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**D E C I S I O N**  
**of 11 April 2005**

**Case Number:** T 0755/02 - 3.3.05

**Application Number:** 93902980.7

**Publication Number:** 0620804

**IPC:** C03C 3/062

**Language of the proceedings:** EN

**Title of invention:**

Fluoride ion-leachable glasses and dental cement compositions containing them

**Patentee:**

DEN-MAT CORPORATION

**Opponents:**

VOCO GmbH  
Schott AG

**Headword:**

Glass composition/DEN-MAT

**Relevant legal provisions:**

EPC Art. 54, 56

**Keyword:**

"Novelty: yes"  
"Inventive step: yes"

**Decisions cited:**

T 0332/87

**Catchword:**

-



Case Number: T 0755/02 - 3.3.05

**D E C I S I O N**  
of the Technical Board of Appeal 3.3.05  
of 11 April 2005

**Appellant:** DEN-MAT CORPORATION  
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**Representative:** -

**Decision under appeal:** Decision of the Opposition Division of the  
European Patent Office posted 8 May 2002  
revoking European patent No. 0620804 pursuant  
to Article 102(1) EPC.

**Composition of the Board:**

**Chairman:** M. M. Eberhard  
**Members:** B. P. Czech  
H. Preglau

## Summary of Facts and Submissions

I. The appeal is from the decision of the opposition division posted 8 May 2002 revoking the European patent No. 620 804.

II. Independent claims 1, 2 and 13 of the patent as granted read as follows:

"1. A glass composition consisting essentially of the following ingredients by molar percent:

SiO <sub>2</sub>	17.6 - 19.7
P <sub>2</sub> O <sub>5</sub>	0.8 - 3.5
Al <sub>2</sub> O <sub>3</sub>	9.0 - 11.0
Na <sub>2</sub> O	0.5 - 3.0
MO	17.9 - 19.7
F	42.2 - 56.1

wherein MO is selected from BaO, BaO-CaO, BaO-SrO, and BaO-CaO-SrO."

"2. A glass composition consisting essentially of the following ingredients by molar percent:

SiO <sub>2</sub>	20
P <sub>2</sub> O <sub>5</sub>	2
Al <sub>2</sub> O <sub>3</sub>	10
Na <sub>2</sub> O	2
MO	18
F	48

wherein MO is selected from BaO, BaO-CaO, BaO-SrO, and BaO-CaO-SrO."

"13. A dental cement composition comprising the glass composition of any of claim 1 to 12."

III. As grounds of opposition, the opponents had invoked lack of novelty and lack of inventive step.

IV. The references relied upon in the opposition proceedings include the following:

D1/OI: WO-A-88/05651

D2/OI: EP-A-0 225 706 (initially EP-B-0 225 706)

D4/OI: US-A-4 492 777

D6/OI: EP-B-0 383 873

D7/OI: J. Dent. Res. 58(3), March 1979, pages 1072 to 1079

D8/OI: J. Dent. Res. 65(2), February 1979, pages 146 to 148

D1/OII: JP-A-61-215234 (translation into English)

D2/OII: US-A-5 051 453

V. In the contested decision, referring to decision T 332/87 of 23 November 1990, the opposition division held that the subject-matter of claim 1 as granted lacked novelty over D2/OI and that the subject-matter of further restricted claims 1 and 2 filed as an

- auxiliary request lacked the required inventive step in view of the combined teachings of D1/OI and D2/OI.
- VI. With its statement of the grounds of appeal dated 18 September 2002, the appellant (proprietor of the patent) submitted a fresh set of amended claims as auxiliary request and comparative results intended to show the superior properties of the compositions according to the patent in suit as compared to the calcium fluoroaluminosilicate composition known as "G200". Referring also to D1/OII, it *inter alia* argued that D2/OI was not novelty-destroying for claim 1 as granted. Considering documents D1/OI, D2/OI, D1/OII, D4/OI, D6/OI it argued that the subject-matter of claim 1 as granted was also based on an inventive step.
- VII. In its reply of 11 April 2003, respondent 2 (opponent 2) maintained that the subject-matter of claims 1 and 2 as granted lacked novelty over D2/OI. Referring to D1/OI, D2/OI, D6/OI, D8/OI, D1/OII and D2/OII it also argued that claims 1 and 2 as granted were not based on an inventive step.
- VIII. In its reply of 23 June 2003, respondent 1 (opponent 1) also considered the subject-matter of the claims as granted to lack novelty over D2/OI. Referring also to D1/OI, D4/OI, D6/OI, D8/OI and D1/OII, it also argued that the subject-matter of the claims as granted was at least not based on an inventive step in view of D2/OI.
- IX. Oral proceedings took place on 11 April 2005 in the absence of the appellant, who had been duly summoned but who previously had indicated that it would not attend.

- X. The essential arguments of the parties can be summarised as follows:

The appellant argued in writing that D2/OI was not novelty-destroying for the subject-matter claimed in the patent in suit. It pointed out that D2/OI did not contain any specific example for the replacement of calcium by barium. Although calcium oxide was the preferred additional basic oxide besides alumina, the whole range of basic oxides, including  $\text{Na}_2\text{O}$ , was suggested as additional basic oxide(s). It argued *inter alia* that the finding of the present inventors therefore involved a selection. Concerning inventive step, the appellant emphasised the superior radiopacity and translucency of the glass composition according to the patent as compared to the known "G200" (calcium) glass. The merely theoretical suggestion in D2/OI did not encourage replacing calcium with barium in "G200", in particular since it does not disclose a single specific barium containing glass composition. Such a replacement was also not obvious in view of the other cited prior art. D1/OI taught mixing two types of glass powders for obtaining radiopacity. The authors of D1/OII considered it difficult to obtain a glass ionomer cement with X-ray contrast properties. Hence, without hindsight after reading the patent in suit, a skilled person would not consider that the said substitution could be achieved by only a few routine attempts and was worth trying.

At the oral proceedings, novelty of the claimed subject-matter was only objected to on the basis of D2/OI. Both respondents argued that claim 1 covered

glasses having the composition of the well known "G200" glass, but wherein the calcium oxide was partially or fully replaced by an equivalent, i.e. equimolar, amount of barium oxide. Such a glass, and a dental cement including it, were disclosed in D2/OI by virtue of the combined teachings of example 4, which related to the known "G200" composition, and the passage on page 4, lines 8 to 13, which taught such a replacement. Since there was no reason not to combine these teachings, they could be combined according to decision T 332/87, thereby constituting a clear disclosure of the subject-matter of claims 1 and 13 of the contested patent. At the oral proceedings, the respondents argued that in view of the total content of D2/OI, the expression "aluminosilicate glass" as used on page 4, line 6 in D2/OI was to be considered as a generic term also covering fluoroaluminosilicate glasses. Therefore, the expression "**other** aluminosilicate glasses" (emphasis added by the board) as used in the subsequent paragraph on page 4 of D2/OI which refers to fluorinated aluminosilicate glasses did not imply that this paragraph referred to other aluminosilicate glasses. This paragraph merely related to further such glasses to which the information contained in lines 8 to 13 equally applied.

Both respondents considered the glass composition according to example 4 of D2/OI to represent the closest prior art. At the oral proceedings, they relied on D2/OI taken alone, and on a combination of the teachings of D2/OI and D1/OI to support their objection of lack of inventive step. Document D1/OII was also discussed during the oral proceedings. According to both respondents, the glass composition described in

example 4 of D2/OI was the composition well known in the art as "G200" and referred to in D8/OI. In D8/OI it was indicated that this calcium fluoroaluminosilicate glass composition was of opal, and hence translucent, appearance and according to the patent in suit (page 2, lines 28 to 29) such glasses had acceptable fluoride release properties. In view of the express suggestion given in the description of D2/OI, the skilled person would consider it as obvious to follow this suggestion and to replace calcium contained in the composition of example 4 of this document by an equimolar amount of barium, thereby arriving at a composition falling under the terms of claim 1 without any inventive step being involved. Moreover, the skilled person could gather from D1/OI that barium containing glasses could be used as a component of dental cements in order to impart radiopacity to the latter. The skilled person, wanting to impart radiopacity to the already translucent and fluoride releasing fluoroaluminosilicate glass compositions of example 4 of D2/OI and of dental cements incorporating them, was thus further encouraged by D1/OI to carry out the said replacement of calcium by barium. D1/OII confirmed that barium could be incorporated into fluoroaluminosilicate glass compositions as a radiopacity imparting component. The respondents contested that the values reported in the examples of the patent in suit for the visual opacity and fluoride release of some composites incorporating glass compositions as claimed could establish the presence of an inventive step. Respondent 1 additionally argued that the translucency of a composite also depended to some extent on the particle size distribution of the glass and the difference in terms of refractive index between the matrix material



and the glass component used, none of which were described in sufficient detail in the patent in suit. Hence, the reported results did not permit the conclusion that the glass according to the patent in suit was more translucent than the known glass ("G200", example 4 of D2/OI). The mere equimolar replacement of calcium by barium leading, without modifications of the relative amounts of the other glass components, to an increase of the refractive index of the glass, the latter was more adapted to be used with the aromatic matrix resin referred to in the patent in suit. An improvement in terms of translucency had not been shown for the full scope of claim 14, e.g. for compositions based on matrix resins having lower refractive indices. Concerning fluoride release values reported in the patent, it argued that they were also depending on the type of the matrix material used in the composite. The slight differences reported were irrelevant in dental applications of the cements, and the issue of fluoride release had not been emphasised in the grounds of appeal. Moreover, the main problem to be solved by the claimed compositions being the lacking radiopacity of the known translucent and fluoride releasing compositions, possible minor improvements in terms of translucency and fluoride release had to be considered as bonus effects. Respondent 2 shared the view of respondent 1 concerning the issue of translucency, and additionally argued that an increase in fluoride release could have been expected considering the incorporation of cations with larger radii into the glass network and/or the presence of different earth alkaline ions. Both respondents were of the opinion that D1/OII discouraged the skilled person from merely adding barium to a known composition and hence

suggested a replacement of calcium by barium. A skilled person would carry out said replacement on a molar basis rather than on a weight basis since this was the more precise and sensible way of optimising properties by variation of comparable components (earth alkaline metals).

- XI. The appellant had requested in writing that the decision under appeal be set aside and that the patent be maintained as granted (main request) or, in the alternative, on the basis of the auxiliary request filed with letter dated 18 September 2002.

The respondents requested that the appeal be dismissed.

## **Reasons for the Decision**

### *Novelty*

1. *Document D2/OI*
- 1.1 D2/OI generally relates to hardenable ionomeric cement-forming compositions with improved setting characteristics, for use as e.g. dental cement. The compositions comprise (i) a poly(carboxylic acid) or precursor thereof, and (ii) a particulate ion-leachable silicate, aluminosilicate or metal oxide reactable with (i) in the presence of water to set to a hardened composition, and (iii) a compound comprising at least one phosphorus-carbon or phosphorus-boron covalent bond, in an amount effective to extend the working time of the composition. See claim 1 and page 1, lines 1 to 4

and 30 to 32; page 2, lines 1 to 9; and page 9, lines 9 to 15.

- 1.2 It is specifically indicated in D2/OI that the generic term "(fluoro)aluminosilicates" is used therein to cover both "fluoroaluminosilicate or aluminosilicate" (see page 3, lines 31 to 32). The particular term "(fluoro)aluminosilicate" is used several times in D2/OI, see e.g. page 6, line 3, page 7, lines 24 and 34, page 8, lines 17, 21 and 23 and page 9, line 27. According to the said explanation given on page 3, lines 31 to 32, the term "aluminosilicate" is thus more specific in meaning than the term "(fluoro)aluminosilicate". However, in the context of claim 1 of D2/OI, the term "aluminosilicate" is apparently supposed also to cover components (ii) comprising "(fluoro)aluminosilicate" glass powder, see claim 4 which is dependent on claim 1. Moreover, on page 5, line 1, reference is made to "aluminosilicate glasses suitable for use in the present invention" which may be prepared by fusing mixtures of the components, but on the subsequent lines 16 to 20 it is stated that fluorides may be added to the mixture as fluxing agent, desirably not in large amounts. In example 4, a fluoride containing glass is also designated as "aluminosilicate" (page 13, line 5) and not as "fluoroaluminosilicate". The board thus notes that the three quoted terms are used in D2/OI in an inconsistent or even contradictory manner. Consequently, the board cannot accept that the term "aluminosilicate" wherever used within the description of D2/OI must generally be considered as a generic designation also covering fluoroaluminosilicates.

1.3 In the paragraph (page 3, line 27 to page 4, line 5) of D2/OI generally referring to (fluoro)aluminosilicate glasses as preferred components (ii), it is also indicated that aluminium oxide is the principal basic oxide contained therein. The relative contents of silica and alumina of these glasses may vary to a large extent.

1.4 The following paragraph of the description (page 4, lines 6 to 17) contains more detailed indications concerning possible compositional variations of the "aluminosilicate" glass, which read as follows: "The aluminosilicate glass desirably contains at least one other basic oxide, preferably calcium oxide, which may be present in the glass composition in an amount from 0 to 50% w/w. The calcium oxide may be partly or wholly replaced by sodium oxide or other basic oxide such as strontium oxide or barium oxide or a mixture of basic oxides, although in some applications the presence of sodium oxide may be undesirable as this oxide tends to increase the solubility of the resulting cement. Preferred glasses for use in the present invention containing alumina, silica and calcium oxide are the gehlenite and anorthite glasses, and in general glasses falling within the composition range 10 to 65% w/w silica, 15 to 50% w/w alumina and 0 to 50% w/w calcium oxide."

However, this particular paragraph is silent about the presence of fluoride. Due to the previously mentioned (see point 1.2) inconsistent use of the term "aluminosilicate", it cannot be clearly and unambiguously gathered from this paragraph alone that

the information contained therein is also generally applicable to **fluoroaluminosilicate** glasses.

- 1.5 Moreover, the subsequent paragraph (page 4, lines 18 to 25) starts with the expression "**Other** aluminosilicate glasses suitable for use in the present invention may contain fluoride ..." (emphasis added by the board) and hence relates to some preferred **fluoroaluminosilicate** glasses. In this paragraph, the composition of a class of fluoroaluminosilicate glasses particularly suited to dental applications is given in terms of the relative weight ratios of silica, alumina and fluorine. In the board's view, the use of the term "other" at the beginning of the paragraph indicates to a skilled reader that the subsequent information is to be read in juxtaposition to, and not necessarily in combination, with the information presented in the preceding paragraph. It is noted that the sole basic oxide actually mentioned in this particular paragraph is alumina.

The skilled reader would thus not necessarily combine the possible fluoride content of the glasses also referred to as "fluoroaluminosilicate glasses" in this paragraph (page 4, lines 20 to 21) with the possibility of including mixtures of specific earth alkaline oxides addressed in the previous paragraph in connection with the "aluminosilicate glass". The two paragraphs in question could also be understood to concern various alternative embodiments of useful aluminosilicate glasses on the one hand and of useful fluoroaluminosilicate glasses on the other hand.

- 1.6 The board acknowledges that some of the specific ion-leachable components (ii) disclosed as suitable materials in D2/OI are fluoroaluminosilicate glasses containing both fluoride and basic oxides in addition to aluminium oxide. For instance, the "aluminosilicate" glass disclosed in example 4 contains fluoride, calcium oxide and sodium oxide. Claim 5 and the last paragraph on page 4 of D2/OI recite five particularly preferred (fluoro)aluminosilicate glass compositions. However, only four of them contain fluorine and calcium, and only one of these four additionally contains sodium. None of the specific glasses disclosed in D2/OI contains barium or strontium oxide.
- 1.7 Considering the inconsistent terminology of D2/OI, the use of the terms "other aluminosilicate glasses" on page 4, line 18, and the absence of specifically disclosed glass compositions comprising barium or strontium, let alone in combination with sodium, the board thus holds that the disclosure of the specific fluoroaluminosilicate glasses mentioned under point 1.6 does not imply that the two adjacent paragraphs on page 4, lines 6 to 25 clearly and unambiguously disclose the partial or total replacement of calcium oxide by barium oxide in fluoroaluminosilicate glasses in which part of the calcium oxide has already been replaced by sodium oxide.
- 1.8 Under certain circumstances, novelty may be attacked on the basis of a combination of the teaching of an example with the teaching of some other part of the description of a same reference (see e.g. decision T 332/87, Reasons 2.2). In their attempts to establish a lack of novelty, the respondents combined page 4 of

D2/OI with the teaching of example 4 of the same document. However, as already set out above, it cannot be clearly and unambiguously derived from D2/OI that the information concerning the optional partial or full replacement of the preferred calcium oxide content by sodium or other basic oxides such as strontium or barium oxide mentioned on page 4, lines 6 to 13 is necessarily generally applicable to all the **fluoroaluminosilicate** glasses referred to in the subsequent paragraph, let alone to the very specific fluoroaluminosilicate glass of example 4. Hence, a skilled reader not knowing the patent in suit would not necessarily combine example 4 with the information presented on page 4 of the description. Even assuming for the sake of argument that the skilled reader would indeed understand the passage on page 4 relating to the replacement of calcium by other basic oxides as applying to all fluoroaluminosilicate glasses, he would read example 4 as what it is, namely as disclosure of an example of a composition wherein the preferred basic oxide, i.e. calcium oxide, has already been partially replaced by a further basic oxide, namely sodium oxide. Moreover, D2/OI does not expressly indicate whether the replacement of calcium oxide is to be made on a molar or on a weight basis. Therefore, the skilled reader of D2/OI, not knowing the patent in suit, is not presented with clear and unambiguous information concerning a glass having a composition as indicated in example 4, but wherein calcium oxide would be partially or fully substituted by an equimolar amount of barium oxide, whilst leaving its sodium content unchanged.

- 1.9 Summarising, the board cannot accept that D2/OI contains a clear and unambiguous disclosure of an ion-leachable fluoroaluminosilicate glass containing a combination of additional basic oxides (besides alumina) selected from Na<sub>2</sub>O/BaO, Na<sub>2</sub>O/BaO/CaO, Na<sub>2</sub>O/BaO/SrO or Na<sub>2</sub>O/BaO/CaO/SrO, let alone in the molar composition prescribed by claims 1 and 2 of the patent in suit.
- 1.10 The claimed subject-matter is also novel with respect to the disclosure of the other cited documents. Since this was not disputed by the respondents, a detailed reasoning needs not to be given.

*Inventive step*

2. *Closest prior art*

- 2.1 It emanates from D7/OI and D8/OI that glass-ionomer cements containing a glass called "G200" were well known in the art for some years before the priority date of the patent in suit. The "G200" glass is prepared using six different starting materials (SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, Na<sub>3</sub>AlF<sub>6</sub>, AlPO<sub>4</sub>, CaF<sub>2</sub> and AlF<sub>3</sub>) in specific amounts given in parts by weight (175, 100, 30, 60, 207 and 32, respectively), see e.g. D7/OI, page 1072, right-hand column, section "Materials and methods", second sentence; D8/OI, page 146, right-hand, column, lines 12 to 16 of the section "Materials and methods", page 147, 7<sup>th</sup> row of Table 1 and corresponding footnote. In the quoted part of D8/OI, it is additionally indicated that "G200" has an "opal glass" appearance.



2.2 In example 4 of D2/OI, a specific glass is described by indications concerning the nature and the relative amounts in weight-% of the same six components used in its preparation. The composition given in weight-% in example 4 is the same as the one indicated in D7/OI and D8/OI in parts per weight, see e.g. the conversion of the latter into weight-% as reported in the letter of 18 September 2001 of respondent 1, page 2, "Tab.1", columns 1 to 4. Example 4 is thus referring to the glass known in the art as "G200". This was acknowledged in the contested decision and not contested by the appellant.

2.3 According to calculations based on the said indications filed by respondent 1 during the opposition proceedings (see letter of 18 September 2001, table on page 3), the composition of the glass disclosed in example 4 of D2/OI, expressed in **mole** percent, can be computed to be:

SiO <sub>2</sub>	19.7
Al <sub>2</sub> O <sub>3</sub>	10.0
Na <sub>2</sub> O	1.5
P <sub>2</sub> O <sub>5</sub>	1.7
CaO	17.9
F	49.3

These calculations are plausible and have never been contested by the appellant. A comparison of the above table with the one of claim 1 shows that the composition of the glass according to example 4 of D2/OI is very similar. In particular, although the above composition contains CaO and not BaO, BaO-CaO or BaO-CaO-SrO as earth alkaline metal oxide component,

the above numerical values fall within the numerical ranges indicated in claim 1 of the patent in suit.

- 2.4 It is questionable whether D2/OI represents the closest prior art since, unlike D1/OII, it does not deal with the issues of radiopacity and translucency. However, considering the similarity of glass composition according to example 4 of D2/OI and of the claimed glass compositions, and the fact that the glass ionomer cement compositions of D2/OI may be used as dental cements (see page 9, second paragraph) the board can accept the approach of both respondents that example 4 of D2/OI represents the closest prior art.

3. *Technical problem*

- 3.1 In the contested patent (see page 2, lines 25 to 29), it is stated that known calcium aluminofluorosilicate glass used in ionomer cements is acceptable in fluoride release, but not desirable in dental use because of its visual opacity and limited radiopacity. It is moreover expressly and generally stated (see page 4, lines 4 to 15) that due to the presence of BaO or BaO/SrO, the glass compositions of the invention have a "high level of radiopacity" and an "increased translucency". In the quoted passage, the glass compositions are also stated to impart translucency to dental compositions containing them, in particular when the latter is methacrylate resin based. Moreover, the ease of fluoride release is presented as a critical feature of the invention. Dental compositions based on glasses that contain strontium or barium are stated to release fluoride at a greater rate than compositions based on calcium glass. From this passage, it can thus be

gathered that the claimed barium-containing glass compositions lead to high radiopacities and translucencies and high fluoride releases of the cements composites including them.

3.2 In accordance therewith, the experimental results reported in the patent in suit (page 7, lines 6 to 29) show that composites of glasses according to the teaching of the patent and of an aromatic methacrylate resin matrix perform better than composites of the comparative calcium fluoroaluminosilicate "base glass" referred to as "PREPARATION 1" and of the same matrix material in three aspects. More particularly, the former show a higher radiopacity, a significantly higher fluoride release rate and a lower visual opacity (i.e. a higher translucency).

3.2.1 In this connection, the board notes that the glass according to "PREPARATION 1" is prepared like the glass of example 1 except for the equimolar replacement of barium fluoride by calcium fluoride. According to the calculations presented by respondent 1 in its letter of 18 September 2001, the relative amounts of the starting materials and hence the composition of the "PREPARATION 1" glass is also the same as the one of the "G200" glass, and thus as the glass of example 4 of D2/OI (see the table on page 4 of the said letter and the explanations thereunder).

3.2.2 It is plausible and it was not disputed that the barium-containing glasses according to the invention, and the dental cements comprising them have a radiopacity increased in comparison to "G200" glass and dental cements incorporating it.

3.2.3 The respondents however argued that the comparative "PREPARATION 1" (i.e. "G200") glass was already fluoride releasing and of opal and hence translucent appearance, and that an increase in translucency and/or fluoride release of the glass itself had not been convincingly shown. They pointed out that the comparative examples only show improvements of the properties of composites, and only in connection with a particular kind of matrix material. However, the respondents did not give any reasons why these improvements obtained with the claimed glasses when used in a dental composition should not be taken into consideration when examining whether the claimed glasses themselves are inventive.

3.2.4 The board accepts that the translucency of composites also depends to a certain degree on further parameters (glass particle size distribution, relative refractive indices of matrix material and glass, see e.g. D1/OII, page 4, lines 6 to 8) not specified in the patent, and that therefore it cannot be derived from the relative translucency ranking alone that the higher composite translucencies measured were attributable to a higher translucency of the glass component itself. However, the translucency of a composite also depends on the translucency of the glass component (see e.g. the appellant's letter of 22 November 1999, page 31, 2nd paragraph). This means that it can be gathered from the examples that the glass itself is indeed translucent and that at least in conjunction with a methacrylate matrix material a better composite translucency can be achieved than for the glass of "PREPARATION 1". Moreover, although the burden of proof rested on their

side, the respondents have not submitted evidence supporting their allegation that improved cements would not be obtained with other known polymerisable matrix materials used in dental cements due e.g. to the difference of the refractive indices of the glass and the polymerised matrix material.

3.2.5 Considering that the matrix material used was the same in all the examples, and in the absence of any evidence to the contrary, the board takes the view that the higher fluoride release of the composites according to the invention must be due at least to a certain extent to the different compositions of the glass component, in accordance with what is stated in the general description (page 4, lines 13 to 15). The reported increase of at least about 17% (see the table on page 7) of the critical feature fluoride release cannot be considered merely as a "minor improvement".

3.2.6 The respondents have not contested the values as such of the comparative examples reported in the patent in suit. Hence, the board concludes from these examples that the claimed glasses indeed lead to dental cements improved in terms of radiopacity, translucency and fluoride release, at least when used in conjunction with the particular methacrylate resin material referred to in these examples.

3.3 In view of the above, starting from the glass compositions of example 4 of D2/OI as closest prior art, the technical problem to be solved can thus be seen in the provision of fluoroaluminosilicate glass compositions of improved radiopacity which are suitable for use in dental cements and which impart improved

radiopacity, translucency and fluoride release to dental cements containing them, in particular when used in polymerisable methacrylate matrix materials.

- 3.4 In view of the stated properties (see also page 2, lines 55 to 56 and lines 27 to 29 of the contested patent) and the comparative results reported in the patent, and in the absence of any evidence to the contrary, the board accepts that this problem is solved by the provision of glass compositions according to claims 1 and 2.
- 3.5 Hence, it remains to be seen whether starting from the said closest prior art, and considering the prior art relied upon by the respondents, the provision of the claimed compositions was an obvious solution of the stated technical problem.
4. D2/OI is concerned with the improvement of the setting characteristics of ionomeric cement-forming hardenable compositions by certain phosphorus-containing additives.
- 4.1 The issues of radiopacity, translucency and fluoride release are not addressed at all, let alone in connection with the use of barium or strontium oxide as additional basic oxide components of a fluoroalumino-silicate glass component. D2/OI contains no indications concerning the potential benefits of totally or partially replacing calcium oxide by other basic oxides such as sodium oxide and barium and/or strontium oxide. It does not specifically point out which combination of basic oxides could be used as a replacing "mixture of basic oxides". None of the specific compositions disclosed in D2/OI actually contains barium or

strontium oxide. Moreover, D2/OI gives no guidance concerning the relative amounts in which sodium oxide on the one hand and earth alkaline metal oxides on the other hand should be combined. It merely states that the presence of sodium oxide may be undesirable in some (unspecified) applications as it tends to increase the solubility of the resulting cement (page 4, lines 11 to 13).

Taken alone, D2/OI can thus not suggest the full or partial replacement of calcium oxide by an equimolar amount of barium oxide or of barium and strontium oxides in the specific composition of its example 4 to solve the stated technical problem.

4.2 According to one line of argument of the respondents, the skilled person, starting from example 4 and trying to provide further glasses of the type according to D2/OI would "simply follow the suggestion" given on page 4, lines 8 to 11, and thus replace all the calcium oxide of example 4 by an equimolar amount of barium oxide, thereby naturally arriving at the claimed improved glass without any inventive step being involved. This argument cannot be accepted for the following reasons:

4.2.1 Example 4 discloses a glass composition which contains calcium oxide and sodium oxide, and which can therefore be considered as a specific composition wherein the calcium oxide has already been partially "replaced" by sodium oxide in the sense of the passage on page 4, lines 8 to 11. It is thus questionable whether a skilled person would consider a further replacement of calcium at all in the specific embodiment of example 4,

let alone by "simply following" a "suggestion" which is not clearly and unambiguously intended to apply generally to the fluoroaluminosilicate glasses mentioned elsewhere in D2/OI, let alone to a fluoroaluminosilicate glass wherein calcium oxide has already been partially replaced by sodium oxide (see points 1.4 to 1.9 above).

4.2.2 Moreover, the passage on page 4, lines 6 to 17 does not specifically address a replacement of calcium oxide by a "mixture" of sodium and barium oxides (or a mixture of sodium, barium and strontium oxides). Although the board can accept that in principle, when studying the impact of variations of the basic oxides present in a glass composition on its properties, it might be sensible to vary the composition on a molar basis, D2/OI does not particularly favour this measure.

4.2.3 Hence, even assuming for the sake of argument that the skilled person would consider applying the said "suggestion" to fluoroaluminosilicate glass compositions disclosed elsewhere in the document, it would not, without any suggestion in D2/OI that this particular replacement might solve the technical problem stated under point 3.3 above, consider modifying the specific composition of example 4 by replacing calcium oxide by barium oxide (or barium oxide and strontium oxide) in equimolar amounts and without modifying the molar sodium oxide content. Taking the latter measures cannot be considered as "simply following" the said "suggestion".



4.3 D1/OI relates to compositions for use as a dental cement or liner containing an ion-leachable calcium-containing high fluoride fluoroaluminosilicate glass and a resinous binder. The composition should also meet the criterion of translucency. Continuous fluoride release of such ionomer cements is also mentioned. See page 1, the last sentence of the first paragraph, the last paragraph, and page 2, lines 1 to 2 and the section "The Invention".

4.3.1 In order for the dentist to be able to detect imperfections in restorations on radiographs, the authors of D1/OI suggest the use of cements containing a further component labelled "agent" or "filler" which confers radiopacity, such as barium glass or barium sulphate, see page 1, the last two paragraphs, and page 2, lines 1 to 4 of the section "The Invention". It is however apparent from the description of D1/OI that the barium glass or "other suitable radiopaquer agent" is contained in the cement composition as an **additional** component **distinct** from the calcium fluoroaluminosilicate glass component, see page 2, 2nd paragraph ("both glasses") and page 3, line 5 ("mixture of powders").

4.3.2 The skilled person could thus gather from D1/OI that barium (containing) glass was radiopaque and that the additional incorporation of such a glass or of a barium compound may lead to the desired radiopacity of the cement. However, no other way for obtaining radiopaque cements than adding a distinct barium-containing component to the fluoroaluminosilicate glass component is mentioned or suggested in D1/OI. Aware of the possible radiopacifying effect of a barium-containing

material, and despite the necessity of having to mix one more components into the composition, the authors of D1/OI nevertheless did not even envisage the possibility of incorporating barium into the composition of the calcium fluoroaluminosilicate glass itself, let alone as an equimolar replacement for the calcium contained therein.

4.3.3 Moreover, it cannot be derived from D1/OI that a fluoroaluminosilicate glass obtained by replacing the calcium content of such a known glass (for example "G200", example 4 of D2/OI) fully or partially by equimolar amounts of barium or by barium and strontium, would not only be radiopaque but would also still result in useful dental compositions meeting all the criteria considered important in D1/OI (see page 1, last paragraph and page 2, first paragraph) and solving the stated technical problem.

4.3.4 In this connection, the respondents have emphasised that since the glass composition of example 4 of D2/OI was the same as the one described as "G200" in D8/OI, i.e. of "opal glass" appearance, it was thus already translucent in the sense of the contested patent. They argued that the skilled person, trying to incorporate barium into the glass of example 4 of D2/OI to render it radiopaque, would expect that the glass obtained would still be translucent but have a higher optical density and refractive index. By virtue of this higher refractive index, such a glass would be more suited for obtaining translucency within the particular matrix resins as used in the examples of the patent. No evidence was presented for supporting the allegation that such a modified glass could be expected to be as

translucent as the known "G200" glass when used in the said matrix resin. However, considering the particular microstructure of the "G200" opal glass (see e.g. the abstract of D7/OI), and considering further the impact of the specific composition of calcium fluoroaluminosilicate glasses on their translucency (see e.g. D8/OI, page 146, right-hand column, section "Glasses" and the table on page 147, column "Appearance"), the board cannot accept this argument in the absence of such evidence.

4.3.5 At the oral proceedings, the respondents also argued that the skilled person would have assumed that, due to the looser glass structure that would result from the replacement of calcium ions by larger earth alkaline ions, and/or from the incorporation of different earth alkaline ions, a somewhat higher fluoride release of the glass could be expected. However, this argument cannot be accepted since the said assumption is not supported by any kind of evidence showing a significant relationship between earth alkaline ion size, network tightness and fluoride release.

4.3.6 From the above, the board concludes that although the skilled person confronted with the stated technical problem could know from D1/OI that a barium containing glass was radiopacifying, it could not gather from D1/OI without *ex post facto* considerations a suggestion to modify the known calcium-containing fluoroaluminosilicate glasses for dental compositions, including the one disclosed in example 4 of D2/OI, in a manner leading to the claimed subject-matter.

5. Document D1/OII was also discussed at the oral proceedings. It discloses glass compositions to be used in powder form together with polycarboxylic acid matrix materials in glass ionomer cements, which are useful as dental cements.

5.1 More particularly, the glasses disclosed are powders of fluoroaluminosilicate glasses comprising **at least** the following components (in ion weight percentages, see the table on page 2 of the translation):

Si <sup>4+</sup>	2 - 25
Al <sup>3+</sup>	6 - 18
one or more of Mg <sup>2+</sup> , Ca <sup>2+</sup> , Sr <sup>2+</sup> and Ba <sup>2+</sup>	9 - 35
a total of Sr <sup>2+</sup> , Ba <sup>2+</sup> , Zn <sup>2+</sup> , Y <sup>3+</sup> , La <sup>3+</sup> , Gd <sup>3+</sup> , Yb <sup>3+</sup> , Zr <sup>4+</sup> , Nb <sup>5+</sup> , Ta <sup>5+</sup> , and W <sup>6+</sup>	10 - 35
F <sup>-</sup>	10 - 40
O <sup>2-</sup>	balance

The alkaline earth metal ions Mg<sup>2+</sup>, Ca<sup>2+</sup>, Sr<sup>2+</sup> and Ba<sup>2+</sup> are stated to be indispensable for the initial hardening of the cement, see page 5, 2<sup>nd</sup> paragraph of the translation. On the other hand, at least one ion selected from a list including Sr<sup>2+</sup>, Ba<sup>2+</sup> and nine other polyvalent cations must be included in the composition in an amount from 10% to 35% to confer the hardened cement with X-ray contrast properties, see the claim and page 5, 6<sup>th</sup> paragraph of the translation. One or both of B<sup>3+</sup> and P<sup>5+</sup> and one or more of Li<sup>+</sup>, Na<sup>+</sup>, K<sup>+</sup> and Cs<sup>+</sup> may also be included in the composition, see the claim and page 5, the 3<sup>rd</sup> and 4<sup>th</sup> paragraphs of the translation. The glass ionomer cements comprising these glasses have X-ray contrast properties and their

appearance matches that of dentin, see page 14, last paragraph, of the translation.

- 5.2 Starting from known glass ionomer cements comprising calcium fluoroaluminosilicate glass and a polycarboxylic acid matrix and having properties required in dental applications, including a semi-transparent appearance, the authors of D1/OII attempted to improve the X-ray contrast properties of these cements, see page 2, last paragraph to page 4, 1st paragraph. More particularly, they refer to unsuccessful attempts consisting in adding compounds such as barium or strontium compounds or zirconium and lanthanum oxides for imparting X-ray contrast to the cement. The results were not satisfactory for several reasons, *inter alia* because the required transparency was lost, see page 3, 2<sup>nd</sup> paragraph from the bottom. Another unsuccessful attempt, consisting in adding components with X-ray contrast properties to the components of a starting material glass, is referred to on page 4, lines 1 to 10. This attempt led to several problems such as an inadequate strength of the hardened cement and a refractive index of the glass which was too high and not matching that of carboxylic acids or dentin. Again, as a result, the appearance of the hardened cement was not semi-transparent.
- 5.3 It is noted that none of the examples of D1/OII actually discloses a glass containing all of the components recited in claim 1 of the patent in suit. The glasses of examples 1 to 4 and 6 to 10 neither contain Na<sub>2</sub>O (or any other alkaline metal ion) nor P<sup>5+</sup>, and only the glasses of examples 3 and 4 contain barium, see the tables on pages 10 to 12. Moreover, only one

(example 4) out of the ten examples does not contain substantial amounts of further components (e.g. of B, La or Zn) besides the ones recited in claims 1 and 2 of the patent in suit. However, the composition according to this example not only lacks sodium oxide but also contains more  $\text{Si}^{(4+)}$  and less  $\text{F}^{(-)}$  than the compositions according to the patent in suit (compare the values in weight-% given in table 1B, column 4, of the translation of D1/OII with the values indicated by the appellant in its telefax of 18 September 2001, page 6, table III, column 5 concerning  $\text{MO}=\text{BaO}-\text{CaO}-\text{SrO}$ ).

- 5.4 D1/OII thus discloses that it is possible although difficult to obtain fluoroaluminosilicate glasses containing barium and/or strontium as radiopacifying components of their composition, and which lead to a sufficient radiopacity when incorporated into a dental glass ionomer cement with polycarboxylic acid matrix. However, D1/OII merely aims at retaining, and not at improving, "the characteristics of the conventional glass ionomer cements" whilst improving the radiopacity thereof (see page 4, lines 10 to 13). It is entirely silent about the issue of fluorine release. Moreover, most of the glass compositions disclosed in the ten practical examples of D1/OII do not contain barium, and the two glasses containing barium (see examples 3 and 4) differ substantially in terms of their composition from the glass of example 4 of D2/OI. In particular, the said two glasses contain neither sodium oxide nor phosphorus oxide. Hence, the teaching of document D1/OII cannot suggest either, without the application of *ex post facto* considerations, partly or fully replacing calcium oxide by an equimolar amount of barium oxide or of barium oxide and strontium oxide in

the glass of example 4 of D2/OI while maintaining the rest of the composition unchanged to thereby solve the stated technical problem.

- 5.5 The board is thus not convinced that the glass composition of claims 1 and 2 was obvious in view of a combination of D2/OI with D1/OI and/or D1/OII.
  
6. The remaining documents which were no longer relied upon at the oral proceedings contain no additional information which, in combination with the preceding documents, would point towards the claimed glass compositions.
  
7. The subject-matter of independent claims 1 and 2 and, consequently, of independent claim 13 directed to a dental cement comprising the novel and inventive glass composition according to claim 1 or 2, and of dependent claims 2 to 12 and 14 to 18 is thus novel and inventive.

**Order**

**For these reasons it is decided that:**

1. The decision under appeal is set aside.
2. The patent is maintained as granted.

The Registrar:

The Chairman:

A. Wallrodt

M. Eberhard