant moulded article (cf. paragraphs [0003] and [0004] of the patent in suit), since the values for the Specific Energy Absorption (SEA) given in the patent in suit and in document D1 could not be compared, since different types of bullets / projectiles were used. The passage in column 7, lines 32 to 36, of document D1 was a clear teaching to the person skilled in the art to eliminate the void spaces as much as possible. It was known that by using higher pressures and longer heat setting times voids were substantially eliminated, see document D17, column 4, lines 15 to 19. Example 28 of document D17 (see column 17, line 44 to column 18, line 25) showed that increasing the pressure from 4,3 to 12,9 MPa led to an increase of about 25% in the absorbed energy of the ballistic-resistant plaques. Thus, the person skilled in the art, starting from the ballistic-resistant moulded article known from Example 10 of document D1 and seeking to improve its ballistic resistance for the type of projectile mentioned therein (cf. column 7, lines 62 to 68), would try to eliminate the void spaces as much as possible by increasing the pressure and would hence arrive at a ballistic-resistant moulded article according to the preamble of claim 1 of the main request and having a relative density close to the theoretical maximum, ie in the range from 98 to 100%. Alternatively, the person skilled in the art would consult document D2, which taught to compress a fiber reinforced article to at least 98% of its theoretical density (see column 5, lines 34 to 37), or even to at least 99% of its theoretical density (see column 7, lines 26, 27 and 39 to 41). The subject-matter of claim 1 of the main request therefore did not involve an inventive step.

The subject-matter of claim 7 of the main request differed from the process for manufacturing a ballistic-resistant moulded article known from document D1 in that the stack of monolayers was compressed under a pressure of at least 13 MPa rather than under a pressure of 7,57 MPa as used in Example 10 of document D1. However, it was known in the art of manufacturing ballistic-resistant moulded articles to employ pressures in the order of magnitude of 13 MPa or higher (see eg document D5, column 11, lines 3 to 5, where a pressure of 69 MPa was mentioned, or document D17, column 17, lines 49 to 51, where pressures of 4.3, 12.9 and 25.8 MPa were mentioned). Whether such high pressures were necessary to obtain a relative density of 98% was questionable, since in Example III of the patent in suit a relative density of 98,1% was obtained with a pressure of only 1 MPa. The subject-matter of claim 7 of the main request therefore also lacked an inventive step.

VII. The respondent's arguments, in writing and during the oral proceedings, can be summarized as follows:

In the passage at column 7, lines 54 to 61, of document D1 it was said that the fibre network comprised a certain volume percent of the composite concerning the void space, "*with the matrix occupying the remaining volume*". This was only a statement based on the general idea that a composite existed of fibres and matrix only, it could not be inferred therefrom that the "remaining volume" comprised 100% matrix and was free of void spaces. Special measures were necessary to attain a relative density of more than 98%, in particular when the composite had a fibre content of more than 80% by weight. There were important differences between the fibre- and

matrix materials used in Example 10 of document D1 and the fibre- and matrix materials used in Example I of the patent in suit, eg the fineness of the fibre and the type of Kraton 1650 matrix, so that no conclusion with respect to the density could be drawn on the basis of the pressure employed in Example 10 of document D1. It followed that the subject-matter of claim 1 of the main request was new.

The inventors of the present invention had surprisingly found that the SEA value of ballistic-resistant moulded articles was increased when the relative density of said articles was increased to at least 98%, see paragraph [0007] of the patent in suit. In contrast, document D1 was completely silent about the relative density of the ballistic-resistant moulded articles disclosed therein. Of the two techniques for forming the laminate described in column 7, lines 33 to 40, of document D1, only the first mentioned in a general way that the remaining void spaces were occupied by matrix material during consolidating and heat setting the overall structure. In the passage in column 4, lines 15 to 19, of document D17 cited by the appellant, it was stated that voids were *substantially* eliminated, meaning that the voids were not completely eliminated and not that they were totally eliminated. Moreover, it was stated in said passage that higher pressures and longer heat setting times caused the fibres to deform and be compressed. Since typically high-drawn fibres of high-molecular-weight were used in ballistic-resistant moulded articles, and the fibres rather than the matrix absorbed the bulk of the impact energy of projectiles of various kinds, the person skilled in the art would refrain from measures that deformed and compressed said fibres. It was not possible

to conclude from Example 28 of document D17 (loc. cit.), wherein twisted yarn was used, that increasing the pressure led to an increase in the absorbed energy of the ballistic-resistant plaques, since increasing (doubling) the pressure from 12,9 to 25,8 MPa reduced the ballistic resistance. Document D2 was not in the field of ballistics and would not be consulted by the person skilled in the art. For all of the above reasons the subject-matter of claims 1 and 7 of the main request was not obvious to the person skilled in the art.

Reasons for the Decision

MAIN REQUEST

1. *Objection of lack of novelty, Article 54 EPC*

Document D1 discloses a ballistic-resistant moulded article containing a compressed stack of prepreg sheets, with each prepreg sheet containing unidirectionally oriented reinforcing high-drawn fibres of high-molecular-weight linear polyethylene and at most 13,4 wt.% of a plastic matrix material (see Table 6, column 16, line 43 to 60) and with the fibre direction in each prepreg sheet being rotated with respect to the fibre direction in an adjacent prepreg sheet, see Example 10 (column 10, lines 58 to 61), which refers to Sample 9 (see Example 9, column 10, lines 36 to 55), which Example in turn refers to "Precursor Preparation Method 1" (see column 8, lines 41 to 60) and "Molding Procedure 1B (Ex. 8)" (see column 10, lines 29 to 34), whereby in Example 10 the thermoplastic elastomer solution used to prepare the prepreg sheets is composed of 60 g Kraton G1650 per liter

of toluene, rather than 100 g as in Example 9. It may be noted that whilst the yarn used in Example 10 of document D1 is the same yarn as used in Example 1, which consists of 118 filaments having a fineness of the about 10 denier (see column 8, lines 35 to 40), the fibre areal density and the fibre content of the prepreg sheets of Example 10 are not necessarily the same as for Example 1 (0,148 kg/m^2 and 72,7%, respectively, see column 8, line 57).

Document D1 is silent about the relative density of the compressed stack of prepreg sheets.

In document D1 the technique to form a laminate wherein the matrix material is caused to flow and occupy the remaining void spaces, in particular the steps thereof of "consolidating and heat setting", is described in general terms (cf. the passage in column 7, lines 45 to 48, wherein it is stated that when the matrix material is caused to melt, relatively little pressure is required to form the composite, and the passage in column 7, lines 49 to 52, wherein the pressure and time to set the composite are said to depend generally on the matrix material and the processing temperature). The amount of pressure needed to obtain a density of 100% of the maximum theoretical density, or a certain lower percentage thereof, is not presented. None of the Examples 1 to 31 (see column 8, line 19, to column 18, line 5) refer to the techniques for forming the laminate described in column 7, lines 32 to 60, and none of the Examples 1 to 31 mentions that the ballistic-resistant composite article has no void spaces at all, or mentions the relative density.

The passages of document D1 in column 7, lines 33 to 37 and lines 53 to 60, cited by the appellant can therefore

not be construed as a clear and unambiguous disclosure that the density of the prepreg of Example 10 is at least 98.0% of the theoretical maximum density.

In view of the differences in the filament fineness, and in the matrix material and matrix content by weight percent as used in Example 10 of document D1 and as used in Example I of the patent in suit, it cannot unambiguously inferred from document D1 on the basis of the pressure of 7,57 MPa (1100 psi), which is slightly higher than the compression pressure of 7 MPa used in Example I of the patent in suit, that the relative density of the moulded article according to Example 10 must be in the same order of magnitude as the relative density of the moulded article according to Example I of the patent in suit, which is 99%.

The subject-matter of claim 1 according to the main request is therefore new vis-à-vis document D1, Article 54 EPC.

2. *Objection of lack of inventive step, Article 56 EPC*

In the field of ballistic-resistant moulded articles it is a common objective to improve the level of protection for a given weight per unit area thereof, or to reduce the weight of the moulded article offering the same level of protection as the known moulded article. The level of protection is quantified by means of the Specific Energy Absorption (SEA), a measure of the amount of energy that can be absorbed by a moulded article on impact of a projectile per unit areal density of the moulded article. The examples and comparative experiments referred to in the patent in suit, cf. in particular Table 1 in paragraph

[0049], show that the ballistic-resistant moulded article according to claim 1 of the main request having a density of at least 98.0% of the theoretical maximum density solves said problem in the sense that the article according to the invention offers a higher level of protection than ballistic-resistant moulded articles having a lower density but which are otherwise the same.

The ballistic-resistant moulded article known from Example 10 of document D1 represents the closest state of the art. The subject-matter of claim 1 of the main request differs from the known ballistic-resistant moulded article in particular in that "*the density (ρ_p) of the compressed stack is at least 98.0% of the theoretical maximum density*". The subject-matter of claim 7 of the main request differs from the process for manufacturing a ballistic-resistant moulded article known from Example 10 of document D1 in that "*the stack is compressed under a pressure of at least 13 MPa*".

As noted in point 1 above, document D1 is silent about the relative density ("amount of void space") of the moulded articles of the Examples 1 to 31, and hence silent about the importance of producing a moulded article with a relative density of at least 98.0% ("less than about 2% of void space") with a view of increasing the level of protection afforded by the article. No hint or suggestion to the distinguishing feature mentioned above can thus be found in document D1. Moreover, none of the documents cited by the appellant disclose that the relative density of a ballistic-resistant moulded article should be at least 98.0% with a view of increasing the level of protection afforded by the article. Document D17 relates to a ballistic-resistant article made of polyolefin fibres

having a weight average molecular weight of at least about 500.000, see column 2, lines 23 to 38, and claim 1. In Example 28 three pairs of plaques are produced from fibres (only using a twisted yarn) at pressures of 4.3, 12.9 and 25.8 MPa, respectively, whereby the highest energy absorption (Jm^2/kg) was obtained for a pressure of 12.9 MPa. (see column 17, line 44 to column 18, line 25, and Table 14). Assuming that the person skilled in the art would expect that the higher the pressure, the higher the relative density, he or she would not infer from these data that, as a rule, increasing the relative density leads to an improvement of the ballistic-resistance of the article. It may be noted that the absolute value of the relative densities of each pair of plaques is not disclosed in document D17. A person skilled in the art starting from the ballistic-resistant moulded article known from Example 10 of document D1 (having an unknown relative density itself!) would thus not consider the relative density as being a crucial parameter as regards ballistic resistance, and particularly could not expect a significant improvement when achieving a relative density above 98%. Even if the person skilled in the art would pay attention to the relative density, he or she would not know which way to go: increasing or reducing the relative density (or increasing or decreasing the pressure of 7.57 MPa with which the article is molded). Whilst the feature "a relative density of at least 98%" is known in isolation from document D2 (see eg column 6, lines 33 to 36, for the intermediate article 22, and column 7, lines 11 to 27, for the final article 30, which is preferably compressed to 99% of its maximum theoretical density), that document does not relate to ballistic-resistant moulded articles. In the judgement of the Board, the argument of the appellant that the person skilled in the art would apply

the teaching of document D2, viz. to compress the article 30 preferably to at least 98% of its theoretical density, to the moulded article known from document D1 with a view to enhance the ballistic properties thereof, is based on an *ex post facto* analysis, ie an analysis based on the knowledge of the invention.

In the judgement of the Board, it was thus not obvious to the person skilled in the art, starting from the ballistic-resistant moulded article known from Example 10 of document D1, on the basis of his or her technical knowledge, and/or taking document D17 into account, to provide a ballistic-resistant moulded article having a density of at least 98.0% of the theoretical maximum density. Likewise, it was thus not obvious to the person skilled in the art, starting from the process for manufacturing a ballistic-resistant moulded article known from Example 10 of document D1, to compress the stack under a pressure of at least 13 MPa.

The subject-matters of claims 1 and 7 of the main request thus involve an inventive step within the meaning of Article 56 EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

D. Meyfarth W. Zellhuber