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**Datasheet for the decision
of 16 May 2013**

Case Number: T 0409/11 - 3.3.09

Application Number: 01917780.7

Publication Number: 1288272

IPC: C08J 9/16, C08J 9/20,
B01J 13/14, C08 F2/18

Language of the proceedings: EN

Title of invention:

Heat-expandable microsphere and production process thereof

Patent Proprietor:

Kureha Corporation

Opponent:

Eka Chemicals AB

Headword:

-

Relevant legal provisions:

EPC Art. 54, 56, 83, 84, 100(a), 100(b), 123(2), 123(3)

Keyword:

"Main request (inventive step: no)"

"First and second auxiliary requests (inventive step: no)"

"Third auxiliary request (allowable)"

Decisions cited:

T 0999/10

Catchword:

-



Case Number: T 0409/11 - 3.3.09

D E C I S I O N
of the Technical Board of Appeal 3.3.09
of 16 May 2013

Appellant: Kureha Corporation
(Patent Proprietor) 3-3-2, Nihonbashi-Hamacho, Chuo-ku
Tokyo 103-8552 (JP)

Representative: HOFFMANN EITLE
Patent- und Rechtsanwälte
Arabellastrasse 4
D-81925 München (DE)

Respondent: Eka Chemicals AB
(Opponent) SE-445 80 Bohus (SE)

Representative: Schalkwijk, Pieter Cornelis
Akzo Nobel N.V.
Legal & IP
P.O. Box 9300
NL-6800 SB Arnhem (NL)

Decision under appeal: Decision of the Opposition Division of the
European Patent Office posted 2 December 2010
revoking European patent No. 1288272 pursuant
to Article 101(3) (b) EPC.

Composition of the Board:

Chairman: W. Sieber
Members: N. Perakis
K. Garnett

Summary of Facts and Submissions

I. Mention of the grant of European patent No. 1 288 272 in the name of Kureha Corporation was published on 5 July 2006 (Bulletin 2006/27). The patent was granted with 24 claims, independent claim 1 reading as follows:

"1. A thermally foamable microsphere having a structure in which a foaming agent is encapsulated in a shell formed of a polymer, wherein:

- (1) the shell formed of a polymer is formed of a polymer that is obtained by polymerization of a polymerizable monomer and a crosslinkable monomer used at a proportion of greater than 1% by weight up to 5% by weight based on the polymerizable monomer, and
- (2) a maximum expansion ratio of the thermally foamable microsphere is at least 5".

II. An opposition was filed by Eka Chemicals AB, requesting revocation of the patent in its entirety on the grounds that the claimed subject-matter was neither novel nor inventive (Article 100(a) EPC). After the nine month time limit set by Article 99(1) EPC the opponent raised a new ground for opposition, namely that the patent did not disclose the invention in a manner sufficient clear and complete for it to be carried out by a skilled person in the art (Article 100(b) EPC).

III. With the notice of opposition the opponent filed *inter alia* the following documents:

- D1: English Translation of JP-A-2000 024488;
- D2: EP-A2-0 566 367;

D3: EP-A1-1 059 339

(although published after the priority date of the patent in suit, the document was considered as a translation of pre-published WO-A-9943758); and

D4: EP-A2-0 484 893.

The following documents were filed later in the opposition proceedings:

D8: Declaration of Mr Ejiri Tetsuo dated 17 February 2006 filed by the patent proprietor in their US patent application Serial No, 10/258,790 relating to the same invention as the opposed patent;

D9: Textbook of Polymer Science, F.W Billmeyer, Jr, 3rd edition, 1984, pages 138, 151 and 348;

D10: A statement including technical evidence filed by the applicant of D2 during prosecution thereof before the EPO;

D11: Technical evidence (Figures I-VII in colour); and

D11': Figures I, II, V, VI of D11 in black and white.

IV. The patent proprietor filed the following documents:

D10a: Product data sheet concerning dicyclopentenyl acrylate; and

D12: Affidavit of Mr Ejiri Tetsuo dated 2 November 2007 including three figures;

V. By a decision announced orally on 25 October 2010 and issued in writing on 2 December 2010 the opposition division revoked the patent. This decision concerned the main request and auxiliary requests 1 to 3 of the patent proprietor. The opposition division admitted the late-filed ground for opposition under Article 100(b)

EPC and all the late-filed documents, namely D8, D9, D10, D10a, D11, D11' and D12 into the proceedings.

The patent was revoked because the main request was held to be not novel over D10 and auxiliary requests 1 to 3 were held to be not inventive over D2. However, for the present decision only auxiliary request 3 is relevant, claim 1 of which reads as follows:

"1. A thermally foamable microsphere having a structure in which a foaming agent is encapsulated in a shell formed of a polymer, wherein:

(1) the shell is formed of :

(a) a vinylidene chloride (co)polymer obtained by polymerization of vinylidene chloride alone or a mixture of vinylidene chloride with a vinyl monomer copolymerizable therewith as a polymerizable monomer, and a bifunctional crosslinkable monomer, or

(b) a (meth)acrylonitrile co(polymer) obtained by polymerization of (meth)acrylonitrile alone or a mixture of (meth)acrylonitrile with a vinyl monomer copolymerizable therewith as a polymerizable monomer, and a bifunctional crosslinkable monomer,

wherein the bifunctional crosslinkable monomer is a compound having a structure in which two polymerizable carbon-carbon double bonds are linked together via a flexible chain derived from a diol compound selected from the group consisting of polyethylene glycol, polypropylene glycol, an alkyldiol, an alkyl ether diol and an alkyl ester diol, and the bifunctional

crosslinkable monomer is used at a proportion of 1.1 to 5% by weight based on the polymerizable monomer, and

(2) a maximum expansion ratio of the thermally foamable microsphere is at least 5."

The opposition division decided that the subject-matter of claim 1 of the auxiliary request 3 lacked an inventive step since it was the result of an arbitrary selection from two lists in D2 for the shell forming polymer and the bifunctional crosslinkable monomers. No technical effect had been demonstrated for this selection.

- VI. On 8 February 2011 the patent proprietor (hereinafter: the appellant) filed an appeal against the decision of the opposition division and paid the appeal fee on the same day. The statement setting out the grounds of appeal was filed on 12 April 2012 including a new main request and five auxiliary requests. It also stated the intention of the filing of further experimental data at a later stage during the appeal proceedings, since its experimental work had been abruptly interrupted due to an earthquake and the subsequent damaging events at its research facilities.
- VII. With a letter dated 18 August 2011, the opponent (hereinafter: the respondent) raised objections against the patentability of all requests.
- VIII. With a letter dated 12 March 2013, the appellant submitted a new main request and five auxiliary requests which, if admitted into the proceedings, were to replace the previous requests on file. In support of

its arguments regarding the patentability of these requests the appellant filed the following additional documents:

D13: Product catalogue FANCRYL of Hitachi Chemical Co Ltd. (July 2011);

D14: US-A-5 753 156; and

D15: An experimental report (Annex 2 of letter dated 12 March 2013).

For the present decision only the main request and auxiliary requests 1 to 3 are relevant.

Claim 1 the **main request** reads as follows:

"1. A thermally foamable microsphere having a maximum expansion ratio of at least 5 and having a structure in which a foaming agent is encapsulated in a shell formed of

(i) (a) a vinylidene chloride (co)polymer obtained by polymerization of vinylidene chloride alone or a mixture of vinylidene chloride with a vinyl monomer copolymerizable therewith as a polymerizable monomer; or

(b) a (meth)acrylonitrile (co)polymer obtained by polymerization of (meth)acrylonitrile alone or a mixture of (meth)acrylonitrile with a vinyl monomer copolymerizable therewith as a polymerizable monomer; and

(ii) a crosslinkable monomer;

wherein the requirements (1) and (2) are fulfilled:

- (1) the proportion of crosslinkable monomer, based on the polymerizable monomer is 1.1-5 wt.-%; and
- (2) the crosslinkable monomer is a bifunctional compound having a structure in which two polymerizable carbon-carbon double bonds are linked together via a flexible chain derived from a diol compound selected from polyethylene glycol, polypropylene glycol, an alkyldiol, an alkyl ether diol and an alkyl ester diol."

Claim 1 of the **auxiliary request 1** derives from claim 1 of the main request with the following underlined limitation in requirement (2):

"(2) the crosslinkable monomer is a bifunctional compound having a structure in which two polymerizable carbon-carbon double bonds, selected from vinyl, methacryl, acryl and allyl, are linked together via a flexible chain derived from a diol compound selected from polyethylene glycol, polypropylene glycol, an alkyldiol, an alkyl ether diol and an alkyl ester diol".

Claim 1 of the **auxiliary request 2** derives from claim 1 of the main request with the following underlined limitation in requirement (2):

"(2) the crosslinkable monomer is at least one bifunctional compound selected from polyethylene glycol di(meth)acrylate, polypropylene glycol di(meth)acrylate, an alkyldiol di(meth)acrylate, an alkyl ether diol di(meth)acrylate and an alkyl ester diol di(meth)acrylate".

Claim 1 of the **auxiliary request 3** derives from claim 1 of the main request with the following underlined limitation in requirement (2):

"(2) the crosslinkable monomer is at least one bifunctional compound selected from polyethylene glycol di(meth)acrylate and an alkyldiol di(meth)acrylate".

IX. With a letter dated 7 March 2013 the respondent withdrew its request for oral proceedings and indicated that it would not attend the arranged oral proceedings. The request for revocation of the patent based on the grounds set out in the written submissions was maintained.

X. Oral proceedings before the board were held on 16 May 2013. In accordance with its letter of 7 March 2013, the respondent did not attend. During these oral proceedings the appellant submitted a **new auxiliary request 3** replacing auxiliary request 3 on file. Claim 1 of this request reads as follows:

"1. A thermally foamable microsphere having a maximum expansion ratio of at least 5 and having a structure in which a foaming agent is encapsulated in a shell formed of

(a) a vinylidene chloride (co)polymer obtained by polymerization of vinylidene chloride alone or a mixture of vinylidene chloride with a vinyl monomer copolymerizable therewith as a polymerizable monomer and a crosslinkable monomer;
or

(b) a (meth)acrylonitrile (co)polymer obtained by polymerization of (meth)acrylonitrile alone or a mixture of (meth)acrylonitrile with a vinyl monomer copolymerizable therewith as a polymerizable monomer and a crosslinkable monomer; and

wherein the requirements (1) and (2) are fulfilled:

- (1) the proportion of crosslinkable monomer, based on the polymerizable monomer is 1.1-5 wt.-%; and
- (2) the crosslinkable monomer is at least one bifunctional compound selected from polyethylene glycol di(meth)acrylate and an alkyldiol di(meth)acrylate".

XI. The relevant arguments put forward by the appellant in its written submissions and during the oral proceedings may be summarised as follows:

- The main request and the auxiliary requests fulfilled the requirements of Article 123(3) EPC. The wording of the claims restricted the crosslinkable monomer in a cascade like manner, namely the amount of crosslinkable monomer that could be present, and the nature of the crosslinkable monomer to be used.
- The main request and the auxiliary requests also fulfilled the requirements of Article 123(2) EPC. Firstly, the lower limit of the range 1.1 to 5 wt.-% was disclosed as such in the application as filed and not in the form of "greater than 1.1". Secondly, the restriction of the shell polymer to vinylidene

chloride (co)polymers and (meth)acrylonitrile (co)polymers in combination with the specific types and amounts of crosslinkable monomers would be considered by the person skilled in the art to be directly and unambiguously derivable from the application as filed as a whole.

- The invention as defined in the claims of the main and the auxiliary requests was sufficiently disclosed to be carried out by a skilled person and was thus in conformity with the requirements of Article 100(b)/83 EPC. Respondent's document D11 was all but conclusive in demonstrating that crosslinkable monomers as defined in the claims were not suitable to achieve the desired maximum expansion rate. Based on his common knowledge and the general information in the application as filed the person skilled in the art would consider different polymerization conditions. Depending on the nature of the crosslinking monomer to be used he would adapt the conditions so that the desired expansion ratio would be finally achieved.

- The subject-matter of claim 1 of all requests was novel over D1 to D4. Neither of these documents disclosed a thermally foamable microsphere wherein the amount of crosslinkable monomer was greater than 1% by weight. In each of these documents, irrespective of the general mention of the broad range of 0.01-5% by weight, the actual disclosure was restricted to thermally foamable microspheres having a crosslinkable monomer content of always below 1% by weight. As regards D10, the inner olefin-containing monomer used in examples 3-7 was

substantially different from the bifunctional crosslinkable monomer defined in the present requests with respect to both structure and crosslinking reactivity.

- The subject-matter of claim 1 of the main request involved an inventive step.

- D2 should be considered to represent the closest state of the art. Claim 1 differed from the disclosure of D2 at least with regard to the amount of the bifunctional crosslinkable monomer in the shell polymer, which should be at least 1.1-5% by weight. D2 did not disclose thermally foamable microspheres wherein the amount of the crosslinkable monomer present in the shell polymer was more than 1% by weight.

- The technical problem was the provision of thermally foamable microspheres wherein the shell had reduced dependency of its modulus of elasticity on temperature (so that a wider range of proper processing temperature could be ensured), and the thermally foamable microspheres had resistance to polar solvents, plasticizers, etc (chemical resistance and solvent resistance) and high capability of retaining foaming properties.

- The solution of the technical problem was illustrated in the experimental part of the patent in suit, in particular figure 1, and in the additional technical evidence D12 and D15.

- Neither D2 nor any other prior art document on file disclosed or suggested that the said problem would be solved by increasing the amount of the specific bifunctional crosslinkable monomers.

- Regarding the subject-matter of claim 1 of the auxiliary requests, which defined the shell polymer compositions more narrowly, it also involved an inventive step. This was even more convincingly illustrated by the available technical evidence.

XII. The relevant arguments put forward by the respondent in its written submissions may be summarised as follows:

- The main request (filed with the statement of grounds of appeal) did not fulfil the requirements of Article 123(3) EPC.

- The main request did not fulfil the requirements of Article 123(2) EPC, because the lower limit for the amount of the bifunctional crosslinkable monomer was not connected to the term "greater than" as disclosed in description as filed. Furthermore, the combination of this new lower limit for the amount of the bifunctional crosslinkable monomer with the monomers of the two alternatives (a) or (b) had no basis in the application as filed.

- The invention of claim 1 of the main request was not operable within the entire scope (Article 100(b) EPC). On the one hand claim 1 covered a significant number of crosslinkable monomers but the patent in suit showed only one to be useful for obtaining microspheres having an expansion ratio of at least 5

and/or other desired properties when used in an amount greater than 1.1% by weight, namely diethylene glycol dimethacrylate (DEGDMA). On the other hand the experimental results of D11 demonstrated that the desired results could not be achieved when using more than 1.1% by weight of crosslinkable monomers structurally similar to DEGDMA and within the scope of claim 1.

- Claim 1 of the main request lacked novelty over each of D1 to D4.

- Furthermore, claim 1 of the main request lacked an inventive step. D2 should be considered to represent the closest state of the art. Claim 1 was distinguished from D2 by requiring an amount of crosslinkable monomer greater than 1.1% by weight.

- The appellant had argued that the problem solved by this feature was the provision of expandable microspheres with reduced dependency of the modulus of elasticity of the polymer shell on temperature and having improved resistance to polar solvent, plasticizers, etc. However, there was no evidence that this problem was solved over the entire scope of claim 1. The problem could also not be seen in the provision of microspheres with high expansion capability and high heat resistance. The technical data in D11 showed that the tested crosslinkable monomers encompassed by claim 1, except DEGDMA, gave significantly inferior expansion capability when used in amounts exceeding 1.1% by weight. Moreover there was no comparative example in the patent showing any difference between different amounts of

the same crosslinking monomer. Nor could figure 1 of the patent provide the necessary evidence since this figure was not based on actual experimental data. Finally the credibility of the experimental results of the patent in suit was questionable in view of the contradictory results obtained in respect of comparative example 2 in the patent in suit and D8, a sworn statement produced by the appellant during the prosecution of a US application relating to the same invention as the opposed patent. Consequently the problem to be solved was to provide an alternative expandable microsphere defined by technical features already disclosed per se in D2.

- The claimed invention was nothing more than an arbitrary choice of a specified amount of a broadly defined crosslinkable monomer which provided alternative expandable microspheres. Even if it was established that this technical problem was solved, the solution would be obvious to the skilled person since he would be motivated by his common general knowledge to produce microspheres with more than 1.1% by weight of the crosslinkable monomers including the most preferred DEGDMA. In this context reference was made to D9, a document which represented the common general knowledge of the skilled person and disclosed that the effect of crosslinking was dependent on the amount of the bifunctional monomer.

- Although the subject-matter claimed in the auxiliary requests had been further limited, the objections raised against the main request still applied.

XIII. The appellant requested that the decision under appeal be set aside and that the patent be maintained on the basis of the main request or alternatively auxiliary requests 1 to 2 all as filed with letter dated 12 March 2013, alternatively the amended auxiliary request 3 as filed during the oral proceedings, alternatively auxiliary requests 4 or 5 as filed with letter dated 12 March 2013.

XIV. The respondent requested in writing that the appeal be dismissed.

Reasons for the Decision

1. The appeal is admissible.
2. Admissibility of the new requests filed with letter dated 12 March 2013

The new main request and auxiliary requests 1 to 5 were filed in an attempt to overcome the objection raised by the respondent under Article 123(3) EPC against amended claim 1 of the requests filed with the statement setting out the grounds of appeal. Due to the limitation of the crosslinkable monomers to a specific group in claim 1 of these requests, there was no longer any limitation on the amount of other crosslinkable monomers outside this definition but still covered by the claim.

The new requests *prima facie* overcome the respondent's objection by arranging the two requirements relating to the crosslinkable monomer (i.e. amount and nature) in a

"cascade-like" manner. Furthermore, such a restriction had been the appellant's intention from the beginning of the appeal procedure, so that these new requests cannot have come as a surprise to the respondent. The respondent did not file any objection to them.

During the oral proceedings the board observed that the main request (as well as the auxiliary requests) filed with the letter dated 12 March 2013 appeared to be objectionable by virtue of the separation of the feature (ii) ("a crosslinkable monomer") from the features (i) (a) and (b). The discussion continued on the basis that if, apart from this objection, one of the requests of this set was found to be allowable, an amended request would be filed by the appellant to deal with this objection.

On this basis, the board admitted the requests filed with the letter dated 12 March 2013 into the proceedings.

3. Admissibility of documents filed in appeal

The appellant filed documents D13 to D15 with a letter dated 12 March 2013. Document D13 was filed in order to demonstrate that D10 was not novelty destroying and D14 and D15 in support of the argument that the claimed subject-matter involved an inventive step. The respondent did not object to the admissibility of these documents and the board considered them *prima facie* relevant for the respective issues and admitted them into the proceedings.

The main request

4. Novelty

4.1 The appellant raised novelty objections in view of D1 to D4. Although the reasoning was given only for D2, it was argued that it was applicable also to D1, D3 and D4. In fact D1 to D4 originate from the same corporate applicant and each of the documents discloses nearly the same heat-expandable microcapsules (a synonymous term for microspheres as used in the patent in suit).

4.2 D2 discloses thermally expandable microcapsules excellent in heat resistance after expansion (page 2, lines 1-2). The microcapsules comprise a shell and an expanding agent, wherein the shell is made from a copolymer consisting essentially of a polymerizable monomer (A) having two or more polymerizable double bonds and a monomer (B) which can produce a homopolymer having a high glass transition temperature (claim 1). An especially preferred monomer (B) is, amongst others, methacrylonitrile (page 2, lines 44-49).

The polymerizable monomer (A) is a polyfunctional vinyl monomer and/or an inner olefin-containing monomer. The most preferred polyfunctional vinyl monomers are the bifunctional ethylene glycol di(meth)acrylate and the trifunctional trimethylolpropane tri(meth)acrylate and triacrylformal (page 2, lines 29-34).

For optimal cross-linking the polymerizable monomer (A) may be used preferably in the amount of 0.01 - 3% by weight, more preferably 0.05-2% by weight (page 2, lines 38-43).

However, there is no direct and unambiguous disclosure in D2 as regards the combination of the overlapping range of 1.1 to 3 wt.-% with the bifunctional crosslinkable monomer ethylene glycol di(meth)acrylate. Such a combination would be necessary to arrive at an embodiment falling within the scope of claim 1 of the main request. Therefore novelty of the subject-matter of claim 1 over the general disclosure of D2 is acknowledged.

Regarding the examples in D2, it is noted that the exemplified combinations always use a trifunctional crosslinkable monomer, namely the trimethylol propane trimethacrylate (TMPRMA), in a proportion based on the polymerizable monomers, namely acrylonitrile, methacrylonitrile and methyl methacrylate or isobornyl methacrylate, which is about 0.5 wt.-%. Thus novelty is also acknowledged over the specific examples of D2.

4.3 Also the similar documents D1, D3 and D4 do not disclose the use of a bifunctional crosslinking monomer having the structure required in claim 1 in combination with the required amount of 1.1 to 5 wt-% thereof.

4.4 D10, a statement including technical evidence filed by the applicant of D2 during prosecution thereof before the EPO, was also cited in the decision under appeal. In example 7 of this document thermally expandable microcapsules were obtained by polymerizing acrylonitrile and methacrylonitrile together with a trifunctional crosslinkable monomer, namely trimethylolpropane trimethacrylate (TMPTMA), and dicyclopentenyl acrylate (DCPA). Although DCPA could be

considered as a bifunctional crosslinkable monomer (which was disputed by the appellant), it does not have the structure required by claim 1, namely two polymerizable carbon-carbon double bonds linked together via a flexible chain derived from a diol compound. Therefore D10 is irrelevant for the novelty of claim 1.

5. Inventive step

5.1 Closest state of the art

As already mentioned above, D1 to D4 disclose nearly the same thermally foamable microspheres and could equally be selected as closest state of the art. Since both parties agreed with the view of the opposition division to start from D2 as the closest state of the art, the board follows this line.

5.2 The technical problem

The appellant saw the technical problem underlying the patent in suit in the light of D2 as being the provision of thermally foamable microspheres having a shell polymer with limited dependency of its modulus of elasticity on temperature so that a wide range of appropriate processing temperatures could be ensured, an improved resistance to polar solvents and plasticizers, and high capability of retaining foaming properties (paragraphs [0020], [0021] of the patent in suit).

5.3 The appellant argued that this problem had been successfully solved by thermally foamable microspheres

characterized by the features which distinguish the claimed subject-matter from D2, namely the use of a crosslinkable monomer in the shell polymer that must satisfy the following two requirements:

(1) the proportion of crosslinkable monomer, based on the polymerizable monomer, is 1.1-5 wt.-%; and

(2) the crosslinkable monomer is a bifunctional compound having a structure in which two polymerizable carbon-carbon double bonds are linked together via a flexible chain derived from a diol compound selected from polyethylene glycol, polypropylene glycol, an alkyldiol, an alkyl ether diol and an alkyl ester diol.

In this context the appellant referred to the experimental part of the patent in suit (examples 1 and 2; figure 2) and the additional experimental evidence D15.

5.4 However, as the respondent correctly observed only one single bifunctional crosslinkable monomer is used in the patent in suit, namely diethylene glycol dimethacrylate (DEGDMA). With regard to D15, two additional bifunctional crosslinkable alkyl diol acrylate monomers were used, namely 1,10 decanediol dimethacrylate (1,10-DDDA) and 1,6-hexanediol dimethacrylate (1,6-HDMA).

Although in principle some extent of generalisation from specific examples might be allowed, the board agrees with the respondent that there is no sufficient evidence supporting the solution of the problem over the entire scope of claim 1 of the main request. In

fact the bifunctional crosslinkable monomers of claim 1 concern a very broad spectrum of chemical compounds. The appellant has also not provided any convincing argument or evidence that the alleged improvement would be achieved by other chemical compounds than those exemplified.

The board also does not agree with the appellant that technical evidence for the successful solution of the technical problem can be found in figure 1, "a graph showing relations between the modulus of elasticity of the shell polymer of a thermally foamable microsphere and temperature" (paragraph [0027]). Even if figure 1 shows an improvement, the board observes that the curves of figure 1 do not relate to any concrete experimental data mentioned in the patent. Thus, an advantage derived from figure 1 cannot be attributed to bifunctional crosslinkable monomers. In fact claim 1 as granted relates merely to "a crosslinkable monomer" and even the patent specification refers in this context to polyfunctional compounds having two or more carbon-carbon double bonds (see paragraphs [0047] to [0049]). In other words, it is completely unclear on the basis of which experimental data the curves of figure 1 have been drawn.

- 5.5 In view of the above considerations the problem to be solved in the light of D2 can only be seen in the provision of an alternative thermally expandable microsphere.

5.6 Obviousness

The board in agreement with the opposition division and the respondent considers that the skilled person starting from D2 (page 2, lines 24-44 and examples 1-4) and looking for alternative thermally expandable microspheres would find in this document the disclosure of:

- the use of any vinyl monomer having two or more polymerizable double bonds as the crosslinkable monomer (page 2, lines 29-30), which disclosure encompasses the monomers now required in claim 1 of the main request, and even specifically mentions DEGDMA;
- the use of such monomer in an amount of 0.01-3% by weight, a range which overlaps with the amount of 1.1-5% by weight of claim 1 of the main request.

Thus the selection on the one hand of the specifically claimed crosslinkable monomers and on the other hand of the specifically claimed amount is nothing more than an arbitrary selection from the disclosure of D2, such selection not being associated with any unexpected technical effect.

5.7 Consequently claim 1 of the main request lacks an inventive step with the result that the main request is not allowable.

Auxiliary requests 1 and 2

6. In claim 1 of auxiliary requests 1 and 2 the nature of the crosslinkable monomer has been further restricted.

6.1 Claim 1 of auxiliary request 1 defines the carbon-carbon double bonds as follows:

"the crosslinkable polymer is a bifunctional compound having a structure in which two polymerizable carbon-carbon double bonds, **selected from vinyl, methacryl, acryl and allyl**, are linked together via a flexible chain derived from a diol compound selected from polyethylene glycol, polypropylene glycol, an alkyldiol, an alkyl ether diol and an alkyl ester diol".

(amendment over claim 1 of the main request in bold)

6.2 Claim 1 of auxiliary request 2 provides a list of crosslinkable monomers:

"the crosslinkable polymer is **at least one bifunctional compound selected from polyethylene glycol di(meth)acrylate, polypropylene glycol di(meth)acrylate an alkyldiol di(meth)acrylate, an alkyl ether diol di(meth)acrylate and an alkyl ester diol**

di(meth)acrylate". (amendment over claim 1 of the main request in bold)

6.3 However, for the reasons set out above regarding the main request, the subject-matter of claim 1 of auxiliary requests 1 and 2 also lacks an inventive step. The board considers that the definition of the crosslinkable monomer in the respective requests is still very broad in comparison to the available

technical evidence. Therefore these requests are not allowable.

Auxiliary request 3

7. Auxiliary request 3 was filed during the oral proceedings in view of the board's objection against the separation of the crosslinkable monomer, i.e. feature (ii), from the polymers defined in (i) (a) and (b). The amended wording merely re-establishes that the crosslinkable monomer is used in the polymerisation of the shell polymers (a) and (b). The respondent had chosen not to attend oral proceedings and the board saw no reason not to admit this request into the proceedings (see also point 2 above).

8. Amendments under Article 123(2) EPC

8.1 Claim 1 of the third auxiliary request differs from claim 1 as granted (point I above) in that:

- the shell polymer is defined as either (a) a vinylidene chloride (co)polymer or (b) a (meth)acrylonitrile (co)polymer (based on claim 5 as filed);
- the crosslinkable monomer has to meet the following two requirements:
 - (1) the proportion of crosslinkable monomer, based on the polymerizable monomer is 1.1-5 wt.-%; and
 - (2) the crosslinkable monomer is at least one bifunctional compound selected from polyethylene

glycol di(meth)acrylate and an alkyldiol di(meth)acrylate (based on the last paragraph on page 19 of the application as filed).

- 8.2 The respondent argued that the amendment of the lower limit for the crosslinkable monomer from "greater than 1% by weight" to "1.1 wt.-%" was not supported by the application as filed.

However, the amendment is based on the first full paragraph on page 19 of the application as filed, which states:

"The lower limit to the proportion of the crosslinkable monomer used is greater than 1% by weight, preferably 1.1% by weight, more preferably 1.2% by weight, and even more preferably 1.3% by weight based on the polymerizable monomer"

The board does not accept the respondent's argument that that the term "greater than" in this passage is also associated with the preferred values. "Greater than 1%" merely defines the most general lower limit, whereas the preferred values disclose specific lower limits, each of which is greater than 1.

- 8.3 Moreover, the board does not agree with the respondent that the restriction of the shell polymers to vinylidene chloride (co)polymers and (meth)acrylonitrile (co)polymers in combination with the restriction of the crosslinkable monomer to specific types and amounts thereof results in an unsupported combination.

As regards the types of the polymers, page 10, line 26 to page 11, line 1, of the application states:

"In consideration of these, vinylidene chloride (co)polymers and (meth)acrylonitrile (co)polymers are preferred for the shell-forming polymer".

This is an explicit disclosure of a general preference of the shell-forming polymers now defined in claim 1 of auxiliary request 3. This applies to all embodiments, and clearly also to embodiments in which preferred crosslinkable monomers are used.

Similarly, the preference for bifunctional crosslinkable monomers is disclosed in the passage bridging pages page 15 and 16 (some of the compounds have been merely deleted without singling out a specific compound), and the preferred amounts thereof are described on page 19, lines 7-14, directly following the detailed definition of the preferred bifunctional crosslinkable monomers. The skilled person reading the entire application would understand that the preferred types of shell polymers can be combined with the preferred crosslinkable monomers and preferred amounts thereof.

8.4 Similar amendments have been made to independent claim 14, which relates to a process for producing a thermally foamable microsphere. For the same reasons as given for claim 1, these amendments are also allowable.

8.5 In view of the above, the amendments to auxiliary request 3 fulfil the requirements of Article 123(2) EPC.

9. Amendments under Article 123(3) EPC

In independent claims 1 and 14 of this request the crosslinkable monomer used in the preparation of the shell polymer has to meet two requirements, each of which has to be fulfilled individually. These two requirements are (1) the content of crosslinkable monomer in general, and (2) the chemical nature of the crosslinkable monomer that is actually present. This "cascade-like" formulation ensures that the amount of crosslinkable monomer is within the claimed range (even if further crosslinkable monomer not specified in (2) were to be present) and that the specified crosslinkable monomer is present (in this context see T 999/10). Consequently the scope of the independent claims of auxiliary request 3 does not extend beyond the scope of the claims as granted and thus these claims are in conformity with the requirements of Article 123(3) EPC.

10. Clarity

The respondent did not raise any objection concerning the clarity of this request and the board is satisfied that the claimed subject-matter is clear and concise and is supported by the description. Therefore it fulfils the requirements of Article 84 EPC.

11. Sufficiency of disclosure

The respondent contested sufficiency of disclosure on the ground that not all claimed bifunctional crosslinkable monomers could be used in the preparation of microspheres with the desired properties. It was

argued that the technical evidence of the patent in suit related only to DEGDMA and that crosslinkable monomers which were even structurally similar to DEGDMA did not provide useful expandable microspheres. In this context reference was made to D11.

The board cannot accept the argument of the respondent:

Firstly, the definition of the crosslinkable monomer has been drastically limited in the third auxiliary request and concerns only two groups of compounds: polyethylene glycol di(meth)acrylate and alkyldiol di(meth)acrylate.

Secondly the respondent did not provide any concrete explanation as to why the technical evidence of D11 was relevant for the sufficiency of auxiliary request 3. The respondent argued in its letter dated 18 August 2011 (see page 3; under the title "Article 100(b)") that D11 should show that none of 1,4-butanediol divinylether (BDDVE), ethylene glycol dimethacrylate (EGDMA) or polyethylene glycol dimethacrylate (PGDMA) could be used in amounts greater than 1.1% by weight and still give useful expandable microspheres. In view of the limitation of the crosslinkable monomer this objection becomes irrelevant for all compounds referred to except for polyethylene glycol dimethacrylate. However for this compound there is no detailed analysis of the data; the respondent has simply stated in very general terms that no useful expandable microspheres could be obtained by using those bifunctional crosslinkable monomers.

Thirdly, as pointed out by the appellant, the person skilled in the art using his common knowledge and the general information presented in the application as filed would consider different polymerization conditions, depending on the nature of the crosslinking monomer to be used, and would adapt the polymerization conditions for a given reaction system so that the desired expansion ratio would be achieved.

Under these circumstances the board considers that the claimed invention is disclosed in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art.

12. Novelty

The subject-matter of claim 1 of auxiliary request 3 is narrower in scope than the corresponding claim 1 of the main request which has been considered to be novel over the opposed state of the art (see point 5 above).

Therefore the subject-matter of claim 1 of auxiliary request 3 and, by the same token, the subject-matter of claim 14 are also novel over that state of the art.

13. Inventive step

13.1 The closest prior art

As for the main request, D2 is still considered to represent the closest state of the art, a document which discloses thermally expandable microcapsules excellent in heat resistance after expansion (page 2, lines 1-2).

13.2 The technical problem

The appellant still saw the technical problem in the provision of thermally foamable microspheres wherein (a) the shell polymer has a limited dependency of its modulus of elasticity on temperature, so that a wide range of proper processing temperatures can be ensured, (b) the microspheres have resistance to polar solvents and plasticizers (chemical resistance and solvent resistance) and (c) the microspheres have a high capacity of retaining foaming properties.

13.3 This problem is solved by thermally foamable microspheres characterized by the use of a crosslinkable monomer in the shell polymer that must satisfy the following two requirements:

(1) the proportion of crosslinkable monomer, based on the polymerizable monomer is 1.1-5 wt.-%; and

(2) the crosslinkable monomer is a bifunctional compound selected from polyethylene glycol di(meth)acrylate and an alkyldiol di(meth)acrylate.

13.4 The solution of the technical problem is indeed illustrated in the technical evidence of the patent in suit (concerning the bifunctional crosslinkable monomer DEGDMA), the additional technical evidence provided by the appellant as D12 (concerning the bifunctional crosslinkable monomer DEGDMA) and D15 (concerning the bifunctional crosslinkable monomers 1,10-DDDA and 1,6-HDMA). On the basis of this technical evidence and in view of the narrower scope of claim 1 of auxiliary request 3 and in the absence of any clear and

unambiguous counter-evidence presented by the respondent the board accepts that the technical problem has successfully been solved over the entire scope of claim 1.

13.4.1 The respondent argued that the experimental data of D11 showed that some crosslinkable monomers encompassed by claim 1 gave significantly inferior expansion capability when used in amounts exceeding 1.1% by weight. However, this objection of the respondent had essentially been raised for the main request. No specific argument regarding auxiliary request 3 in view of the technical problem was raised in writing and the respondent did not attend the oral proceedings in order to provide the necessary clarifications on this point. Considering the experimental evidence of D11 the board has come to the conclusion that it is not *prima facie* relevant since it does not clearly demonstrate that compounds falling within the claimed bifunctional crosslinkable monomers in a proportion between 1.1-5 wt.-% do not solve the technical problem set out above.

The respondent also relied on D8, a document produced by the appellant in other proceedings, in order to undermine the credibility of the experimental data in the patent in suit. D8 reports that microspheres with a shell comprising 1.5% by weight of the trifunctional crosslinkable monomer TMPDMA are thermally foamable, whereas for microspheres with 1.6% by weight of TMPDMA in comparative example 2 of the patent in suit no foaming is observed. D8 can only show that comparative example 2 of the patent is not conclusive. However no conclusion can be drawn with respect to the specific

bifunctional crosslinkable monomers now required in claim 1.

Finally, the respondent argued that the technical problem, although not explicitly mentioned in D2, was implicitly disclosed therein since the modulus of elasticity of the microspheres, their resistance to polar solvents and plasticizers and their capacity of retaining foaming properties were properties clearly encompassed by the more general term of heat resistance disclosed in D2. The board does not agree with these assertions of the respondent, which do not find any support in the disclosure of D2.

13.4.2 In summary, there is nothing on file which casts doubt on the above identified technical problem as also being the objective technical problem and on the conclusion that this problem has been credibly solved.

13.5 The question of obviousness

13.5.1 The question which remains to be answered is whether the skilled person starting from D2 and intending to provide microspheres with a shell polymer having a limited dependency of its modulus of elasticity on temperature, improved chemical and solvent resistance, and high capability of retaining foaming properties, would find in this document or the other cited documents of the state of the art any motivation to select from the crosslinkable monomers encompassed by the disclosure of D2 at least one bifunctional compound selected from polyethylene glycol di(meth)acrylate and an alkyldiol di(meth)acrylate in a proportion of 1.1 to 5-wt.% based on the polymerizable monomer.

13.5.2 The board in agreement with the appellant considers that the skilled person would not find such a motivation in D2 itself since this document is essentially interested in high heat resistance after expansion (page 2, lines 21-23; page 3, line 30; table 1). Moreover the skilled person following the teaching of D2 would rather be motivated to use trifunctional rather than bifunctional crosslinkable monomers since in all examples a trifunctional crosslinkable monomer was used, namely TMPTMA. Furthermore, all the examples use the crosslinkable monomer in an amount of around 0.5% by weight. The board thus concludes that the claimed subject-matter is not obvious in view of D2.

13.5.3 The respondent also alleged that a skilled person would expect from his common general knowledge that an increased amount of crosslinkable monomer would give polymers with higher modulus of elasticity and higher resistance to solvents. In this context, reference was made to D9, a textbook representing common knowledge in respect of polymers, which discloses on pages 138, 151 and 348 that the effect of crosslinking is dependent on the quantities of the difunctional monomer in a copolymerization, that crosslinked polymers do not dissolve easily and that the addition of crosslinks in a polymer leads to stiffer and stronger products.

However, the board does not concur with the respondent's view. Firstly, D9 is very general in nature with no direct relation to thermally foamable microspheres. Secondly, although D9 states on page 138 that "It is usual to reduce the effect of the

crosslinking reaction by utilising only small quantities of the difunctional monomer in a copolymerization", the board has difficulties to read into this sentence a direct or indirect link to the dependency of the modulus of elasticity on temperature of a thermally foamable microsphere. Thus, it appears that the respondent's attack is based on hindsight.

- 13.6 Claim 14 is directed to a process for producing the thermally foamable microsphere as defined in claim 1. Due to the patentability of claim 1 the patentability of the process claim is also established. The same applies to dependent claims 1 to 13 and 15 to 18.

Auxiliary requests 4 and 5

14. Since the claims of auxiliary request 3 are considered to fulfil the requirements of the EPC, there is no need to consider these hierarchically lower auxiliary requests.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the opposition division with the order to maintain the patent on the basis of claims 1 to 18 according to auxiliary request 3 filed during the oral proceedings of 16 May 2013 after any necessary consequential adaptation of the description.

The Registrar:

The Chairman:

M. Cañueto Carbajo

W. Sieber