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D E C I S I O N
of 5 December 2001

Case Number: T 0596/99 - 3.3.3

Application Number: 85901259.3

Publication Number: 0174343

IPC: C08L 67/02

Language of the proceedings: EN

Title of invention:

Toughened thermoplastic polyester compositions

Patentee:

E.I. DU PONT DE NEMOURS AND COMPANY

Opponent:

BASF Aktiengesellschaft, Ludwigshafen

Headword:

-

Relevant legal provisions:

EPC Art. 56, 113(1), 114(1)

Keyword:

"Late submitted material - document page admitted"

"Solution of problem - accepted on basis of overall picture of evidence"

"Obviousness (no) - burden of proof on opponent/respondent"

"Procedural violation (no)"

Decisions cited:

-

Catchword:

-



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Boards of Appeal

Chambres de recours

Case Number: T 0596/99 - 3.3.3

DECISION
of the Technical Board of Appeal 3.3.3
of 5 December 2001

Appellant:
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Representative: -

Decision under appeal: Decision of the Opposition Division of the
European Patent Office posted 29 March 1999
revoking European patent No. 0 174 343 pursuant
to Article 102(1) EPC.

Composition of the Board:

Chairman: R. Young
Members: P. Kitzmantel
J. C. M. De Preter

Summary of Facts and Submissions

I. Mention of the grant of European patent No. 0 174 343 in respect of European patent application No. 85 901 259.3 (= PCT/US85/00284; WO 85/03718) in the name of E.I. DU PONT DE NEMOURS AND COMPANY, which had been filed on 22 February 1985, was announced on 29 April 1992 on the basis of 28 claims, Claim 1 reading as follows:

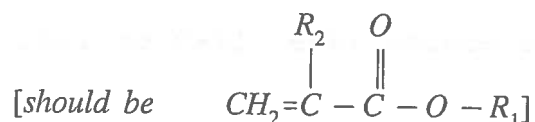
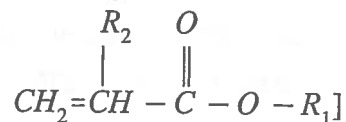
"A polyester molding composition comprising

- (A) 60-97 weight % based on the total of components A and B of a polyester matrix resin having an inherent viscosity of at least 0.3, and
- (B) 3-40 weight % based on the total of components A and B of an ethylene copolymer of the formula E/X/Y

where

E is the radical formed from ethylene and comprises at least 40 weight percent of the ethylene copolymer,

X is the radical formed from



where R_1 is alkyl of 2-8 carbon atoms and R_2 is H, CH_3 , or C_2H_5 , and X comprises 10-40 weight percent of the ethylene copolymer, and

Y is selected from the group consisting of glycidyl methacrylate and glycidyl acrylate, and Y comprises 0.5-20 weight percent of the ethylene copolymer."

Claims 2 to 28 are dependent on Claim 1.

II. Notice of Opposition requesting revocation of the patent in its entirety on the grounds of Article 100(a) EPC was filed by BASF Aktiengesellschaft on 18 January 1993.

The opposition was *inter alia* based on documents

D1: US-A-4 172 859,

D2: C.B. Bucknall, "Toughened Plastics", 1977, pages 290 to 297,

D3: Bruno Vollmert, "Grundriß der makromolekularen Chemie", 1979, vol. IV, pages 130 to 133,

D4: Bruno Vollmert, "Grundriß der makromolekularen Chemie", 1979, vol. IV, pages 198 to 201,

D6: E.A. DiMarzio, J.H. Gibbs, Journal of Polymer Science, vol. XL, 1959, pages 121 to 131,

D6': Macromolecules 1989, 1380 to 1384,

D7: EP-A-0 017 942, and

D8: DE-A-2 454 002.

III. By its decision announced orally on 27 January 1999 and issued in writing on 29 March 1999, the Opposition Division revoked the patent.

The decision was based on the granted version of the patent (main request) and on its version as amended according to the submission dated 27 November 1998 comprising a Claim 1 wherein the meaning of the substituent R_1 in the radical X had been restricted to an "alkyl of 4 carbon atoms" (auxiliary request).

It was held in that decision that the subject-matter of both requests was novel over the cited prior art, but, on the overall balance of probability, did not involve an inventive step,

- (i) because evidence was lacking for the solution of the existing technical problem (ie improving the low temperature impact strength of the toughened PET compositions according to D1) by the use as toughener of ethylene/ethyl acrylate/glycidyl methacrylate (E/EA/GMA) terpolymers, and thus within the whole ambit of Claim 1 of the main request,
- (ii) because the skilled person, being aware of the beneficial influence on the impact strength of a polyester composition of a toughener having a lower Tg, had expected that the replacement of an ethylene/methyl acrylate/glycidyl methacrylate (E/MA/GMA) terpolymer by an ethylene/butyl acrylate/glycidyl methacrylate (E/BA/GMA) terpolymer would result in an improvement of the impact strength, and

- (iii) because the alleged existence of a "long-felt need" and an "outstanding commercial success", which were anyway not established, could not - in the light of the overriding obviousness conclusion - turn the scales.
- IV. On 28 May 1999 the Patentee (Appellant) lodged an appeal against the decision of the Opposition Division and paid the appeal fee on the same day. The Statement of Grounds of Appeal was submitted on 30 July 1999.
- V. The arguments presented by the Appellants in their written submissions and during the oral proceedings held on 5 December 2001 may be summarized as follows:
- (i) In arriving at their conclusion of obviousness of the main request on the basis of a mere criticism of the Patentee's evidence, which had already been found convincing by the Examining Division, the Opposition Division had, in effect, contrary to the requirements in opposition proceedings before the EPO, shifted the burden of proof to the Patentee.
 - (ii) Moreover, in concluding that the subject-matter of the main request was obvious because - in view of the alleged inconclusiveness of the evidence - it failed to solve the underlying technical problem, the Opposition Division had, equally contrary to the requirements in opposition proceedings before the EPO, given the benefit of doubt to the Opponent, because the decision of obviousness was not an immediate corollary of the inconclusiveness of the available evidence.
 - (iii) The Opposition Division's opinion of the inconclusiveness of the evidence was anyway at variance with the facts, because the overall picture established by the experimental data contained in the patent in suit and in the 65-x test report attached to the

Patentee's submission of 27 July 1995 (hereinafter "65-x test report") clearly showed that the replacement of the MA (methyl acrylate) units in the E/MA/GMA terpolymer tougheners of D1 by EA (ethyl acrylate) or BA (butyl acrylate) units led to an improvement of their effectiveness as impact strength improvers for polyesters.

- (iv) The Respondent's criticism that the evidence was altogether unreliable, because it contained examples of identical terpolymer tougheners which led to different impact strength values, was unfounded, since it did not take due account of the almost unavoidable scattering of the notched Izod data, especially if different scientists were involved, caused by
 - (iv-1) the very complex preparation of the polymer blends and test specimens (cf. patent in suit, Example 1, especially page 6, lines 34 to 45),
 - (iv-2) the variations originating from different material properties of the injection molded test specimens at their gate and far ends,
 - (iv-3) the criticality of the depth and positioning of the notch in the test specimens (cf. Patentee's submission of 27 November 1998, Section 3 "Test Samples - Gate End v. Far End", pages 10 to 11), and
 - (iv-4) the temperature sensitivity of the notched Izod measurement in the area of transition of the tested material from the brittle to the ductile breaking mode, which caused considerable impact strength variations at only small temperature changes (cf. plot at bottom of page 2 of Patentee's submission dated 24 June 1997).

- (v) The technical problem underlying the present invention was to be seen in the provision of toughened polyester molding compositions having an impact strength, especially at low temperature, which was improved over that achieved according to D1, which used E/MA/GMA terpolymer tougheners.
- (vi) In practical terms this meant that, at the desired low temperatures, the compositions should exhibit a ductile breaking mode.
- (vii) The solution of the afore-mentioned problem lay in the use of ethylene/C₂₋₈ alkyl acrylate/glycidyl (meth)acrylate tougheners, which provided the desired improvement at low loadings.
- (viii) In view of the evidential situation referred to in subpoints (i) to (iv) supra, the effectiveness of this solution was equally supported for the use of E/EA/GMA and E/BA/GMA tougheners.
- (ix) The inventive solution referred to in subpoint (vii) supra was also unobvious over the cited prior art:
 - (ix-1) While D1 mentioned the possible use of terpolymer tougheners comprising EA and BA units, D1 did not comprise any suggestion that the use of such units in lieu of the MA units, which were present in the E/MA/GMA tougheners exemplified in D1, would provide any benefit, especially in relation to low temperature impact strength.
 - (ix-2) None of the further documents in the proceedings supported the Respondent's allegations (a) that it was known that a lowering of the T_g (glass transition temperature) of a toughener whose T_g was considerably below the envisaged temperature of employment (cf. low temperature test at -20°C) would necessarily improve

the impact strength, nor (b) that the skilled person would expect that the replacement of MA by BA in the E/MA/GMA terpolymer tougheners of D1 would cause a lowering of the Tg of the terpolymer.

- (ix-3) The afore-mentioned allegation (a) was refuted by the reference in the first paragraph of Section 10.4 of document D2 which listed several factors affecting the toughness of rubber-modified plastics but failed to include the Tg of the impact modifier.
- (ix-4) Similarly, the afore-mentioned allegation (b) could not be upheld in the face of the reference in document D4, pages 197 (newly submitted by the Appellant at the oral proceedings as part of a sheet comprising pages 196 and 197) and 201 to the effect that polymers having a polymethylene backbone with side chain branchings exhibited lower Tg's when the chain length of the side chain was shorter.
- (ix-5) Nor was the DiMarzio-Gibbs equation referred to in documents D6 and D6' a reliable tool to calculate the Tg of terpolymers, because (a) it was a very simplified method based on several assumptions, (b) was designed for polymers comprising only two different units not three (ie terpolymers), and (c) was admittedly less reliable for addition polymers than for condensation polymers.
- (x) Finally the Appellant contended that the Opposition Division in its relying in the decision under appeal on the reference in D4, page 201, first complete paragraph, that polybutyl acrylate was an internally plasticized soft rubber having a low Tg, had committed a substantial procedural violation, because the Patentee had not had a possibility to comment on this statement during the whole opposition proceedings.

- VI. The written (letter dated 4 February 2000) and oral submissions of the Respondent (Opponent) can be summarized as follows:
- (i) In the Respondent's view, it was the legitimate right of an Opponent to challenge the conclusions drawn by an Examining Division and doing so would not amount to a reversal of the burden of proof.
 - (ii) D1 represented the closest prior art because it related to toughened polyester compositions which comprised E/MA/GMA terpolymer impact modifiers.
 - (iii) Neither of the Appellant's requests complied with the requirements of Article 56 EPC (a) because D1 itself and also D7 already considered the use of higher alkyl acrylates (AAs) in lieu of MA for the formulation of ethylene/alkyl acrylate/glycidyl methacrylate (E/AA/GMA) impact modifiers for polyesters and (b) because the achievement, by a change to higher AAs, of an improved performance was either not established or at least obvious in the light of the existing prior art.
 - (iv) The latter conclusion was to be drawn because the skilled person was aware (a) from D2 of the enhanced effectiveness of an impact strength modifier with decreasing Tg, (b) from D4 of the much lower Tg of polybutyl acrylate as compared with polymethyl acrylate, and (c) from the DiMarzio-Gibbs equation of the linear contribution of the Tg of homopolymers, whose monomers form the copolymer, to the Tg of the copolymer, with the consequence that the change in an E/AA/GMA terpolymer from AA being MA to BA must lead to a lowering of the terpolymer's Tg.

- (v) However, in the Respondent's view, the question whether or not an improvement of the toughening performance was to be expected by the afore-mentioned change to higher alkyl acrylates was only of secondary importance, because the available experimental evidence anyway did not allow any valid conclusions in that respect.
- (vi) In the Respondent's view, this followed from the many inconsistencies and defects of the available experimental data which was *inter alia* reflected
 - (vi-1) by the fact that many examples of Tables I and II of the patent in suit referred to identical compositions but exhibited quite different Izod values, and
 - (vi-2) by the lack of comparability of the "inventive" and "comparative" experiments in the "65-x test report" because of the simultaneous alteration of more than one compositional feature of the E/AA/GMA terpolymer (cf. Section I of the Respondent's submission dated 4 February 2000, pages 3 to 6).
- (vii) The erratic results contained in Tables I and II could not be excused by the complexity of the preparation of the test specimens and the Izod measuring method, because the patent in suit was not restricted to a particular method (cf. page 5, lines 30 to 36 of the specification), the reported data were average results (cf. Examples 2 to 17, page 7, lines 17 to 18 of specification) and the Izod measurement was a industrial standard test.
- (viii) Nor could the criticized defects of the experimental data be disregarded, since they were far from negligible: the notched Izod value at -20°C of Example 65-4 was e.g. 330% higher than the corresponding value of the very similar composition according to Example 43.

(ix) The Respondent denied that, in arriving at their decision, the Opposition Division had committed a substantial procedural violation because, in their recollection of the oral proceedings before the Opposition Division, the contents of the statement in D4, page 201, first complete paragraph had been amply discussed (cf. Section V (x) supra).

VII. The Appellant requested that the decision under appeal be set aside and that the patent be maintained on the basis of the claims as granted (main request) or of the claims submitted with letter of 27 November 1998 (first auxiliary request).

As a second auxiliary request, the Appellant requested the case to be remitted to the Opposition Division and the appeal fee to be reimbursed.

The Respondent requested that the appeal be dismissed.

Reasons for the Decision

1. The appeal is admissible.

2. *Procedural*

Pages 196 and 197 (both on a single sheet) of document D4 were admitted into the appeal proceedings under Article 114(1) EPC despite of their late submission by the Appellant at the oral proceedings because the relevant information on this sheet only concerns the last three lines on page 197, which are in fact part of a sentence which ends on top of page 201, a page duly submitted by the Opponent with the opposition brief filed on 18 January 1993 together with pages 198 to 200 (in fact only the latter 3 pages, which contain tables

separating the text passages on pages 197 and 201, were referred to in the opposition brief, but the sheet comprising page 200 also comprised page 201). The afore-mentioned information is highly relevant for the contextual understanding of the statement on page 201, first full paragraph of D4, on which the decision under appeal heavily relied for its conclusion of obviousness of the auxiliary request (cf. decision under appeal, page 15, lines 17 to 23; page 18, penultimate paragraph).

3. Citations

3.1 Document D1

This document relates to polyester or polycarbonate compositions having improved ductility or toughness (column 1, lines 7 to 12).

According to Claim 1 these compositions comprise a polyester or polycarbonate matrix resin and a random copolymer of the formula A(a)-B(b)-C(c)-D(d)-E(e)-F(f)-G(g)-H(h), wherein each of the subscripts (a) to (h) may be 0, wherein when monomer A is ethylene and is present, in addition thereto at least one of the monomers B, C, D, or E, and at least one of the monomers F, G and H is also present; D being an unsaturated epoxide of 4 to 11 carbon atoms and F being an unsaturated monomer from the class comprising acrylate esters having from 4 to 22 carbon atoms.

According to column 7, lines 14 to 15 the moiety F may be methyl methacrylate, methyl, ethyl and butyl acrylate.

In column 8, lines 39 to 45 it is stated: "The improvement in ductility of a composition characterized by a higher notched Izod value is approximately

proportional to the concentration of the adherent sites in the polymeric component as well as to the melt viscosity ...".

Among the many random copolymers disclosed in column 7, line 28 to column 8, line 38 are E/MA/GMA and E/MA/glycidyl acrylate (column 8, lines 37 to 38).

Examples 10 and 16 to 18 in Table 3 (columns 15, 16) exemplify blends of matrix polymers 4, 8, 10 and 12 which all comprise polybutylene terephthalate (PBT) ("4GT": cf. Table 1-A, columns 11, 12) and a polymer 8 being E/MA/GMA (cf. Table 1-B, columns 13, 14).

Table 3 indicates several properties of the aforementioned blends including Notched Izod values determined according to ASTM D-246-56 (column 12, lines 29 to 30).

3.2 Document D8

This document relates to thermoplastic moulding compositions from PBT having increased impact strength particularly also at low temperatures (page 2, first paragraph).

According to Claim 1 these compositions comprise 100 parts by weight of a PBT and 0.5 to 35 parts by weight of a graft polymer prepared from

- (i) an α -olefin vinyl ester copolymer or an α -olefin acrylic acid copolymer and
- (ii) unsaturated carboxylic acids or acid esters.

Ethylene/vinyl acetate/acrylic acid and ethylene/n-butyl acrylate/acrylic acid are exemplified as graft copolymers (page 5 (printed), Examples a and b).

Table 1 on page 7 indicates impact strength data ("Lochschlagzähigkeit") at +23°C and -30°C.

Main request

4. Novelty

4.1 As set out in Section 3.1 supra, document D1 exemplifies PBT compositions comprising E/MA/GMA terpolymer tougheners. Furthermore, D1 discloses in column 7, lines 14 to 20 that the unit F of the copolymer formula A(a)-B(b)-C(c)-D(d)-E(e)-F(f)-G(g)-H(h) may *inter alia* be methyl methacrylate, methyl, ethyl or butyl acrylate.

Since D1 does not disclose that EA or BA may actually replace MA in the exemplified monomer combination E/MA/GMA, which is the disclosure of D1 which comes closest to the subject-matter of the patent in suit, the content of this document is not novelty destroying for the said subject-matter.

4.2 None of the other documents in the proceedings was hitherto considered by any party to be relevant to the issue of novelty and the Board sees no reason to deviate from this position.

4.3 The subject-matter of Claim 1 therefore complies with the requirement of Article 54 EPC.

4.4 The same conclusion applies *a fortiori* to the further Claims 2 to 18 which are dependent on Claim 1.

5. *Closest prior art*

5.1 According to page 2, lines 44 to 45 of the patent specification (page 2, lines 32 to 34 of the application) the claimed invention is concerned with polyester molding compositions having extraordinary toughness, especially at low temperatures.

5.2 Document D1 refers to polyester compositions having improved toughness without reference to low temperature toughness.

However, since an improvement of the toughness is normally not confined to a specific temperature range, as reflected by the word "especially" in the aforementioned problem statement of the patent in suit, and since the patent explicitly stresses the superiority of the "inventive" tougheners over "comparative" E/MA/GMA tougheners of the type exemplified in D1 (patent specification: page 8, Examples 18 to 43, lines 8 to 10; application: page 18, lines 13 to 18), this document is considered to be the most appropriate starting point for the assessment of inventive step. At the oral proceedings this stance was accepted by both parties.

5.3 D8, whilst mentioning as its main object the achievement of high impact strength also at low temperatures (cf. page 1 (printed), lines 1 to 3), uses to this end tougheners which are structurally considerably different from those used according to the patent in suit (cf. Section 3.2 supra). D8 is therefore a less appropriate starting point for the assessment of inventive step of the present subject-matter.

6. *Problem to be solved*

In the Board's judgment, and in agreement with the parties, the problem underlying the subject-matter of the patent in suit vis-à-vis D1 is the one referred to in Section 5.1 supra, namely the provision of polyester molding compositions having extraordinary toughness, especially at low temperatures.

7. *Solution of the problem*

7.1 According to Claim 1 of the main request the solution of the afore-mentioned problem is to be achieved by the use of certain tougheners of the type E/AA/G(M)A, wherein AA is a radical derived from an alkyl acrylate of the formula $\text{CH}_2=\text{C}(\text{H}, \text{CH}_3 \text{ or } \text{C}_2\text{H}_5)-\text{C}(\text{O})-\text{O}-(\text{C}_{2-8}\text{-alkyl})$ and G(M)A is a radical derived from glycidyl acrylate or glycidyl methacrylate.

7.2 The available evidence plausibly demonstrates that the use of E/EA/GMA and E/BA/GMA terpolymer tougheners solves the existing technical problem.

7.2.1 For a realistic evaluation of the Izod data account has to be taken of the following:

(i) The Appellant's/Patentee's statement is accepted that the Izod values in the series of Table I, Table II and of the "65-x test report" cannot be compared with one another, since they were determined by different scientists and since the preparation of the test specimens and the carrying out of the Izod test itself is likely to produce somewhat different results if the testing persons are differently experienced.

(ii) While perfect conditions of comparison require that the molar amounts of the comonomers of the terpolymers which are to be compared are identical (cf. D1,

column 8 lines 39 to 45; Section 3.1 supra), certain variations of the ratios of amounts of the comonomers of "inventive" and "comparative" tougheners do not detract from the comparability of the respective tests. This is made credible by the "new" Examples submitted (during examination) with the letter dated 22 June 1990, which show that the Izod impact strength, especially at low temperature, stays within the same order of magnitude when the BA weight content is increased by 10% (corresponding to an increase in mole% of from about 7.3% to about 11.3%) and the ethylene content is correspondingly reduced (from about 90.9 mole% to about 86.7 mole%), while the GMA content is almost kept identical (slight increase from about 1.8 mole% to about 1.9 mole%):

Example	Polyester	% acrylate in toughener	% GMA in toughener	melt flow index	Izod (J/m) 23°C	Izod (J/m) -20°C
new	PET	25BA	7	100	811.5	82.2
new	PET	35BA	6.5	100	944.9	90.2

(iii) With increasing temperature the breaking mode of the test specimens changes from brittle (low Izod values) to ductile (much higher Izod values). In the transition stage the Izod values increase rapidly within a relatively small temperature range (cf. graph on page 2 of the Patentee's submission dated 24 June 1997). Therefore, in that transition stage rather big variations of the Izod values may occur with minor temperature changes.

(iv) While the Izod values in Table I of the patent in suit represent average values of tests on 6 samples, 3 from near the gate end and 3 from the far end of the test bar (page 7, lines 17 to 18 of patent specification)

and while for each Example of the "65-x test report" twenty specimens were tested (ten from the gate and 10 from the far end: Patentee's submission dated 27 November 1998, page 10, last two paragraphs and page 11, Table 2 in conjunction with the identical 65-x results reported in Table attached to the Patentee's submission dated 27 July 1995), the Izod values of Table II of the patent in suit do not report average values (as stated by the Appellant at the oral proceedings). In the latter case experimental errors are not eliminated and considerable deviations of the measured Izod values may thus occur under normal experimental conditions.

- (v) It is also worthwhile to mention that the inclusion of disparate data into the US priority application of the patent in suit was necessary to comply with a legal requirement in the USA which prohibits the exclusion of such data.

7.2.2 A comparison of "inventive" Example 6 with "comparative" Example 8 and of "inventive" Example 7 with "comparative" Example 9 in Table I shows an improvement of the Izod values in the case of the use as comonomer of BA in lieu of MA, which is considered to be significant despite of the minor mole% differences between the MA/BA and GMA units (cf. Table I according to Exhibit I of Patentee's submission dated 14 September 1993; all examples comprising 18 weight% toughener)

Example	Mole% MA	Mole% BA	Mole% GMA	Izod		
				23°C	0°C	-20°C
8 (comp.)	7.22		1.03	351.4	86.2	46.5
6 (inv.)		6.76	1.14	351.4	92.6	59.0

9 (comp.)	8.18		2.13	844.8	103.3	45.9
7 (inv.)		8.58	2.32	1105.4	699.5	98.3

7.2.3 A comparison of the following Examples (inventive and comparative) of Table II (according to Exhibit II of Patentee's submission dated 14 September 1993) shows an improvement of the Izod values for both "inventive" tougheners E/EA/GMA and E/BA/GMA. The "outliers" (data which do not fit into the overall picture), especially the "too high" -20°C result of Example 22 (MA) and the inverted picture of the 0°C and -20°C results of Examples 25 (EA) and 26 (MA), which can be explained by the particular problems of these measurements, as discussed in Section 7.2.1 supra (especially subpoint (iv)), cannot invalidate the conclusion that the replacement of MA by EA or BA causes a clear trend to higher Izod impact strength values, which is particularly distinct at higher E/AA/GMA loadings and at lower temperatures.

Example	wt% E/AA/ GMA	Mole% MA	Mole% EA	Mole% BA	Mole% GMA	Izod		
						23°C	0°C	-20°C
22 (comp.)	3	8.31			1.05	37.4	22.2	30.2
19 (inv.)	3			9.40	1.23	53.4	88.6	21.1
20 (inv.)	3			9.40	1.23	35.2	34.7	20.8
26 (comp.)	10	8.31			1.05	105.2	43.0	40.9
25 (inv.)	10		10.3		1.16	105.2	77.7	15.2
24 (inv.)	10			9.40	1.23	113.7	103.9	45.9
38 (comp.)	25	8.31			1.05	791.4	199.4	108.1
34 (inv.)	25		10.3		1.16	955.9	852.5	134.6

42 and 43 (both comp)	40	8.31			1.05	834.6 720.9	214.4 672.3	117.5 86.5
41 (inv.)	40		10.3		1.16	692.6	932.4	1025.3
39 and 40 (both inv.)	40			9.40	1.23	887.0 828.8	919.0 820.8	937.7 909.1

7.2.4 The "65-x test report" (cf. attachement to Patentee's submission dated 27 July 1995 and Table 10 on page 18 of the Patentee's submission dated 27 November 1998), in spite of some minor inconsistencies in the evolution of the Izod data, also demonstrates the Izod impact strength improvement which is attained with the replacement in the toughener E/MA/GMA of the MA units by EA or BA units. Again some inconsistencies in the Izod data cannot spoil the clear trend.

Example	wt% E/AA/ GMA	Mole% MA	Mole% EA	Mole% BA	Mole% GMA	Izod (mean)		
						23°C	0°C	-20°C
65-1	10	7.9			1.3	109	62	57
65-5	10		12.6		2.0	128	92	67
65-9	10			8.2	1.2	155	87	66
65-2	18	7.9			1.3	306	164	81
65-6	18		12.6		2.0	833	223	137
65-10	18			8.2	1.2	988	245	125
65-3	25	7.9			1.3	945	421	138
65-7	25		12.6		2.0	960	346	232
65-11	25			8.2	1.2	1008	626	250
65-4	40	7.9			1.3	868	1028	374
65-8	40		12.6		2.0	727	1131	1131
65-12	40			8.2	1.2	861	1041	1160

7.2.5 The Respondent's contention (submission dated 4 February 2000) that the totality of the Appellant's evidence could not be relied upon as well as the conclusion of the decision under appeal that the subject-matter of the main request did not solve the problem of improving the low temperature impact strength within the whole scope of Claim 1 is at variance with the evidence set out in the previous Subsections 7.2.2 to 7.2.4. The respective objections were as follows:

(i) Several Examples related to identical compositions, but exhibited quite different Izod values. This applied to:

(i-1) Examples 4 and 31:

	Izod 23 °C	Izod 0 °C	Izod -20 °C
Example 4	427.1	97.2	66.2
Example 31	767.9	512.9	126.0

(i-2) Examples 7, 29, and 30:

	Izod 23 °C	Izod 0 °C	Izod -20 °C
Example 7	1105.4	699.5	98.3
Example 29	-	180.2	145.5
Example 30	738.5	186.9	99.3

(i-3) Examples 19 and 20:

	Izod 23 °C	Izod 0 °C	Izod -20 °C
Example 19	53.4	88.6	21.1
Example 20	35.2	34.7	20.8

(i-4) Examples 27 and 28:

	Izod 23 °C	Izod 0 °C	Izod -20 °C
Example 27	139.9	86.5	56.1
Example 28	130.8	143.6	61.4

(i-5) Examples 34 and 35:

	Izod 23 °C	Izod 0 °C	Izod -20 °C
Example 34	955.9	852.5	134.6
Example 35	-	503.8	105.2

(i-6) Examples 39 and 40:

	Izod 23 °C	Izod 0 °C	Izod -20 °C
Example 39	887.0	919.0	937.7
Example 40	828.8	820.8	909.1

(i-7) Examples 42 and 43:

	Izod 23 °C	Izod 0 °C	Izod -20 °C
Example 42	834.6	214.4	117.5
Example 43	720.9	672.3	86.5

7.2.6 While these discrepancies cannot be denied, they do not destroy the significance of the tendency of the impact strength improvement established by the afore-mentioned evidence (cf. Subsections 7.2.2 to 7.2.4)

Moreover, there are credible reasons for these discrepancies. Firstly, as set out in Section 7.2.1 (i) only results which are comprised by the same set of tests (Tables I, II or "65-x test report") can fairly be compared, thus excluding any comparison of one of Examples 1 to 17 (Table I) with one of Examples 18 to 43 (Table II). This excludes the criticism according to point (i-1) supra and partly (Examples 7 vs. Examples 29, 30) that according to point (i-2) supra. All further discrepancies can be explained by the testing conditions set out in Subsections 7.2.1 (ii) to (iv), especially by the fact that the results in Table II are not average data.

7.2.7 The further observation of the Respondent, namely that, in view of the simultaneous change of the molar amounts of AA and GMA in the Examples to be compared, the data of the "65-x test report" had to be disregarded altogether, is likewise not tenable. While differences in the molar amounts of the constituents AA and GMA exist between the compositions, these are not such as to seriously affect the evidential weight of these Examples; all the more as the differences between E/MA/GMA, and E/BA/GMA are minor (cf. Subsection 7.2.4 supra). As to the greater molar differences between E/MA/GMA and E/EA/GMA (7.9 mole% MA vs. 12.6 mole% EA; 1.3 mole% GMA vs. 2.0 mole% GMA) an influence of these higher amounts of AA and GMA on the Izod values does certainly exist, but is foreseeable in its dimension (cf. Section 7.2.1 (ii) supra) and cannot, therefore, fatally distort the whole picture.

7.2.8 Nor is the Respondent's further objection, namely that the impact strength improving effect of the "inventive" tougheners would not extend down to toughener contents of 10 weight percent and below, able to refute the conclusion that the subject-matter of Claim 1 solves the present technical problem within its whole scope. While it is evident from the graph "Effect of Ester Type on 0 C Izod" submitted by the Patentee at the oral proceedings before the Opposition Division that with decreasing toughener content the impact strength improving effect of E/AA/GMA tougheners comprising EA units approaches the effect of the tougheners comprising MA units, this only confirms the expectation of the skilled person, namely that at lower toughener contents its influence on the impact strength of the polyester composition becomes smaller with the consequence that the Izod improving effect of "good"

and "bad" tougheners must converge. This cannot deprive the Patentee from its legitimate right to obtain a fair protection for its invention also in its "border area", where the beneficial effects are tapering off.

- 7.2.9 Apart from the above detailed discussion of the Appellant's evidence, concerning its manifold criticism by the Respondent, the Board observes the following:

While it is legitimate for an opponent to attack a patent by pointing at an allegedly erroneous appreciation of the evidence by the Examining Division, in opposition proceedings, the burden of proof nevertheless remains with the opponent.

In the present case the Appellant therefore rightly stressed that, even if the Respondent/Opponent had been successful in its effort to cast serious doubt on the persuasiveness of the Appellant's evidence, this would not justify the conclusion that the invention failed to solve the existing technical problem, but only that the evidence was inappropriate. For the Respondent to actually prove that the subject-matter of Claim 1 was **unable** to solve said problem it would have been necessary to submit convincing counter-evidence.

- 7.2.10 In summary, the Board finds that the Respondent's arguments are not sufficient to prove that the existing technical problem, i.e. the achievement of an improved impact strength, especially at low temperatures, had not been solved by the replacement of MA units in the prior art-type E/MA/GMA tougheners by higher alkyl acrylate units, like EA and BA.

8. *Obviousness*

8.1 This issue turns on the question whether it is obvious to solve the existing technical problem by the aforementioned change of the AA units of the E/AA/GMA terpolymer as defined in Claim 1 of the patent in suit.

The Board is convinced that this solution is not obvious over the available prior art.

8.2 The Respondent's case focussed on three assertions:

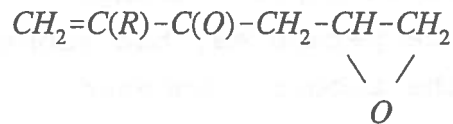
Firstly, the skilled person was aware from D1 and D7 that higher alkyl acrylate units may be used as moieties in E/AA/GMA-type tougheners, secondly, the skilled person was also aware that the lower the Tg of a toughener the better its impact strength improving abilities, and thirdly, it was furthermore known that the replacement in the E/MA/GMA tougheners according to D1 of the MA units by EA or BA units must inevitably lead to a lowering of the tougheners' Tg.

From that it followed, in the Respondent's opinion, that said replacement was an obvious step to make for an expert who wished to provide more efficient tougheners.

8.2.1 While it is correct that D1 discloses the possible use of ethyl and butyl acrylates as moieties of the impact modifiers which are described therein (cf. column 7, lines 14, 15), it nowhere suggests that the impact improving properties of tougheners comprising such higher alkyl acrylate moieties are better than those of analogous tougheners comprising MA units.

8.2.2 The same conclusion holds for D7. Claim 1 of this document relates to a polyethylene terephthalate (PET) molding composition comprising a) PET, b) from 0.1

to 40 parts by weight, based on 100 parts by weight of PET, of a copolymer of an α -olefin, and a glycidyl ester of an α,β -unsaturated aliphatic carboxylic acid having the formula



wherein R is hydrogen or a lower alkyl radical (according to Claim 4: glycidyl methacrylate), and (c) from 0.1 to 5 parts by weight, based on 100 parts by weight of PET, of the barium salt of a fatty acid having 8 to 33 carbon atoms.

The sentence bridging pages 7 and 8 sets out that copolymer (b) may also include unsaturated monomers that are able to be copolymerized with the two other ingredients within the range of about 40 mol%, such as *inter alia* methyl, ethyl or propyl acrylate and methacrylate.

However, D7 nowhere suggests that the impact strength improving properties of tougheners comprising such higher alkyl acrylate moieties are better than those of analogous tougheners comprising MA units.

8.2.3 Concerning the skilled person's expectations of the influence of the Tg on the toughening properties, the Respondent relied on documents D2, D3 and D4.

(i) Document D2

The first sentence of the chapter 10.3.1 "Glass transition of rubber" on page 295 of this textbook excerpt reads: "The relationship between impact strength and the glass transition temperature of the

rubber particles is well known."

The Respondent argued that this statement had to be interpreted in the context of the statements in the second and third sentence of the chapter 10.3 "Effect of Temperature in Impact Strength" on page 290 reading: "At very low temperatures, the rubber phase is hard and glassy, and the rubber-toughened polymer is brittle. At higher temperatures, the multiple-crazing mechanism becomes active, and impact strength rises."

The Board is unable to infer from these statements anything more than the commonly known facts that the impact strength of a toughened polymer becomes better with increasing temperature and that a toughener is ineffective below its T_g .

This information is unrelated to the question whether the effectiveness of a toughener, whose T_g is far below the relevant temperature of use (as is the case with any of the E/AA/GMA terpolymers having high ethylene content which are to be considered here: cf. T_g calculations in Table 1 on page 4 of the Patentee's submission dated 27 November 1998), is improved when its T_g is lowered, but still remains far below the relevant temperature of use, which, according to the low temperature Izod tests performed, is down to about -20°C .

- (ii) Neither of the documents D3 and D4 comprises any statement which is relevant to the question referred to in the preceding Subsection.
- (iii) The Respondent, therefore, failed to produce any evidence in support of its allegation that it was known, in the present context, that a lowering of the toughener's T_g would necessarily entail an enhancement of its impact strength improving properties.

8.2.4 Concerning the alleged expectation of the skilled person that the replacement of MA units in the E/MA/GMA tougheners of D1 by EA or BA units would lead to a lowering of the toughener's Tg, the Respondent also failed to produce convincing evidence in its support.

In this respect, the Respondent mainly relied on the assumption that it was possible to forecast the influence of the AA moiety on the Tg of an E/AA/GMA terpolymer from the Tg of the AA homopolymer. Since the Tg of polybutyl acrylate of about -50°C was much lower than that of polymethyl acrylate of 0°C (Tg's cf. D4, page 199), the Respondent speculated, the Tg of the terpolymer E/BA/GMA should be lower than that of a terpolymer E/MA/GMA.

This assumption is, however, not corroborated by the available evidence constituted by documents D6, D6' and D4.

- (i) D6 is concerned with a simplified method of calculating the Tg of copolymers and to this end the authors DiMarzio and Gibbs state "... we will content ourselves with a very simple and somewhat approximate application" (cf. page 121, especially last sentence of third paragraph). In order to put this project into practice many assumptions were made, thus, finally arriving at an equation (DiMarzio-Gibbs equation) which allows to estimate the Tg of a copolymer *inter alia* from the Tg's (\approx second order transition temperatures) of the homopolymer components (cf. equation (4) on page 125 in conjunction with paragraphs 3 and 4 on page 126).

It is emphasized in the synopsis on page 130 that "[t]his simplified treatment can be applied to various types of copolymer systems but amounts to more than an

approximation in the case of random copolymers of the addition (vinyl) type than in the case of random copolymers of the condensation type."

It is, thus, evident from D6 that the DiMarzio-Gibbs equation does not allow to reliably forecast the Tg of addition type copolymers prepared by the copolymerisation of ethylenically unsaturated monomers, like ethylene and acrylates. Moreover, D6 does not mention terpolymers and it stands to reason that a mathematical calculation of the Tg of a terpolymer must be by far more unsafe than that of a copolymer.

- (ii) The above conclusion is reinforced by the reference in the post-published document D6' to the DiMarzio-Gibbs equation and the comments thereafter concerning "[t]he failure in predicting Tg values, of linear relations ..." as well as the necessity of the addition of an "extra term for diad sequences" into the more elaborate equations of Barton and Johnston (cf. pages 1380 and 1381: "Introduction").
- (iii) Also the Respondent's further argument that the replacement of MA moieties by BA moieties in the E/MA/GMA tougheners of D1 was obvious in view of the reference in D4, page 201 lines 4 to 11 to the soft, internally plasticised character of polybutyl acrylate, an argument that was crucial for the rejection of the auxiliary request by the Opposition Division, is not supportive of the Respondent's case if considered in the context from which this statement originates.

The explication offered in D4 for the low Tg of polybutyl acrylate (page 201, lines 9 to 10: becomes a glassy solid at -50 to -60°C) is that the long butyl groups exhibited a shielding effect which prevented the polar ester groups from coming into contact with other

chains or chain segments (page 201, lines 11 to 18). This shielding explained why polybutyl acrylate was, according to D4, a "striking exception" (page 201, line 4), because without this special effect the skilled person rather had expected that the long butyl group would hinder the mobility of the polymer chain and, thus, lead to a higher Tg than a shorter alkyl group.

The latter conclusion follows from the statement contained in the paragraph bridging pages 197 and 201 (page 197 having been submitted by the Appellant at the oral proceedings only: cf. Section 2 supra): "The smaller the chain substituents and the weaker the van-der-Waals forces, the bigger the mobility of the chain and the lower thus the temperature at which the polymer becomes a glassy solid" [translation from German by the Board].

From the latter statement in D4 the skilled person must conclude that the butyl groups will not be able to exert a Tg-depressing effect if they are spaced apart in a terpolymer and cannot thus effectively prevent the ester groups from coming into contact as in the case of the homopolymer polybutyl acrylate where long sequences of adjacent butyl groups are reported in D4 to function as an internal swelling and/or plasticising agent.

- 8.2.5 The facts, evidence and arguments presented by the Respondent are therefore not able to prove its case.
- 8.2.6 In that circumstance the Board cannot but decide that the subject-matter of Claim 1 of the main request complies with the requirement of Article 56 EPC.
- 9. The same conclusion applies *a fortiori* to the subject-matter of the further Claims 2 to 28 of the main request which are dependent on Claim 1.

10. There is, thus, no need to deal with the first auxiliary request.
11. There is likewise no need to deal with the even lower ranking second auxiliary request, ie the request for remittal to the first instance and reimbursement of the appeal fee. Moreover, the Appellant's contention that the Opposition Division committed a procedural violation is unfounded. It is apparent from the first paragraph of Section 2.2 of the minutes of the oral proceedings before the Opposition Division that the soft character of the butyl acrylate group was discussed during these proceedings and it is equally apparent from the subsequent paragraph of the minutes that document D4 was considered. Consequently, the Opposition Division has not violated the Patentee's right to be heard under Article 113(1) EPC by referring to the statement in D4, page 201 which discusses the "internally plasticized" soft character and the low Tg of polybutyl acrylate and by drawing therefrom its conclusion of obviousness (cf. decision under appeal, page 15, lines 17 to 23 and page 18, lines 5 to 7 from the bottom).

Order

For these reasons it is decided that:

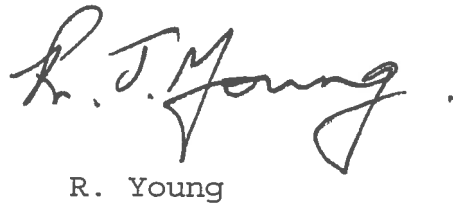
1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to maintain the patent as granted.

The Registrar:



E. Görgmaier

The Chairman:



R. Young

1950

For the purpose of this report

the following information is given

The data is presented in the form of a table

The following

1. 2. 3. 4. 5.

6. 7. 8. 9. 10.