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DECISION
of 7 February 1997

Case Number: T 0046/95 - 3.3.3

Application Number: 88307972.5

Publication Number: 0305214

IPC: C08G 63/62

Language of the proceedings: EN

Title of invention:
A polycarbonate-made optical article and method of preparation therefor

Patentee:
IDEMITSU PETROCHEMICAL CO., LTD.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes) - non-obvious combination of known features"

Decisions cited:
-

Catchword:
-

Case Number: T 0046/95 - 3.3.3

DECISION
of the Technical Board of Appeal 3.3.3
of 7 February 1997

Appellant: IDEMITSU PETROCHEMICAL CO., LTD.
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 1 September 1994 refusing European patent application No. 88 307 972.5 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: C. Gérardin
Members: H. H. Fessel
J. A. Stephens-Ofner

Summary of Facts and Submissions

I. This appeal lies from the decision of the Examining Division 2.1.02.012 refusing European patent application No. 88 307 972.5 (publication No. 0 305 214), filed in the name of Idemitsu Petrochemical Co. Ltd. on 26 August 1988 and claiming a JP priority of 27 August 1987 (JP 213252/87).

That application was published with a set of 7 claims of which the only independent Claims 1 and 7 read as follows:

"1. An article for use in an optical application shaped of a polycarbonate resin represented by the general formula

$$C_6H_5C(CH_3)_2\text{-}C_6H_4\text{-}O\text{-}CO\text{--}[\text{-}O\text{-}C_6H_{4-p}X_p\text{-}R\text{-}C_6H_{4-q}X_q\text{-}O\text{-}CO\text{-}]_n\text{--}O\text{-}C_6H_4\text{-}C(CH_3)_2\text{--}C_6H_5$$

in which R is a divalent group or atom selected from the class consisting of alkylene groups having 1 to 15 carbon atoms substituted or unsubstituted with a phenyl group, alicyclic groups having 3 to 15 carbon atoms, O-, -S-, -SO-, $-SO_2-$ and -CO-, X is an alkyl or aryl group or a halogen atom and p and q are each 0, 1 or 2 and n is a positive integer having such a value that the molecules of the polycarbonate resin have a viscosity-average molecular weight in the range from 10,000 to 17,000, C_6H_4 , $C_6H_{4-p}X_p$ and $C_6H_{4-q}\text{-}X_q$ each being a substituted or unsubstituted 1,4-phenylene group.

7. A method of synthesising a polycarbonate resin of the general formula:

$C_6H_5\text{-}C(CH_3)_2\text{-}C_6H_4\text{-}O\text{-}CO\text{--}[\text{-}O\text{-}C_6H_{4\text{-}P}X_P\text{-}R\text{-}C_6H_{4\text{-}q}X_q\text{-}O\text{-}CO\text{-}]_n\text{--}O\text{-}C_6H_4\text{-}C(CH_3)_{2\text{-}}C_6H_5$,

for use as a base material for making an article of optical application, preferably an optical disc substrate, comprising reacting a dihydric phenol compound and phosgene and using 4-cumylphenol as a molecular weight controlling agent or molecular chain-terminal stopping agent."

II. The decision of 1 September 1994 to refuse the application was based on a set of 5 claims filed on 16 April 1992 of which the only independent Claim 1 reads as follows:

"An optical disc substrate shaped of a polycarbonate resin represented by the general formula

$C_6H_5\text{-}C(CH_3)_2\text{-}C_6H_4\text{-}O\text{-}CO\text{--}[\text{-}O\text{-}C_6H_{4\text{-}P}X_P\text{-}R\text{-}C_6H_{4\text{-}q}X_q\text{-}O\text{-}CO\text{-}]_n\text{--}O\text{-}C_6H_4\text{-}C(CH_3)_{2\text{-}}C_6H_5$,

in which R... 1,4-phenylene group" (as above).

The Examining Division held the claimed subject-matter to be novel within the terms of Article 54(3) EPC with respect to D6: EP-A-0 293 891, but not to involve an inventive step over the following documents:

D1: Patent Abstract of Japan, Vol. 6, no. 231 (C-135) (1982) corresponding to Derwent Abstract AN 82-80546E, JP-A-57 133 149;

D2: Patent Abstract of Japan, Vol. 10, no. 63 (C-332) (1986), JP-A-60 203 632;

D3: Patent Abstract of Japan, Vol. 10, no. 78 (C-335) (1986), JP-A-60 215 020;

all cited in the search report,

D4: Derwent Abstract of JP-A-51 020 993 (An 25563x/14);
D5: Patent Abstract of Japan, Vol. 8, no. 15 (C-206), JP-A-58 180 553;

D7: Kunststoffe, Vol. 74 (1984), pp. 569-72;

D8: US-A-4 514 367;

D9: DE-A-3 512 838; and

D10: US-A-4 216 305,

all introduced by the Examining Division in the course of the examination procedure.

In substance it was held that the general requirements in terms of birefringence and melt flow properties, e.g. molecular weight, which a polycarbonate resin should fulfil to be suitable for optical applications, were known from D2, D3, D5, D8 and D9. Further, the improved stability of p-cumylphenol end-capped polycarbonate resin mentioned in D1 and D4 would have been an incentive for a skilled person to consider such a feature when looking for a polycarbonate having better mechanical properties.

III. On 21 October 1994 a Notice of Appeal was filed together with payment of the prescribed fee.

(i) In the Statement of Grounds of Appeal filed on 11 January 1995 the Appellant submitted Comparative Examples showing the effect on drop-weight impact strength of various end groups, the molecular weight of polycarbonates being maintained constant. These experimental results were said to demonstrate a technical effect of the p-cumylphenol endcapping agent vis-à-vis phenol and other substituted phenols which could not have been predicted from the prior art.

(ii) Furthermore, the Appellant pointed out that, since D2 and D4 had the same proprietor (Mitsubishi Gas), the fact that the experts of that company did not consider a combination of these two teachings was circumstantial evidence that such a combination was not obvious. Moreover, the relevance of D4 was questioned since the thermal stability it mentioned could not be equated with impact resistance. The good properties of polycarbonate resins reported in D5, D8 and D9 were achieved either by adding a phosphorous compound to the polymer or by using small amounts of a polyfunctional phenol in the preparation of the resin, neither of which corresponding to the solution required in the application in suit.

IV. The Appellant requested that the decision under appeal be set aside and that the application be remitted to the first instance with the order to grant a patent on the basis of Claims 1 to 5 as filed on 16 April 1992.

Reasons for the Decision

1. The appeal is admissible.

2. The subject-matter of the claims is not disclosed in any of the citations on file and is, therefore, considered to be new. Since this was not disputed, no further comments need to be given by the Board on this issue.

3. The application in suit is concerned with an optical disc substrate shaped of a polycarbonate resin.

3.1 Such subject-matter is disclosed in D2 and D3 which are in substance equivalent and are regarded by the Board as representing the closest state of the art. Both documents describe the preparation of a transparent article useful as the base for video discs by moulding a terminal modified polycarbonate resin having a viscosity-average molecular weight of 13,000 to 23,000 obtained from a dihydric phenol, phosgene and a chain terminator, the latter being in particular an alkylphenol wherein the alkyl radical has 8 to 30 carbon atoms (see "purpose" and "constitution" of both abstracts). Although the transparency and birefringence properties of these polycarbonate resins can be regarded as quite satisfactory, the articles moulded therefrom do not possess sufficient mechanical strength.

3.2 In the light of this shortcoming the technical problem underlying the application in suit may be seen in the provision of a polycarbonate resin having improved mechanical strength without impairing the transparency and birefringence properties.

3.3 According to the application in suit this problem is solved by using 4-cumylphenol as the chain-terminal stopping agent, as specified in Claim 1.

3.4 The experimental data on file demonstrate that this feature provides an effective solution of the above defined technical problem.

3.4.1 In particular, Table 1 of the application shows that, for a given molecular weight of the polymer within the terms of Claim 1, moulded circular discs prepared from cumylphenol terminated polycarbonate resins (Examples 1 to 3, Resins A1 to A3), exhibit a much higher drop-weight impact strength, which is a standard test for evaluating the impact resistance of an optical disc substrate, than those prepared from polycarbonate resins end-capped with conventional phenols (Comparative Examples 4 to 9, Resins B1 to B3 and C1 to C3), without impairing the birefringence properties (Tables 2 and 3).

3.4.2 The experimental test report submitted together with the Statement of Grounds of Appeal confirm this tendency; the data in Tables 1 to 3 attached thereto clearly demonstrate that the drop-weight impact strength of a p-cumylphenol terminated polycarbonate resin (Resins R11, R21 and R31) is for a given molecular weight between 6.95 and 10.2 times as large as that of a polycarbonate end-capped with p-tert-butylphenol (Resins R12, R22 and R32), phenol (Resins R13, R23 and R33), p-nonylphenol (Resin R14) or ß-naphthol (Resin R15).

4. It remains to be decided whether the claimed subject-matter would have been obvious to a person skilled in the art having regard to the documents relied upon in the decision under appeal.

4.1 In addition to the above mentioned alkylphenol, e.g. octylphenol, D2 and D3 also disclose aliphatic monocarboxylic acids having 8 to 30 carbon atoms as well as specific derivatives thereof. All these compounds thus have in common a fatty radical, which is therefore to be regarded as the essential structural feature of the end-capped polycarbonate resins. In the absence of any reference in these citations to impact strength properties, it is evident that these teachings cannot provide any incentive to use p-cumylphenol as the chain terminator.

4.2 The same applies to the other documents which deal with polycarbonate articles suitable for optical applications.

4.2.1 D8 relates to a method for moulding polycarbonate resins, in particular in the form of digital audio and video discs, which overcomes the disadvantages in terms of colouration or poor mechanical properties which occur when a polycarbonate resin is injection moulded (column 1, lines 14 to 49). Excellent transparency and a small degree of optical strain are ensured by adding 0.005 to 0.5 percent by weight of a phosphorus ester to the end-capped polycarbonate resin, the chain stopper being p-tertiary butylphenol or phenol (column 1, line 63 to column 2, line 38; column 3, lines 9 to 35; Preparatory Examples A, B and C of Polycarbonate Resin).

4.2.2 A similar disclosure is to be found in D5 which teaches to blend a polycarbonate resin having a viscosity-average molecular weight of 15,000 to 18,000, thus presumably end-capped, with a phosphorous antioxidant, whereby excellent resistance to impact is achieved (see "purpose" and "constitution" of the abstract).

4.2.3 The required combination of properties is obtained in D9 by using a polycarbonate resin having a viscosity-average molecular weight between 13,000 and 20,000 which is both end-capped and partially cross-linked (Claim 1 in conjunction with page 3, paragraph 1). As suitable chain terminators this citation, which has the same authors as D2 and D3, mentions the compounds discussed in points 3.1 and 4.1 above, namely compounds characterized by an aliphatic radical having 8 to 30 carbon atoms (Claim 4 in conjunction with page 9, paragraph 3 to page 10, paragraph 1). The partial cross-linking is achieved by using minor amounts of a polyfunctional phenol in the preparation of the polycarbonate resin (Claim 3 in conjunction with page 7, paragraph 2 to page 9, paragraph 2). Emphasis is laid on the good mechanical properties resulting from this combination of features (page 12, lines 11 to 13).

4.2.4 The methods disclosed in the documents which aim at improved mechanical properties and which a skilled person would therefore be highly likely to consider for the solution of the technical problem, are based on either a stabilization or a partial cross-linking of the polycarbonate resin end-capped with a conventional monophenol. None of the teachings would provide an incentive to modify the polymer chain with specific end groups, as required in the application in suit.

4.3 The documents which describe the use of cumylphenol as a molecular weight adjuster for polycarbonate resins are not concerned with optical applications, let alone in combination with improved impact resistance properties.

4.3.1 According to D4 polycarbonate resins are prepared by conventional means in the presence of p-cumylphenol acting as a polymerisation regulator. This increases the thermal stability of the polymer without reducing strength or other mechanical properties (see Abstract).

4.3.2 D10 discloses the preparation of aromatic poly(formal carbonates) by standard phosgenation of a mixture of bisphenol A and a bisphenol dimer in the presence of p-cumylphenol (Claim 1 in conjunction with column 3, lines 29 to 38 and Example 1). The advantageous properties of the resulting block polymers, namely clarity, improved processability, UV stability and hydrolytic stability, which make them suitable for the preparation of films, are attributed to the formal-carbonate units, e.g. to the chemically combined formal dimer units, not to the specific end groups (column 1, lines 6 to 14; column 3, lines 13 to 16).

4.3.3 D1 describes polycarbonate resin compositions containing 10 to 50 percent by weight of glass fibers, the polymer being characterized by the presence of specific terminal benzene groups introduced by using appropriate molecular weight adjusters, such as cumylphenol (formulae I and IV), for its preparation. This improves the mouldability without discolouration and degrading the impact resistance, and makes these filled compositions suitable for electrical and automotive parts (see "purpose" and "constitution" of the abstract).

4.3.4 The spectrum of properties of polycarbonate resins end-capped with p-cumylphenol reported in these documents is thus such that a skilled person faced with the above-defined technical problem would not be encouraged to consider, let alone to try a solution along that line. Whereas these specific end groups can be regarded as promising in order to improve stability - thermal stability in D4, UV stability and hydrolytic stability in D10, colour stability in D1 - no beneficial effect concerning the level of impact strength resistance can be expected since it is said that the mechanical properties can at most be maintained. Moreover, when examining the properties of the polycarbonate resins in these citations a skilled person would be aware of the contribution of the other features of these compositions, namely the combination of specific recurrent units and block structure in D10 and the large amounts of filler in D1, and would thus not consider the terminal groups of the polymer chain in isolation, but in combination with these structural and compositional features. These considerations show that the documents which disclose polycarbonate resins end-capped with p-cumylphenol cannot lead to the claimed subject-matter.

4.4 D7 is a survey of the potential applications of polycarbonate resins and the properties required. In the case of optical disc substrates (page 570, left-hand column in conjunction with Table 2), emphasis is laid on the difficulty to achieve a satisfactory compromise between a relatively low molecular weight and still acceptable mechanical properties; no specific chain terminator is mentioned, let alone a possible effect thereof on impact strength resistance.

4.5 For these various reasons the claimed subject-matter cannot be derived from the cited documents, whether considered in isolation or in combination, and therefore involves an inventive step.

5. Claim 1 being allowable the same applies to dependent Claims 2 to 5 which are directed to preferred embodiments of the optical disc substrate according to Claim 1 and are thus supported by the patentability of that claim.

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 grant a patent on the basis of Claims 1 to 5 as filed on 16 April 1992.

The Registrar: The Chairman:

E. Görgmaier C. Gérardin