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D E C I S I O N
of 30 November 2005

Case Number: T 1053/03 - 3.3.03

Application Number: 93911020.1

Publication Number: 0638097

IPC: C08F 20/54

Language of the proceedings: EN

Title of invention:

Preparing crosslinkable polymers employing macromonomer chain transfer agents

Applicant:

E.I. DU PONT DE NEMOURS AND COMPANY

Opponent:

-

Headword:

-

Relevant legal provisions:

EPC Art. 54, 56, 123(2)

Keyword:

"Inventive step - problem and solution - closest prior art"

Decisions cited:

T 0031/84, T 0229/85, T 0298/93

Catchword:

-



Case Number: T 1053/03 - 3.3.03

D E C I S I O N
of the Technical Board of Appeal 3.3.03
of 30 November 2005

Appellant:

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Decision under appeal:

Decision of the Examining Division of the
European Patent Office posted 20 January 2003
refusing European application No. 93911020.1
pursuant to Article 97(1) EPC.

Composition of the Board:

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

Summary of Facts and Submissions

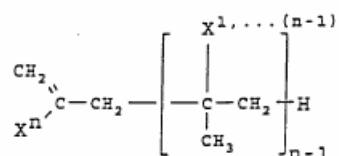
- I. European Patent Application No. 93 911 020.1, filed on 3 May 1993 as international application number PCT/US93/04177, claiming priorities of 1 May 1992 (US 07/876 764) and 22 May 1992 (US 07/887 626) and published on 11 November 1993 as WO 93/22355 was refused by a decision of the Examining Division dated and issued in writing on 20 January 2003.

The decision was based on a set of 17 claims submitted with letter of 5 June 2001, claim 1 reading as follows:

"1. A method of free radical polymerization of unsaturated monomers to make a polymer having reactive functionality, said method comprising:

polymerizing a reaction mixture, which comprises:

- (a) for chain transfer, a macromonomer or a polydisperse mixture of macromonomers, having the following end group:



wherein n is, on average, 2 to 100 and X¹ to Xⁿ are independently -CONR₂, -COOR, OR¹, -OCOR, -OCOR¹, -NR¹COOR¹, halo, cyano, or a substituted or unsubstituted phenyl or aryl, wherein each R is independently selected from the group consisting of hydrogen, silyl, or a substituted or unsubstituted alkyl, alkyl ether, phenyl, benzyl, and aryl, wherein said substituent is selected from the group (*sic*) consisting of epoxy, hydroxy,

isocyanato, cyano, amino, silyl, carboxyl, halo, and acyl; and wherein R¹ is the same as R except not H; and wherein each alkyl is independently selected from the group consisting of branched, unbranched and cyclical hydrocarbons having 1 to 12 carbon atoms; and wherein halo is bromo, iodo, chloro or fluoro; excluding the use of a pure dimer when X¹ to Xⁿ is substituted or unsubstituted phenyl or aryl, and

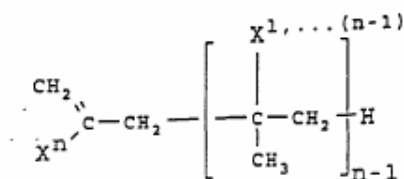
(b) monomers, the same or different, at least a portion of which has said reactive functionality, said reactive functionality being capable of crosslinking with itself or another polymer, and is selected from the group consisting of hydroxyl, epoxy, anhydride, carboxyl, silyl, amide, amine, isocyanato functionalities, and mixtures thereof."

Dependent claims 2 to 12 and 14 to 16 referred to preferred embodiments of the method of claim 1.

Independent claim 13, directed to a method for the production of telechelic polymers read as follows:

"13. A method of free radical polymerization of unsaturated monomers to make a telechelic polymer having terminal functionality, said method comprising: polymerizing a reaction mixture, which comprises:

(a) for chain transfer, a macromonomer or a polydisperse mixture of macromonomers having the following end group:

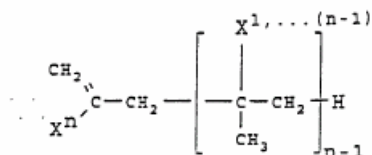


wherein n is, on average, 2 to 100 and X¹ to Xⁿ are independently -CONR₂, -COOR, OR¹, -OCOR, -OCOOR¹, -NR¹COOR¹, cyano, or a substituted phenyl or aryl, wherein each R is independently selected from the group consisting of hydrogen, silyl, or a substituted alkyl, alkyl ether, phenyl, benzyl, and aryl, said substituent being selected from the group consisting of epoxy, hydroxy, isocyanato, cyano, amino, silyl, carboxyl, anhydride, and acyl; and wherein R¹ is the same as R except not H; and wherein each alkyl is independently selected from the group consisting of branched, unbranched, and cyclical hydrocarbons having 1 to 12 carbon atoms; and

(b) monomers, the same or different, wherein a substantial portion of said monomers have said terminal functionality at one or both ends, said terminal functionality being selected from the group consisting of epoxy, hydroxy, isocyanato, cyano, amino, silyl, carboxyl, anhydride and acyl; and wherein said terminal functionality is capable of crosslinking with itself or with a functionality on a separate polymer."

Independent claim 17 read as follows:

"17. Use of a composition as a chain transfer agent having the following structural formula:



wherein n is on average 2 to 100 and X¹ to Xⁿ are independently -CONR² (*sic*), -COOR, OR¹, -OCOR, -OCOOR¹, -NR¹COOR¹, halo, or cyano, wherein each R is independently selected from the group consisting of hydrogen, silyl, and a substituted alkyl, alkyl ether, phenyl, benzyl, or aryl, said substituent being selected from the group consisting of epoxy, hydroxy, isocyanato, cyano, amino, silyl, carboxyl, halo, and acyl; and wherein R¹ is the same as R except not H; and wherein each alkyl is independently selected from the group consisting of branched, unbranched, and cyclical hydrocarbons having 1 to 12 carbon atoms and halo is bromo, iodo, chloro or fluoro."

(a) The decision referred to the following prior art documents:

D1: Cacioli, P. *et al.*, "Copolymerization of ω-unsaturated Oligo(Methyl Methacrylate): New Macromonomers", J. Macromol. Sci.-Chem., **1986**, A23(7), 839-852;

D2: EP-A-135 280.

II. According to the decision, the claims on which it was based, which had been amended compared to the application as filed, met the requirements of Article 123(2) EPC.

The subject matter claimed was furthermore novel since the comonomers employed in the experiments of D1 did not bear reactive functionalities of the kind specified in paragraph (b) of claim 1.

However it was held that the subject matter of all claims lacked an inventive step in view of D1.

The only difference of the application over D1 was the feature that the monomers in paragraph (b) of claim 1 bore functional groups which could be involved in common crosslinking reactions. All other features, in particular the use of the macromonomers as chain transfer agents in a method of free radical polymerization resulting in lower molecular weight polymers than with the macromonomers absent had been explicitly disclosed in D1.

The argument of the Applicant that the chain transfer reaction was considered by the authors of D1 to be a nuisance reaction was dismissed since this reaction and the technical effect thereof were explicitly disclosed. D1 also gave a hint to macromonomers substituted with functional groups and to the use of such substituted macromonomers in further (co)polymerization processes by virtue of the reference to D2.

According to the decision, the problem underlying the application was defined, with reference to page 2

line 31 to page 3 line 3 of the application as filed, as being to provide crosslinkable polymers of controlled (low) molecular weight for coating compositions, which problem was solved by modifying the method and polymers known from D1 by introducing into the polymerisation mixture monomers bearing the defined functionalities and capable of crosslinking (set out in paragraph (b) of claims 1 and 13 recited above).

It would have been immediately evident to the skilled person that the monomers employed in D1 could be replaced or supplemented with further free radical polymerisable monomers. It was common general knowledge that polymers used in coating compositions could bear hydroxyl, carboxyl, amino or isocyanato functionality for crosslinking.

Hence the skilled person seeking to solve the defined problem would simply use monomers which bore some or all of these functional groups.

The argument of the Applicant that it was not evident to employ the macromonomers together with the defined functional monomers since neither D1 nor D2 disclosed such a combination was dismissed as relating to novelty rather than inventive step. In any case the implicit argument that there was no hint in D1 or D2 to use the functional monomers according to the claim was dismissed since D1 disclosed macromonomers which bore functional groups in the end group and referred in this respect to D2. D2 disclosed macromonomers with functional groups along the chain and taught that the terminal groups could be reacted with another free radical to yield a range of terminal groups, e.g.

olefinically unsaturated group. This was the reaction disclosed in D1.

There was nothing in D1 or D2 which would have prevented the skilled person from contemplating the use of monomers according to claim 1(b) upon which the decision was based in the place of or as a supplement to the monomers of D1. Further the general knowledge of the skilled person in the field of coatings would have prompted to the use of such monomers in order to provide crosslinkable polymers of controlled molecular weight.

- III. An appeal against this decision was filed on 28 March 2003, the requisite fee being paid on the same date.

- IV. The Statement of Grounds of Appeal, filed on 30 May 2003, was accompanied by a set of 17 claims. Claims 1 and 13 had been amended, compared to the claims upon which the decision of the examining division had been based, by replacing the term "end group" by the term "structure". Additionally, a clerical error in a dependent claim was corrected.

The Appellant argued substantially as follows:

- (a) There was no hint in D1 and D2 to use functional monomers according to claim 1(b).

- (b) The invention concerned a method of making a polymer by a one-step free radical polymerization method employing monomers with reactive functionalities to obtain a polymer with reactive functionalities. By contrast, the polymers

obtained according to D1 did not exhibit the reactive functionalities.

- (c) D1 did not teach that the macromonomer mixture would be an effective or commercially useful chain transfer agent.
- (d) With regard to the argument that D1 by virtue of its reference to D2 gave a hint to macromonomers with functional groups and their use in further (co)polymerisation via the unsaturated group, the skilled person would not combine the two documents as suggested in the decision under appeal, and even if they were so combined, they would not lead to the claimed invention.
- (e) The polymers resulting from the free radical polymerization disclosed in D2 would mandatorily be terminated by the initiator residue and not by a hydrogen atom. D2 mentioned that functional groups could be sited along the chain, but did not define what these groups were or even include an example of a polymer with such a group.
- (f) In any case D1 was silent on what a "functional substituent" meant and made only a vague reference to D2. It was considered a "leap of faith" to conclude that such term in D1 meant a reactive functionality as defined in the claims.
- (g) The decision did not refer to any authority to support the position that it would have been common knowledge to consider the statement in D1 of functional substituents as meaning one of those

presently claimed. All D1 taught was that oligomers in which the end group could include functional substituents could now be obtained by the use of alkoxyamine initiator-terminators and cited D2 as the source. In this respect the decision adopted a hindsight approach.

- (h) D1 only made reference to a single functionality - i.e. the alkoxyamines of D2 and only to this functionality in the oligomer, but not in the monomer that was polymerized. Hence the combination of D1 and D2 would lead to a change in the structure of the oligomer by adding an alkoxyamine functionality.
- (i) Combining D1 and D2 would result in a compound which was susceptible to radical splitting yielding a radical which in contrast to the compound I of the invention could initiate radical polymerisation but would not act as a chain transfer agent.
- (j) Assuming that part of the compound remained unreacted, it was unpredictable how the radical initiator functionality would influence the reactivity thereof.
- (k) Even assuming that the resulting compound reacted like oligomer (I) of D1, which was considered unlikely, it would result in a different structure than that of the present invention.
- (l) The information in D2 that the polymer might have reactive functional groups along the chain did not

suggest that such monomers could be employed in a reaction with the macromonomer as defined in present claim 1.

- (m) It was further argued that, quite apart from the above, the method claimed had a number of advantages such as lower polymerization temperatures, reduced initiator costs and less colour. The polymer would exhibit improved durability. The method reduced the variabilities common to the use of chain transfer agents.
- (n) Even if the interpretation of the decision regarding D1 and D2 were to be accepted, it could not *a priori* be predicted how such a "highly fictionalized" product would crosslink.

V. On 18 July 2005 the Board issued a summons to attend oral proceedings.

In the accompanying communication, besides noting a number of deficiencies pursuant to Article 123(2) EPC in respect of claims 13 and 14, the Board expressed the preliminary view that the subject matter of claim 17, directed to the use of the macromonomer as a chain transfer agent was not novel in the light of the disclosure of D1.

Regarding inventive step, it was not clear what constituted the "invention" underlying the application. While the description indicated that the invention was directed to the use of the macromonomers for controlling or limiting the molecular weight of

polymers, this aspect was not reflected in the claims, nor in any of the arguments presented by the appellant.

It was also considered that if the problem was, as set out on page 2 lines 31 to 33 of the application, simply to provide a method of polymerisation to obtain crosslinkable polymers by employing the known macromonomers, then the arguments hitherto presented by the Appellant had failed to demonstrate convincingly that the decision of the examining division had necessarily been incorrect. It was considered that there would have been no particular obstacle to investigating the reaction of the macromonomers known from D1 with types of monomers other than those disclosed in D1. On the contrary, it appeared that D1 provided an incentive to investigate reactions with related species capable of crosslinking.

It was also not the case that the claims contained any features restricting the subject matter thereof to the specific end uses envisaged in the application in suit.

The Board however considered that it appeared that the application in suit was based on the realisation that the chain transfer reaction identified and discussed in D1 could be employed in order to control the molecular weight in a radical polymerization. It was considered that, were the claims to be formulated to reflect this "limiting" effect, then the question to be answered would be whether there was an explicit as opposed to inherent teaching in D1 relating to this functional effect of "limiting" or "controlling" the molecular weight.

It was further noted that none of the "advantages" mentioned in the application (e.g. improved durability) were supported by any evidence, so that it would not be possible to rely upon these in the discussion of inventive step.

VI. With a letter dated 31 October 2005, the Appellant submitted an amended set of 15 claims as the sole request, the first phrase of claim 1 having been amended, compared to the claims filed with the statement of grounds of appeal, to read "A method of controlling molecular weight in a free radical polymerization...". Previous claims 13 and 17 had been deleted, and the previous claim 14 (now claim 13) was amended.

VII. Oral proceedings were held before the Board on 30 November 2005.

(a) The Appellant emphasised that D1 taught that polymerisation of the macromonomer with other monomers resulted in limited molecular weight, this limitation being presented in D1 as a disadvantage. Thus, were the skilled person to start from D1 it would be considered necessary to develop methods of overcoming this, i.e. increasing the molecular weight. The fact that there may be a possibility of modifying the teaching of D1 by selecting different monomers was not sufficient to demonstrate that the subject matter now claimed lacked an inventive step. Rather it was necessary to show that there was a clear incentive to make the modifications defined in the claims of the application in suit. It was

not even certain that the monomers in D1 could be replaced or supplemented. D1 did not give any indication of the results that could be expected on replacing the monomers, or that any useful products could in fact be obtained.

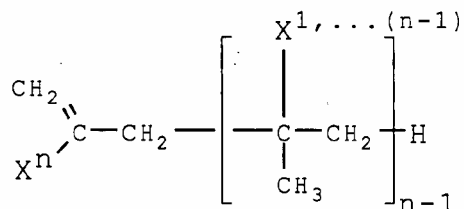
- (b) Following an observation by the Board that claim 1 as submitted on 31 October 2005 failed to specify what was meant by "controlling" the molecular weight as well as further observations regarding the non-conformity of certain claims with the requirements of Articles 84 and 123(2) EPC, the Appellant withdrew the claims of 31 October 2005 and submitted a new set of 12 claims.

Compared to the set of claims filed with the letter of 31 October 2005, claim 1 was amended by specifying the molecular weight per functional unit. Further amendments to claims 1, 5, 7 and 8 had also been made in order to address the objections raised by the Board under Articles 84 and 123(2) EPC. Claims 13 to 15 had been deleted.

Claim 1 as submitted at the Oral Proceedings thus read as follows:

"1. A method of free radical polymerization of unsaturated monomers to make a polymer having reactive functionality and a number average molecular weight per functional group of 70 to 6000, said method comprising:
polymerizing a reaction mixture, which comprises:

- a) for chain transfer, a macromonomer or a polydisperse mixture of macromonomers, having the following structure:



- wherein n is, on average, 2 to 100 and X¹ to Xⁿ are independently -CONR₂, -COOR, OR¹, -OCOR, -OCOOR¹, -NR¹COOR¹, halo, cyano, or a substituted or unsubstituted phenyl or aryl, wherein each R is independently selected from the group consisting of hydrogen, silyl, or a substituted or unsubstituted alkyl, alkyl ether, phenyl, benzyl, and aryl, wherein substituted means with a substituent selected from the group consisting of epoxy, hydroxy, isocyanato, cyano, amino, silyl, carboxyl, halo, and acyl; and wherein R¹ is the same as R except not H; and wherein each alkyl is independently selected from the group consisting of branched, unbranched and cyclical hydrocarbons having 1 to 12 carbon atoms; and wherein halo is bromo, iodo, chloro or fluoro; excluding the use of a pure dimer when X¹ to Xⁿ is substituted or unsubstituted phenyl or aryl, and
- b) monomers, the same or different, at least a portion of which has said reactive functionality, said reactive functionality being capable of crosslinking with itself or another polymer, and is selected from the

group consisting of hydroxyl, epoxy, anhydride, carboxyl, silyl, amide, amine, isocyanato functionalities and mixtures thereof."

Claims 2 to 4 specified preferred embodiments of the functionality in the monomer (b), and of the substituents X^1 to X^n . Claim 5 defined a preferred embodiment wherein the substituents X^1 to X^n were ester groups and the degree of polymerisation n was from 2 to 20. Claim 6 defined a further preferred embodiment of the macromonomer. Claim 7 was directed to the copolymer made by the method of claim 1; claims 8 and 9 were directed to coating compositions comprising the copolymer of claim 7 and a crosslinkable or curable composition containing the polymer made by the method of claim 1 respectively. Claims 10 to 12 defined further preferred embodiments of the method of claim 1, in particular wherein the macromonomer also contained a reactive functionality.

- (c) The Appellant submitted that the majority of examples met the functionality requirement now present in the amended claim 1. It was further submitted that an analysis of inventive step based on the problem set out in the application would lead to an *ex post facto* analysis. The correct approach was to consider the factors necessary for the intended end uses of the polymers, namely that they be stable, crosslinkable, and dry in a reasonable time. None of these requirements are disclosed in or derivable from D1.

The Appellant made the following requests:

- that the decision under appeal be set aside and that a patent be granted on the basis of the main request with claims 1 to 12 filed in the oral proceedings.

Reasons for the Decision

1. *Admissibility*

The Appeal is admissible.

2. *Article 123(2) EPC*

The objections raised by the Board in the communication of 18 July 2005 in particular those under Article 123(2) EPC (section V above) have been addressed by deletion and/or amendment (cf. sections VI and VII.b).

Regarding the amendments made subsequently, i.e. on the occasion of the oral proceedings, the following is noted:

2.1 Claim 1 upon which this decision is based differs from claim 1 as considered by the examination division in that:

- (a) It is specified that the number average molecular weight per functional group of the polymer having reactive functionality be 70 to 6000. This feature is disclosed in the application as originally filed at page 14, line 28 as applying generally to

the crosslinkable polymer products according to the application.

(b) The wording of claim 1 as originally filed has been reinstated in the 5th and 6th lines below the formula ("...wherein substituted means with a substituent...").

2.2 Claim 5 has been amended, compared to the version on which the decision was based, by reinstating the wording of the claim as originally filed (i.e. claim 6) in the third line below the formula ("...which substituent is...").

2.3 Claim 7 has been amended to specify a **copolymer**, and corresponds to originally filed claim 25.

2.4 Claim 8 has been amended to specify "A coating for a **substrate**", and corresponds to originally filed claims 27 and 28.

2.5 Since, for the reasons given above, the claims do not define subject matter extending beyond the content of the application as filed, it is concluded that the requirements of Article 123(2) EPC are satisfied.

3. *The Application in suit*

According to claim 1, the application in suit relates to a method of free radical polymerization of unsaturated monomers to provide a polymer having reactive functionality, and a defined number average molecular weight per functional group. The method involves polymerizing a mixture of a macromonomer chain

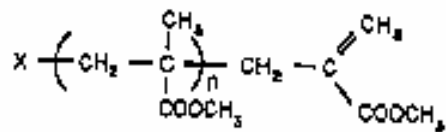
transfer agent of defined degree of polymerisation and one or more co-monomers bearing defined reactive functionality, capable of crosslinking.

According to claim 7, the application also relates to the copolymers resulting from the method of claim 1 and according to claim 8 to coating compositions containing these.

According to the introduction of the application, the intended field of use is in coatings and other curable compositions, the aim being to provide a route to obtaining polymers of controlled low molecular weight (page 1, lines 6 to 12).

4. *The prior art*

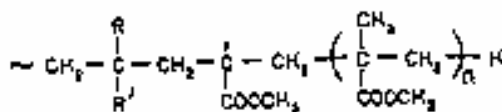
4.1 D1, presented in the application as one of the documents representing the relevant prior art is an academic paper. The background to this is an investigation of the role of ω-unsaturated oligo(methyl methacrylate):



in the radical co-polymerisation thereof with ethyl acrylate, styrene, methyl methacrylate, acrylonitrile and vinyl acetate. The possible use of this species as a starting point for the preparation of graft copolymers is also investigated.

It is concluded ("Conclusions", page 851) that there are limitations regarding the use of this species as a route to graft copolymers due to the low reactivity of

the derived radical and facile β -scission of the radical (12) that is obtained during copolymerisation:



12

Nevertheless it was possible to get "useful" incorporations of ω -unsaturated poly(methyl methacrylate) in polymerisation with various monomers, e.g. ethyl acrylate and styrene. With vinyl acetate while there was "ready" reaction, chain termination reactions however led to low molecular weight products (passage bridging pages 851 to 852 of D1). The discussion at page 844 also shows that reaction with the cyanoisopropyl radical did not lead to a polymeric product. At page 841, lines 1 to 7 it is proposed to replace the terminal H group with functional alkoxyamine end groups derived from use of the free radical compounds known from D2 (reference [7] in D1) as initiators.

D1 does not discuss any potential practical uses of the polymerisation process or the polymers obtained by the reaction disclosed therein.

The conclusions (starting on page 851 and continuing on page 852) thereof are couched in cautious language, broadly stating that the reactions of the macromonomer have "significant implications" (final paragraph), but emphasising in the first paragraph the "limitations" of the use of the macromonomers for the production of graft co-polymers. Indeed a statement at page 850 that "further information...is now being sought in our laboratories" appears to confirm the somewhat

provisional and interim nature of the teachings in this disclosure.

- 4.2 D2 is a patent application, which has a number of inventors in common with the authors of D1 and is referred to in D1. It predates D1 by some 2 to 3 years. D2 is concerned with providing a new polymerization process which allows control of the growth steps in a radical polymerization to produce "relatively short chain length homopolymers and copolymers" (abstract). According to page 1, line 9 - page 2, line 1, low molecular polymers (oligomers) are of interest in surface coatings, in particular high solids and solvent free coatings. However previous methods for preparing polymers of controlled - low - molecular weight were limited by the available free radical technology. The invention of D2 is stated to provide a route to such materials (page 2, lines 26 to 31). This is achieved according to page 7 and claim 1 of D2 by employing a specific nitroxide radical initiator of general formula: $(C(R^1R^2R^3))(C(R^4R^5R^6)N-O-X$, the group X having at least one carbon atom (claim 1 of D2) and being capable of forming a free radical $X\cdot$ which radical is capable of initiating polymerization of unsaturated monomer.

The mechanism by which the polymerisation proceeds is designated "controlled-growth free radical polymerization" (page 6, lines 21 to 26, page 10, lines 15 to 17), involving a reversible termination process, whereby the polymer grows by insertion of the monomer units between the nitroxide radical and the radical $X\cdot$. D2 teaches that the polymerization can be controlled by selection of alkoxyamines with appropriate substituents, the polymerization

temperature and the amount and type of monomer (page 11, line 28 to page 12, line 1).

D2 also contemplates inserting functional groups at the terminus of the molecules obtained either by reaction of the residual nitroxide group or by incorporating such a group in the radical X directly (page 12, line 21 to page 13, line 25). It is also taught, that depending on the monomers employed, the resulting polymers may have chemically reactive functional groups along the chain (page 12, lines 29, 30 and page 13, lines 20 to 25). Only one such functional group - hydroxy - is specifically mentioned (page 13, line 6) or exemplified (example 48), yielding a structure with a OH group which is present at the terminus only, not along the chain.

5. *Novelty*

- 5.1 D1 discloses process in which a macromonomer of the formula defined in present claim 1 is polymerised with a number of defined comonomers. However, D1 fails to disclose comonomers bearing the functional groups defined in present claim 1.

The process according to D2 does not employ the macromonomer defined.

Accordingly it is concluded that neither D1 nor D2 anticipates the method that is the subject matter of independent claim 1.

- 5.2 Regarding the resulting product defined in independent claim 7, since D1 does not define the comonomers

required, it is concluded that the product according to present claim 7 is also not anticipated by the disclosure of D1.

With respect to D2, the polymers directly resulting therefrom will mandatorily exhibit one chain end which is derived from the oxyamine group and one derived from the radical group X. In contrast, the polymer resulting from the method of claim 1 of the application in suit will mandatorily have hydrogen of an isopropylidic methyl group of a methylmethacrylate unit at one terminus. While D2 does teach that the terminal oxyamine groups may be further reacted to yield e.g. hydroxy groups or vinyl groups (page 13, lines 6 and 15), it is apparent that the other terminal will necessarily be an O-X groups wherein X contains at least one carbon atom. Hence the polymers resulting from the method of D2 will not exhibit the terminal group structure resulting from the method of present claim 1, and hence mandatorily in the polymer of claim 7. Further, none of the examples of D2 disclose polymerisation of a methyl methacrylate macromonomer having the degree of polymerisation required by claim 1 of the application in suit with a comonomer having one of the permitted functional groups.

It is thus the case that neither the general nor the specific disclosure of D2 discloses the copolymers that would result from applying the method of claim 1 of the application in suit.

5.3 Accordingly, the Board can concur with the findings of the Examining Division that the subject matter of the application in suit is novel.

Inventive Step

6. *The technical problem to be solved by the application*

6.1 According to the established practice of the Boards of Appeal, determination of the technical problem to be solved should be based on objective criteria. Normally, both in *ex parte* and *inter partes* proceedings, the objective definition of the problem to be solved by an application should start from the problem described in the contested application or patent. An exception to this principle exists if examination reveals that such problem was not solved, or that inappropriate prior art had been employed to define the technical problem. Under such circumstances, it would be necessary to investigate which other problem had objectively existed.

A further requirement when defining the technical problem to be solved is that this not contain pointers to the solution, or partially anticipate the solution, since this would inevitably lead to an *ex post facto* view being taken of inventive step (See T 229/85 (OJ EPO 1987, 237) Headnote and paragraph 5 of the reasons and "Case Law of the Boards of Appeal", 4th Edition 2001, Sections I.D, 4.1, 4.2 and 4.3.)

6.2 According to the application (page 2, lines 31 to 33), it is an object of the invention to provide a method of polymerization to obtain crosslinkable polymers by employing a ω -unsaturated macromonomer as a catalytic chain transfer agent. Such macromonomers are discussed in the immediately preceding paragraph of the

application in which the prior art, *inter alia*, D1 is presented.

This formulation of the problem however already includes elements of its solution, *viz.* use of the macromonomer as a chain transfer agent.

Employing such a formulation of the technical problem however means that when the state of the art (*inter alia* D1) is assessed in terms of that problem necessarily an - inadmissible - *ex post facto* analysis will be the result.

- 6.3 As a consequence, and in view of the case law discussed in paragraph 6.1, the technical problem as formulated in the application in suit cannot serve for assessment of inventive step, and it will be necessary as a first step to identify the valid technical problem to be solved by the application in the light of the relevant closest state of the art.

Since this invalid technical problem arises as a result of considering the prior art cited in the application it must be concluded that the prior art identified in the application is - in the sense of the above discussed case law - "inappropriate", *i.e.* not the relevant closest state of the art.

- 6.4 It is therefore necessary to establish what is the appropriate prior art for the assessment of inventive step.

One of the criteria attaching to identifying the "closest prior art" when applying the problem solution

approach is that this be a document disclosing subject matter conceived for the same purpose as the claimed invention. Ideally that purpose or objective should be something already mentioned in the prior art document as a goal worth achieving (T 298/93 - 19 December 1996 not published in the OJ EPO - reasons 2.2.2).

Once that closest state of the art is identified, it is necessary to "define the object of the invention on the basis of an objective analysis considering the difference or surplus of the results of the invention (effect) beyond such most relevant art" (T 31/84 OJ EPO 1986, 369 Reasons for the decision point 6).

- 6.5 According to the first paragraph of the description, the application in suit relates to the preparation of polymers for coatings. It is further stated ("Background of the invention") that it is necessary to control or limit the molecular weight. Such limitation is stated to be desirable or necessary in the preparation of polymer solutions for use in paints, requiring high solids to provide reduced vapour emission, but nevertheless low viscosity.

Accordingly it appears that the technical field to which the application belongs can be considered as that of polymer based coatings.

This is confirmed by further statements under "Background of the Invention" (page 1, lines 22 to 25) which discuss the desirability of employing limited molecular weight materials in paints and finishes and mention in particular the problem of reducing the solvent content of such products. The passage from

page 1, line 26 to page 2, line 19 of the application discusses various routes available to obtain radical polymers of limited molecular weight and the attendant disadvantages thereof. Page 3, lines 1 to 16, sets out that the invention "avoids problems associated with chain transfer agents previously used commercially, for example in the production of coatings and finishes".

The summary of the invention, starting at line 20 of page 3 states that the invention provides "an improved free radical polymerization of a plurality of monomer species some of which carry functional groups to provide a crosslinking site for the resulting copolymer".

Accordingly, the problem to be solved by the application may be formulated as being to provide an improved free radical process to provide crosslinkable polymers of controlled (limited) molecular weight useful in finishes and coatings.

This formulation of the technical problem corresponds essentially to that employed in the decision under Appeal at page 5, third full paragraph.

7. *The closest prior art*

Since of the two documents cited, only D2 relates to the same technical field and problem as the application, namely to the provision of controlled (limited) molecular weight polymers obtained by a free radical process useful in the field of surface coatings, this document is considered, in accordance

with the relevant case law discussed above in section 6, to represent the closest prior art.

8. *The objective problem to be solved in relation to the closest prior art D2, its solution*

The application states *inter alia* that the polymers obtained by the method claimed are, in comparison to those obtained by previously used chain transfer agents more durable (page 3, line 6), in particular less susceptible to degradation by ultraviolet light (page 3 lines 13 to 14). There is no evidence that these improvements with respect to polymers prepared employing any of the previously known chain transfer agents are in fact obtained, and no evidence that allows any comparisons to be made with the polymers obtained by the process disclosed in D2.

Accordingly, this aspect must be disregarded in the assessment of inventive step.

The objective problem to be solved by the application in relation to D2 can thus be formulated as to provide a further or alternative free radical method of providing polymers of controlled low molecular weight suitable for use in paints and coatings and further low molecular weight polymers containing reactive functional groups suitable for use in coatings.

The evidence provided by the application credibly demonstrates that this objective problem is solved by the process claimed according to claim 1, and the copolymer according to claim 7 of the operative claims.

9. *Obviousness of this solution*

It must now be decided whether the claimed solution to this problem, i.e. the subject matter of independent claims 1 and 7 is rendered obvious by the disclosures of D2 either alone, or in combination with other documents on file.

9.1 The closest prior art D2 does not contain any reference to the macromonomers or the comonomers defined in the present claims, but as noted in section 4.2 above proposes a different route to the polymers. Further it is noted that the polymers obtained by D2 will not exhibit the chain structure deriving from the macromonomer, or either of the terminal groups mandatorily to be exhibited according to the claims of the application in suit. Accordingly, taken in isolation, D2 does not provide any pointers to the method as defined in claim 1, or to the polymers resulting therefrom, defined in claim 7.

9.2 As to the question of what might arise from a combination of D1 and D2, there is nothing in D2 that points to or relates to the macromonomers of D1. Thus *a priori* there would be no reason for the skilled reader of D2 to consult D1.

Even if the skilled person with knowledge of D2 had consulted D1, the teaching of this document is, as noted above, somewhat cautious, suggesting that polymerisations employing the macromonomer would have only limited practical use. With regard to the preparation of polymers bearing functional groups, D1 discusses only terminal functionality, and does not

itself disclose how such functionality could be incorporated, but directs the reader (back) to D2 (D1 page 841, first partial paragraph) for a disclosure of how to attain such terminal functionality.

9.3 Accordingly, D2 does not render the subject matter claimed according either to claim 1 or claim 7 obvious.

9.4 Even if the skilled person were to start from D1 as the closest prior art, as proposed according to the application in suit, the overall conclusions would be no different. D1 is a research paper the focus of which is on the reaction mechanism involved in the free radical polymerisation of the macromonomer with other defined monomers. It does not discuss anything related to coatings or indeed any present any considerations of potential practical uses of the reactions studied or the polymers so obtained.

On the contrary, while D1 concludes that it is possible to obtain "useful incorporations" of the macromonomer in copolymers with a limited number of monomers, there is no teaching that this reaction allows products with any practical uses to be obtained. If anything, the conclusion of D1 is somewhat pessimistic, referring to the limitations in the use of the ω -unsaturated oligo (methyl methacrylate) as macromonomers for the synthesis of graft polymers and explicitly indicating the need for further research.

Accordingly, the skilled person seeking to solve the technical problem formulated above would have had no reason *a priori* to consult D1.

9.5 Even if D1 had been consulted, the rather negative conclusions thereof would not have provided the skilled person with the necessary guidance or suggestions to employ the macromonomer of D1 in order to provide an alternative process for obtaining low or limited molecular weight polymers bearing reactive groups, employing co-monomers having the functional groups as required by independent claims 1 and 7 of the application in suit.

9.6 Assuming that D1 was a document of which the relevant specialist in the coatings field would have knowledge, it is not immediately apparent from D1 that the phenomenon of chain transfer, which is reported as disadvantageous therein could be put to any practical use for the purpose of providing limited molecular weight polymers for use in coatings.

The realisation that this phenomenon could after all be put to a practical use, e.g. to provide an alternative to the process employed in D2 or other free radical routes to obtain polymers of controlled (low) molecular weight with a specific content of groups required, in the Board's view, an insight over and above that which may be expected of the skilled person. This is in particular the case since the comonomers defined according to claim 1 of the present application are not suggested or foreshadowed in D1, nor is there any suggestion in general terms to incorporate comonomers which would lead to introduction of crosslinkable functionality along the chain.

- 9.7 There is in any case no suggestion in D1 that a directed limitation of the molecular weight and consequently controlled distribution of functional groups along the polymer chain, as required by the claims of the application by means of the feature restricting the number average molecular weight per functional group to the range of 70 to 6000 would be possible by employing the macromonomers of D1.
- 9.8 Accordingly, it must be concluded that the subject matter claimed is not rendered obvious by the disclosure of D1 or D2, either alone or in combination.
10. Due to the considerations set out under section 9 above, the Board comes to the conclusion that the subject matter of claim 1 and *a fortiori* that of dependent claims 2 to 6, 9 to 12 is founded on an inventive step.

The same considerations apply to the subject matter of claim 7 (and *a fortiori* that of dependent claim 8), since this is directed to the copolymer product of the method of claim 1.

11. The Board notes that the Appellant has not as yet demonstrated that all of the examples of the application fall within the scope of the claims as amended during these proceedings. Hence during the adaptation of the description prior to grant of a patent, it will be necessary to delete all those examples not satisfactorily demonstrated to fall within the scope of claim 1.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the examining division with the order to grant a patent on the basis of claims 1 to 12 filed during the oral proceedings, and after any necessary consequential amendment of the description.

The Registrar:

The Chairman:

E. Görgmaier

R. Young