Internal distribution code:

(A) [-] Publication in OJ
(B) [-] To Chairmen and Members
(C) [-] To Chairmen
(D) [X] No distribution

Datasheet for the decision of 25 April 2017

Case Number: T 1634/13 - 3.2.08

Application Number: 01400534.2

Publication Number: 1245328

IPC: B23K35/26

Language of the proceedings: EN

Title of invention:
Use of silver in a lead-free solder paste

Patent Proprietor:
SENJU METAL INDUSTRY CO., LTD.

Opponent:
Heraeus Holding GmbH

Headword:

Relevant legal provisions:
EPC Art. 100(c), 100(b), 100(a), 54, 56, 84, 123(2), 123(3)

This datasheet is not part of the Decision.
It can be changed at any time and without notice.

Keyword:

Grounds for opposition - added subject-matter (no) - insufficiency of disclosure (no)
Novelty - (yes) - selection from a range
Inventive step - after amendment - (yes) - auxiliary request (yes)
Claims - clarity - auxiliary request (yes)
Amendments - allowable (yes)

Decisions cited:

G 0002/88, G 0002/10, T 0653/93, T 0759/10

Catchword:

This datasheet is not part of the Decision.
It can be changed at any time and without notice.

Beschwerdekammern
Boards of Appeal
Chambres de recours

European Patent Office
D-80298 MUNICH
GERMANY
Tel. +49 (0) 89 2399-0
Fax +49 (0) 89 2399-4465

Case Number: T 1634/13 - 3.2.08

D E C I S I O N
of Technical Board of Appeal 3.2.08
of 25 April 2017

Appellant: (Patent Proprietor)	SENJU METAL INDUSTRY CO., LTD. 23 Senju-Hashido-cho Adachi-ku Tokyo, 120-8555 (JP)
Representative:	Zimmermann & Partner Patentanwälte mbB Postfach 330 920 80069 München (DE)
Appellant: (Opponent)	Heraeus Holding GmbH Heraeusstr. 12-14 D-63450 Hanau (DE)
Representative:	dompatent von Kreisler Selting Werner - Partnerschaft von Patent- und Rechtsanwälten mbB Deichmannhaus am Dom Bahnhofsvorplatz 1 50667 Köln (DE)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 23 May 2013 concerning maintenance of the European patent No. 1245328 in amended form.**

Composition of the Board:

Chair	P. Acton
Members:	C. Herberhold
	R. Cramer

Summary of Facts and Submissions

I. By decision posted on 23 May 2013 the Opposition Division maintained in amended form European patent No. EP-B-1 245 328 according to the 5th auxiliary request then on file.

II. Appellant I (patent proprietor) and appellant II (opponent) lodged appeals against that decision. Both appeals were duly filed and reasoned.

III. Oral proceedings before the Board were held on 25 April 2017. For the course taken by the proceedings, in particular the issues discussed with the parties and the parties' initial requests, reference is made to the minutes of the oral proceedings.

At the end of the oral proceedings the requests of the parties were as follows:

Appellant I requested that the decision under appeal be set aside and the patent maintained as granted (main request), or alternatively maintained in amended form on the basis of one of the 1st to 5th auxiliary requests filed with the statement of grounds of appeal, or on the basis of the 6th auxiliary request filed during the oral proceedings.

Appellant II requested that the decision under appeal be set aside and that European patent No. 1 245 328 be revoked.

IV. Claim 1 of the main request (patent as granted) reads as follows:

"A Pb-free solder paste for soldering chip components consisting in a mixture of a powder of a lead-free Sn-based twin-peak solder alloy powder mixed with a flux, the solder alloy consisting of 0.2 - 1.0 mass percent of Ag, at least one of the below-listed (i)-(iii), and the balance of Sn and having a first peak of heat absorption in a differential scanning calorimeter curve at the start of melting of the solder alloy and a second peak when the major portion of the solder alloy subsequently melts:
(i) at least one element of Sb and Cu in a total amount of at most 1.0 mass percent;
(ii) at least one element selected from the group consisting of Ni, Co, Fe, Mn, Cr and Mo in a total amount of at most 0.3 mass percent;
(iii) at least one element selected from the group consisting of P, Ga and Ge in a total amount of at most 0.2 mass percent."

The independent method claims of the main request (claim 3) and of auxiliary requests 1-4 played no part in the present decision.

V. Claim 1 of auxiliary request 1 differs as follows from claim 1 as granted:

"A Pb-free solder paste for reflow soldering of leadless chip components consisting ~~in~~ **of** a mixture of ...".

VI. Claim 1 of auxiliary request 2 differs from claim 1 as granted in the following amendments:

"A Pb-free solder paste for reflow soldering of leadless chip components **consisting in** a mixture of ...

... and a second peak when the major portion of the solder alloy subsequently melts, wherein the magnitude of the first peak is less than or equal to the magnitude of the second peak:
(i)...".

VII. Claim 1 of auxiliary requests 3 and 4 likewise comprises the amendment made to auxiliary request 2, in particular the addition of

"... wherein the magnitude of the first peak is less than or equal to the magnitude of the second peak ...".

VIII. Claim 1 of auxiliary request 5 reads as follows

"Use of a ~~A~~ Pb-free solder paste for reflow soldering of leadless chip components without causing tombstoning, wherein the solder paste consists~~ing~~ in a mixture of a powder of a lead-free Sn-based twin-peak solder alloy powder mixed with a flux, and wherein the solder alloy consists~~ing~~ of 0.2 - 1 .0 mass percent of Ag, at least one of ...".

IX. Claim 1 of auxiliary request 6 reads as follows:

"Use of Ag in a ~~A~~ Pb-free solder paste for preventing tombstoning during reflow soldering of leadless chip components, wherein the solder paste consists~~ing~~ in a mixture of a powder of a lead-free Sn-based twin-peak solder alloy powder mixed with a flux, and wherein the solder alloy, after addition of the Ag, consists~~ing~~ of 0.2 - 1 .0 mass percent of Ag, at least one of the below-listed (i)-(iii), ...".

X. The following documents are relevant for the present decision:

D1: M. E. Loomans et al., "Investigation of Multi-Component Lead-Free Solders, Journal of Electronic" Materials, Vol. 23, No. 8, 741 (1994);
D2: EP-A-0 251 611;
D3: JP 08-215880;
D3a: English translation of D3;
D4: JP 11-221695;
D4a: English translation of D4;
D8: DSC Curve Sn-Ag1.0-Cu1.0;
D9: Ullmann's Encyclopedia of Industrial Chemistry, A24, "Soldering and Brazing", pages 427-436;
D10: Textbook, R. J. Klein Wassink,"Soldering in Electronics", 2nd Edition, 1989, pages 195-196;
D14: Textbook, R.J. Klein Wassink, "Weichlöten in der Elektronik", 2. Auflage, 1991, pages 608-615;
D15: US-B-6,050,480 (published 18 April 2000);
D16: A. Takaki et al., "Protection of Tombstone Problems for Small Chip Devices", Proceedings — Electronic Components & Technology Conference, 1999;
D17: JPH 09-168887 A (published 30 June 1997);
D17a: English machine translation JPH 09-168887 A;
D18: Ullmann's encyclopedia of Industrial Chemistry, A24, "Silver, Silver Compounds, and Silver Alloys", pages 141-143;
D19: Ullmann's Encyclopedia of Industrial Chemistry, A27, "Tin, Tin Alloys, and Tin Compounds", page 50.

XI. The essential arguments of appellant II can be summarised as follows:

Main request - Article 100(b) EPC

For several claim features, the patent did not provide any information as to how these were to be put into practice.
Firstly, the claim defined a first peak of heat absorption in a digital scanning calorimeter (DSC) curve at the start of melting of the solder alloy and a second peak when the major portion of the solder alloy subsequently melts, without, however, specifying with respect to what parameter - e.g. chemical amount in Mole, mass, amplitude of the DSC peak, integrated area below the DSC peak or enthalpy - said "major portion" was to be determined.
Secondly, the claim required that the DSC curve have twin peaks. However, the only example alloys having a silver content in the claimed range as well as at least one of the additional elements defined in features i) to iii) as claimed exhibited a triple peak instead of a twin peak; see Figures 3 and 4. Since the examples in Figure 1 and 2 did not have the required additional alloy element and the examples of Figures 3 and 4 did not exhibit a twin-peak DSC curve, the patent did not disclose a single specific embodiment falling under claim 1 as granted.
Thirdly, in view of the possible addition of several different elements mentioned in features i) to iii), the claimed subject-matter covered a tremendous amount of differently composed solder alloys, for all of which the skilled person had to determine whether they exhibited a twin-peak DSC curve and whether the major portion of the alloy melted at the second peak, without even knowing how to determine said major portion.

Consequently, the European patent did not disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art.

Main request - Article 100(c) EPC

In claim 1 as granted the term "comprising" had twice been replaced by "consisting". This change in wording was tantamount to a disclaimer excluding the addition of further alloy components from the subject-matter, an amendment for which there was no basis in the application as originally filed. In accordance with decision T 759/10, the subject-matter of the European patent extended beyond the content of the application as filed.

Main request - Novelty

Document D1 disclosed in Table II a SN-1Ag-1Sb solder alloy in combination with a flux – see page 744, column 2, paragraphs 4 and 6. The claim being devoid of any definition regarding the particle size of the solder alloy powder and the amount of flux in the paste, the ingots with the flux placed thereon as disclosed in D1 had to be considered a solder paste within the meaning of claim 1.

D2 likewise disclosed a solder alloy as defined in claim 1 of the present invention. Even if none of the examples had the claimed low copper content, it was the disclosure of the document as a whole which had to be taken into account. In this context, the skilled person derived from claim 4 and from the description page 3, lines 20ff, that a particular preferred alloy

composition exhibited a silver content of at least 0.25% by weight in combination with a copper content of at least 0.7% by weight. Since there was no teaching in D2 discouraging the use of a low copper content, the person skilled in the art would seriously contemplate working with the disclosed low copper and silver ranges which overlapped with the claimed ranges.

Furthermore, document D3 disclosed in Table 1 a solder alloy having the claimed composition; see examples 1 and 2. According to paragraph [0015], said lead-free solder was provided in a variety of forms such as powder and – see paragraph [0013] – was provided with a flux. The combination of a powder with a flux being nothing other than a paste, D3 thereby disclosed the solder paste as claimed.

To conclude, the subject-matter of claim 1 was not new over the disclosure of any of D1, D2 and D3.

Main request, Auxiliary request 1 - Inventive step, Admission of D14-D19 into the proceedings

In a first line of attack, D3, which according to paragraph [0001] was from the same technical field as the invention, was considered to be the closest prior art document. Its disclosure differed from the claimed subject-matter only in that the alloy was provided in powder form, without explicitly mentioning a paste. Therefore, the technical problem was to provide the solder in an alternative form which made it for example suitable for reflow soldering - a technical problem likewise formulated in paragraph [0009] of the opposed patent. Reflow soldering was, however, a solder process well known to the person skilled in the art in which solder in the form of a flux comprising paste was

routinely used, see D9, pages 429 and 430. The person skilled in the art would thus find it obvious to provide the D3 solder powder in the form of such a paste, thereby arriving at a solder paste as claimed.

Secondly, document D14 - which, just like documents D15 to D19, had been provided at an early stage of the appeal proceedings in response to the first instance decision and which therefore should be admitted into the proceedings – disclosed on page 613, last paragraph, that solder pastes exhibiting retarded melting were advantageous in reflow soldering. Starting from the tombstoning-preventing retarded-melting paste of D14, the person skilled in the art would find it obvious to use the solder compositions of D3, Table 1, examples 1 and 2, i.e. the compositions exhibiting the largest melting range, to prepare a lead-free solder paste, which fell under the definition of claim 1 as granted.

Likewise, D15 and D16 disclosed tombstoning-preventing solder pastes, using, however, a Pb-comprising solder alloy. When trying to overcome Pb-related problems of said paste such as health hazards or environmental aspects, it was again obvious to replace the Pb-comprising alloy with the highest melting range Pb-free alloy example in D3, i.e. with one of the alloys according to D3, Table 1, examples 1 and 2.

These objections applied likewise to claim 1 of auxiliary request 1.

Consequently, claim 1 of the main request and of auxiliary request 1 did not involve an inventive step.

Auxiliary requests 2-4 - Clarity

Claim 1 of auxiliary requests 2 to 4 comprised an additional feature according to which the magnitude of the first peak was less than or equal to the magnitude of the second peak. However, the term "magnitude" could refer either to the peak amplitude or to the integrated area under the DSC peak. As could be seen from document D8, these two different meanings of the term led to opposite conclusions, as one and the same peak might well have higher amplitude but a lower integrated area below the peak. Hence, the peaks in D8 would fall under the definition of the claim on one interpretation but not on the other. The added feature thus did not allow for a clear definition of the matter for which protection was sought, contrary to the requirements of Article 84 EPC.

Auxiliary request 5

All objections raised against the main request applied *mutatis mutandis* to auxiliary request 5, as claim 1 defined nothing other than the use of a particular Pb-free solder paste which was suitable for a specific use.

Even if the use mentioned in the claim was to be considered a limiting technical feature, said use was obvious, as discussed above. In particular, the wording "without causing tombstoning" did not make any difference with respect to the specific use claimed.

Furthermore, also starting from the Pb-comprising solders known for preventing tombstoning as disclosed in D14-D19, the person skilled in the art was motivated

to replace the Pb in the alloys because of its known health hazard. In trying to solve this problem it was obvious to use an alloy as disclosed in D3, Table 1, examples 1 and 2, because of its large melting range.

Consequently, claim 1 of auxiliary request 5 was also not inventive.

Auxiliary request 6 - Article 123(3)

Claim 1 of auxiliary request 6, which related to the use of silver in a Pb-free solder paste for a particular purpose extended the scope of protection conferred by claim 1 as granted. While it had been possible before to sell silver for use in such a solder paste without being restricted by claim 1 as granted, this now fell under the protection of the amended claim.

Therefore, the requirements of Article 123(3) EPC were not met.

XII. The essential arguments of appellant I can be summarised as follows:

Main request - Article 100(b) EPC

In paragraphs [0022] to [0027] the patent provided detailed information as to how the claimed paste was to be prepared. With respect to the feature of the alloy having a first peak of heat absorption in a differential scanning calorimeter curve at the start of melting of the solder alloy and a second peak when the major portion of the solder alloy subsequently melts, paragraph [0022] explained that this was an inevitable technical consequence of the claimed silver content.

There was thus no difficulty for the person skilled in the art in putting the claimed invention into practice.

Moreover, the examples whose DSC curves were shown in Figures 1 to 4 had to be considered embodiments of the invention. With no lower boundary being defined for the amounts of the elements mentioned in features i) to iii), alloys without any of these elements, such as the examples shown in Figures 1 and 2, also formed part of the subject-matter. Furthermore, as made clear in paragraphs [0036] and [0037], the DSC curves shown in Figures 3 and 4 had to be considered twin-peak DSC curves within the meaning of the present invention. The patent thus indicated several specific examples enabling the person skilled in the art to carry out the invention.

Main request - Article 100(c) EPC

The examples in paragraphs [0022] to [0025] and [0040]-[0045] disclosed solder pastes in which the flux and the solder alloy added up to 100%. These passages thereby supported the term "consisting". Furthermore, the skilled person in the field of metallurgy was aware of the fact that additional elements in an alloy generally changed the alloy properties and would therefore *a priori* not interpret the term "comprising" as allowing other non-mentioned elements to be part of the composition. For this reason too the ruling in T 759/10 did not apply in the present case.

Main request - Novelty

D1 disclosed solder pellets having a thickness of 3 mm and a diameter of 5 mm with 2 drops of flux placed

thereon, an ensemble which clearly did not qualify as a solder paste.

The low Cu and Ag values mentioned in D2 were only disclosed as respective lower end points of ranges for these elements. Furthermore, these ranges overlapped only to a minimal amount with the Ag and Cu ranges claimed. There was, therefore, no indication leading the skilled person to combine exactly those 2 lower margins in a particular alloy composition. Indeed, the examples in D2, Table II - none of which fell under the definition in claim 1 as granted – as well as the Cu and Ag values defined in claims 8 and 9 taught that an Ag content below 2 weight percent was not to be combined with a Cu content below 2 weight percent, because only with a high Cu content could the desired high liquidus temperature and the wide melting range be reached. The person skilled in the art would thus not seriously contemplate using a combination of low silver and copper content in the D2 solder alloy.

With respect to D3, it was true that examples 1 and 2 were lead-free solders having a composition falling under the definition of claim 1 as granted and consequently having a twin peak DSC curve as claimed. However, paragraph [0013] mentioned the presence of flux only in combination with cored solders, but not in combination with the solder alloy in powder form described in paragraph [0015]. D3 thus did not disclose a solder paste.

Consequently, the subject-matter of claim 1 as granted was novel over the disclosure of documents D1, D2 and D3.

Main request, Auxiliary request 1 - Inventive step, D14-D19 not to be admitted into the proceedings

Document D3 could not be considered to be the closest prior art because it did not relate to the problem underlying the invention, i.e. it dealt neither with solder pastes nor with the specific problem of tombstoning in reflow soldering. Even if considered to be the closest prior art, formulating the technical problem in a way that included reflow soldering or the specific problem of tombstoning, which occurred only in reflow soldering, was based on hindsight. Instead, an appropriately formulated technical problem could e.g. be based on paragraph [0048] of the patent, namely to provide a "high reliability lead-free solder paste". However, D3 did not relate to solder pastes either. Moreover, there was nothing to indicate picking exactly examples 1 and 2 - which had Ag and Cu content in the claimed amount - from the 6 compositions disclosed in D3, Table 1. In addition to this first selection, a second selection from the several possibilities listed in paragraph [0015] had to be made with respect to the solder being provided in powder form. Then, a third selection from the different alternative known uses of a solder in powder form, choosing the form of a solder paste, was required. Such a series of purposive selections could only be made retrospectively with knowledge of the invention and was thus not obvious.

Documents D14 to D19 were not *prima facie* relevant and their filing was not occasioned by new submissions or arguments, either during the oral proceedings or in the decision. Hence, these late-filed documents should not be admitted. However, even if they were admitted, they would make no difference to the above analysis.

While D14 mentioned retarded-melting solder pastes as a means of preventing tombstoning, this was in the context of mixed solders, i.e. tin-rich mixed with lead-rich. Starting from D14 as closest prior art, there was thus no indication leading the person skilled in the art to refer to D3, a document which did not relate to tombstoning, retarded melting, twin-peak DSC curve solders or mixed solders, and to select therefrom specifically examples 1 and 2. Again, such a series of selections had to be seen as based on hindsight.

Also starting from D15 the person skilled in the art would not derive a paste as claimed in an obvious way. D15 disclosed a totally different alloy, comprising considerable amounts of Pb. There was no indication that an effect observable in this alloy would equally occur in an alloy which did not have one of the major constituents. Moreover, D15 explicitly referred to a solder having a liquidus temperature below 200°C in order to prevent thermal damage of electronic components; see e.g. the abstract and column 3, lines 16-26. With this teaching in mind, the skilled person would disregard the alloys disclosed in D3, in particular examples 1 and 2, which had a liquidus temperature around 230°C.

This analysis applied likewise to the subject-matter of claim 1 of auxiliary request 1, which further underlined the suitability of the claimed solder paste for reflow soldering.

Auxiliary requests 2-4 - Clarity

According to paragraph [0038] of the patent, due to the magnitude of the first peak being less than or equal to the second peak, the major portion of melting occurred

at the second peak so that tombstoning was effectively prevented. This clearly implied that the magnitude of the peak was defined as the integrated area under the peak of the DSC curve, the integrated area being indicative of the total heat absorbed during melting and therefore of the amount of the solder molten at a given temperature. Therefore, in the context of the present invention, the feature was clear for the skilled person.

Auxiliary request 5

According to the well-established examination practice at the EPO, the specific use in a use claim was to be considered a technical feature. None of documents D1 to D3 disclosed the use of the respective solder for reflow soldering of leadless chip components without causing tombstoning. Thus neither were these documents suitable as closest prior art for the use claim under consideration, nor was it obvious to consult their teaching when dealing with a process of reflow soldering of leadless chip components.

With respect to documents D14-D19, while it was true that the alloys disclosed therein were intended for use in reflow soldering of leadless chip components without causing tombstoning, these alloys comprised considerable amounts of Pb. Replacing or suppressing Pb in such alloys fundamentally changed the composition and consequently the thermal behaviour of the alloy too. The person skilled in the art thus would not have found it obvious to fundamentally modify the alloy composition known from documents D14 to D19 while expecting to preserve their favourable tombstoning-preventing properties.

Consequently, claim 1 involved an inventive step.

Auxiliary request 6 - Article 123(3)

Claim 1 as granted was directed to a solder paste including silver. Amended claim 1 of auxiliary request 6 related to the use of silver in a solder paste for a particular purpose, i.e. for preventing tombstoning during reflow soldering of leadless chip components. As ruled in G 2/88, Headnote II, such an amendment was not open to objection under Article 123(3) EPC.

Reasons for the Decision

1. Main request - Article 100(b) EPC

Appellant II was of the opinion that the European patent did not disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art.

1.1 Paragraphs [0022] to [0028] of the patent provide detailed information as to how a solder paste according to the present invention may be prepared.

The Board concurs with appellant I in that according to the explanations in paragraph [0022] of the patent, the DSC curves are a direct consequence of the solder alloy composition. The above feature relating to the twin-peak thus merely redundantly defines an inherent property of an alloy having the claimed composition. The DSC curves illustrated in documents D7 and D8 are also in accordance with this interpretation, as both exhibit a larger area-below-the-curve second peak. This

is at least not inconsistent with the claimed feature according to which the DSC curve has a "second peak when the major portion of the solder alloy subsequently melts". There is thus no need for the skilled person to elaborate on possible further ways of determining the "major portion".

1.2 It is true that the alloys corresponding to Figures 1 and 2 do not fall under the definition of claim 1.

Contrary to the opinion of appellant I, the fact that the ranges defined for the elements mentioned under i) to iii) have no lower value does not mean that alloys not comprising any of these elements also form part of the claimed subject-matter. The claim stipulates that the solder alloy consists of "at least one of the below listed (i) – (iii)" and under each of points (i) to (iii) it repeats that "at least one element of …" has to be present. If none of the elements mentioned under (i) – (iii) is present in the alloy – as in the examples according to Figures 1 and 2 – the condition that at least one of these elements is present will not be satisfied. Since the alloys corresponding to Figures 1 and 2 do not comprise any of the elements mentioned under (i) – (iii), they do not fall under the claimed invention.

1.3 However, the examples shown in Figures 3 and 4 do form embodiments of claim 1 as granted. In this context it is pointed out that, for the skilled person, the very small shoulder peaks shown in Figures 3 and 4 do not change the twin-peak character of the respective DSC curves. Indeed, the description explicitly teaches that all the DSC curves shown in Figures 1-4 relate to "twin-peak solders"; see paragraph [0038] of the A1 publication.

Thus, at least the examples shown in Figures 3 and 4 clearly indicate particular ways enabling the person skilled in the art to carry out the invention.

1.4 While the claim allows for the presence of several further strengthening or oxidation-preventing elements in the alloy, appellant II has not shown that in the claimed low-mass percentage, these would (apart from minor shoulder peaks) substantially alter the twin-peak character of the DSC curves and thus pose a problem in carrying out the invention.

1.5 The subject-matter is therefore disclosed in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art.

2. Main request - Article 100(c) EPC

2.1 Claim 1 as filed defines a solder paste for soldering chip components comprising a mixture of a powder of a Pb-free Sn-based solder alloy mixed with a flux, the solder alloy containing 0.2 to 1.0 mass % of Ag. Dependent claims 3, 4, 5, 8 and 9 as filed further define the solder paste as additionally comprising at least one strengthening or oxidation-preventing element of a number of explicitly listed elements.

Claim 1 as granted essentially combines the subject-matter of claims 1, 3, 4, 5, 8 and 9 as filed (a basis for combining the features of these claims can be found in paragraphs [0022], [0023] and [0025] of the A1 publication), with the terms "comprising" and "containing" being replaced by the terms "consisting in" or "consisting of".

Appellant II considered this change in wording to be an unallowable amendment.

2.2 However, the original application discloses specific embodiments consisting of Sn, Ag and Ni (Figure 3) or Sn, Ag and P (Figure 4) in the claimed amounts. Furthermore, for all disclosed examples / comparative examples the lead-free solder alloy powder and the paste-type flux add up to 100% (paragraphs [0028], [0040], [0042], [0043] and [0045] of the A1 publication), i.e. the disclosed pastes consist in a mixture of the alloy powder mixed with a flux.

The specific examples in Figures 3 and 4 (which, as discussed above, form embodiments of claim 1) thus teach that the terms "comprising"/"containing" include the term "consisting" as a particular, originally disclosed meaning.

2.3 While it is true that the change in wording restricts the subject-matter with respect to the original wording, such a restriction is not objectionable under Article 123(2) EPC. In particular, there has been no singling out within the meaning of G 2/10 because in view of the claims as filed and of the specific examples (see above), the person skilled in the art would regard the subject-matter remaining in the claim as directly and unambiguously disclosed.

2.4 As an aside, the Board notes that T 759/10, cited by appellant II in support of its arguments, is indeed not relevant for the present amendment: that case concerned a change from "comprise" to "consist essentially of", whereas the replacement of the word "comprising" by "consisting of" was actually allowed (see Case Law of

the Boards of Appeal, 8th edition 2016, II.E.1.13, first and last paragraphs).

2.5 Hence, the subject-matter of claim 1 as granted does not extend beyond the content of the application as originally filed.

3. Main request - Novelty

3.1 D1

Document D1 discloses the solder alloy in the form of pellets prepared by pressing ingots to a thickness of 3 mm and then punching out 5 mm diameter cylinders (p. 744, right column, 4th paragraph). Subsequently, 2 or 3 drops of flux are placed on these specimens (p. 744, right column, 6th paragraph). For the person skilled in the art, this ensemble of single pellets of considerable size with a few drops of flux thereon cannot possibly qualify as a solder paste. The subject-matter of claim 1 is thus novel over prior art D1.

3.2 D2

D2 discloses a solder alloy with a copper content in the range of 0.7 to 6% and a silver content in the range of 0.05 to 3%, 0.1 to 2% or 0.25 to 1.25% (see claim 4 and page 3, lines 20 to 23).

Therefore, the composition overlaps partially with the composition of the alloy claimed in the patent in suit.

Appellant II argues that an alloy comprising 0.25% silver and 0.7% copper was explicitly disclosed in the above-mentioned passages and that since this value falls in the claimed range, D2 was novelty-destroying.

It is correct that in the case of a single range, normally each of its end points is considered to be explicitly disclosed and hence this value destroys the novelty of a claimed range which overlaps with it.

In the present case, however, D2 discloses two ranges, one referring to copper and having a lower margin of 0.7%, and the other referring to silver and having a lower margin of 0.25%. Because the alloy comprises balance tin, every combination of silver and copper values within the two ranges is valid. Undisputedly, there is no explicit disclosure of an alloy with 0.7% copper and 0.25% silver in D2. In the case of two combined ranges, the value corresponding to the combination of the end points of both ranges is generally not considered to be disclosed (see T 653/93, point 3.2).

Hence, for assessing novelty the criteria used for sub-ranges have to be applied.

Firstly, it is noted that the overlapping sub-range from 0.7 to 1% copper by weight within a copper range of 0.7 to 6% by weight according to D2 is narrow.

Moreover, none of the examples exhibits a copper amount of below 2% by weight, such that none of the examples falls within or comes close to the overlapping range.

Since the patent discloses for the claimed range the particular effect of preventing tombstoning while reflow soldering, it is not necessary in the present case to discuss whether the so satisfied third criterion (the requirement of a "purposive selection")

has to be applied for the assessment of novelty of selection inventions or not.

Finally, it is observed that not only do none of the examples combine a silver amount in the claimed range with a copper amount below 2% by weight, but also claims 8 and 9 of D2 suggest that a low silver content (below 2%) is to be combined with a copper content of at least 2% by weight. In view of this teaching, the person skilled in the art would not seriously contemplate working within the range claimed in the patent.

Hence, the partly overlapping sub-range claimed in claim 1 as granted is novel over D2.

3.3 D3

Examples 1 and 2 in Table 1 disclose a solder alloy having the composition defined in claim 1 as granted. It was common ground between the parties that said alloy exhibits the twin-peak DSC curve as claimed. According to paragraph [0015], the disclosed lead-free solder may be moulded into a variety of forms, including powder. However, although paragraph [0013] further mentions flux, this is in the context of cored solders and cannot be considered a disclosure of a powder mixed with a flux. Therefore, D3 does not disclose a solder paste, and the subject-matter of claim 1 is thus novel over the disclosure of D3.

4. Main request, Auxiliary request 1 - Inventive step

4.1 D3 as closest prior art

4.1.1 Document D3 is considered to be the closest prior art. It relates to a Pb-free solder used to mount a microchip component or a semiconductor component on a circuit board of electronic or electrical devices (paragraph [0001]), i.e. it is from the same technical field as the invention. Although it does not explicitly mention pastes, it discloses the solder alloy to be in powder form, powder being a typical constituent of solder pastes. Furthermore, by being Pb-free it aims - just like the invention (see paragraph [0009] of the impugned patent) - to solve environmental problems of lead-containing solders. While it is true that D3 does not mention tombstoning, there is no requirement that the closest prior art document address all problems underlying the patent.

4.1.2 As discussed in point 3.3 above, the teaching of D3 differs from the claimed subject-matter in that it discloses a solder powder but not a solder paste.

Appellant I has argued that in order to derive from the teaching of D3 a solder paste with the claimed composition, a double selection - firstly of the alloy composition, and secondly of the alloy form - is required. However, examples 1 and 2 in Table 1 are specifically disclosed solder alloys, individually forming possible starting points for the skilled person. Unless they were unsuitable for the claimed purpose – which in view of their composition is not the case – there is no need to discuss why either was selected as a starting point. Furthermore, each alloy needs to be provided in some form, with powder being

one of only five explicitly mentioned, well-known forms. The alloy of examples 1 and 2 in powder form is thus considered directly and unambiguously disclosed.

4.1.3 An alternative to a solder powder, a solder paste does not dislocate as easily from the application site, thus solving handling problems of the solder alloy powder.

With respect to the problem to be solved, the Board observes that the problems suggested by both parties comprise hindsight elements. The problem as formulated by appellant II mentions suitability for reflow soldering, whereas the problem mentioned by appellant I mentions a paste. Since a paste suitable for reflow soldering is the solution, the problem needs to be formulated without these elements.

As discussed during the oral proceedings, a more appropriate formulation of the objective technical problem is the provision of the solder alloy of D3 in an alternative, more reliable form for overcoming the inevitable handling problems associated with the powder form (such as e.g. dislocation of the powder from the application site).

4.1.4 As evidenced by D9, p. 430, first paragraph, the person skilled in the art was well aware of solder pastes being a typical and conventional way to reliably apply solder powder (e.g. by printing the powder comprising paste onto circuit boards) and would thus consider it obvious to provide the alloy powder known from D3 in paste form. Such a paste is inherently suitable for reflow soldering of leadless chip components. Although it is true that solder powder may in principle be applied in alternative ways, solder paste is by far the

most common. Consequently, selecting this routinely used solder alloy form cannot be considered inventive.

4.1.5 Thus, the subject-matter of claim 1 of the main and first auxiliary requests does not involve an inventive step.

4.2 Admission of D14-D19 into the proceedings and further inventive-step objections based thereon are discussed - as far as relevant - in the context of auxiliary request 6.

5. Auxiliary requests 2-4 - Clarity

Claim 1 according to auxiliary requests 2-4 comprises an additional feature according to which the magnitude of the first peak is less than or equal to the magnitude of the second peak. The term "magnitude" normally refers to the amplitude of the peak, whereas according to appellant I, in the context of the present patent, it means the integrated area under the peak. The term is thus ambiguous. As evidenced by D8, which of the two interpretations of the term applies may be decisive when determining whether a particular alloy falls within the claimed subject-matter or not.

The ambiguous term thus cannot clearly define the matter for which protection is sought. Consequently, the amendments do not fulfil the requirements of Article 84 EPC.

6. Auxiliary request 5

Claim 1 of auxiliary request 5 defines the "Use of Pb-free solder paste for reflow soldering of leadless chip components without causing tombstoning ...".

As discussed above, the Board came to the conclusion that it was obvious to provide the lead-free solder alloy powder disclosed in D3, the alloy powder being intended for soldering of microchip or semiconductor components on a circuit board (see paragraph [0001] of D3), in the form of a solder paste. For the person skilled in the art in the above-mentioned field, the use of solder paste is consonant with reflow soldering. This includes the soldering of surface-mounted leadless devices (SMDs) directly onto the surface of the circuit board (D9, page 430, first paragraph).

To put it differently, the skilled person knows not only that in the field of soldering microelectronic components the solder alloy powder is typically provided in the form of a paste, but also that the conventional use of a solder in paste form implies printing the paste on the circuit board and applying the components with subsequent reflow soldering. The claimed use of the paste is thus as obvious as the provision of the solder in paste form.

Appellant I argued that at least the particular feature that the reflow soldering process does not cause tombstoning, which has not been made available to the public, should suffice to make the subject-matter inventive. However, the claim merely enunciates the fact that the (obvious) use of the solder alloy for reflow soldering results in circuit boards without tombstoning. To put it differently, the term "without causing tombstoning" does not define a method feature; rather it is no more than a disguised property of the product. Thus, the claimed use is still exactly the same use for reflow soldering of leadless chip components as a use without the added words "without

causing tombstoning". Adding a (disguised) property of the product which inevitably results from the obvious use of the paste does not result in a different use and thus does not make the subject-matter of the use claim inventive.

Consequently, the subject-matter of claim 1 of auxiliary request 5 does not involve an inventive step.

7. Auxiliary request 6

Note: Point 7 also deals with objections raised by appellant II (partly with reference to its written submissions) during the discussion of the main request, auxiliary request 1 and auxiliary request 5, insofar as they are relevant in the context of the subject-matter claimed in auxiliary request 6.

7.1 Article 123(3) EPC

Claim 1 as granted was directed to a solder paste including particular amounts of silver. Claim 1 of auxiliary request 6 is directed to the use of the same amounts of silver in the very same solder paste. According to G 2/88 (OJ EPO 1990, 93), Headnote 2, such an amendment of the granted claim is not open to objection under Article 123(3) EPC.

7.2 Clarity

Appellant II has argued that the wording "use of Ag in a Pb-free solder paste for preventing tombstoning during reflow soldering of leadless chip components" could be interpreted as claiming the use of Ag in a Pb-free solder paste, with the paste being merely suitable for preventing tombstoning during reflow soldering of

leadless chip components. However, since G 2/88, the wording and interpretation of second non-medical use claims is well established. Since claim 1 is formulated according to the standard formulation used for second non-medical use claims, it has to be interpreted as including the technical effect "for preventing tombstoning during reflow soldering of leadless chip components as a functional technical feature". Therefore, claim 1 is clear and complies with the requirements of Article 84 EPC.

7.3 Article 83 EPC

Appellant II - in its letter of 10 February 2014 - argued that additional parameters not mentioned in the patent had to be considered in reflow soldering and that D14 had shown the addition of a certain amount of Ag to be insufficient to prevent tombstoning. The patent was thus insufficiently disclosed.

However, the experiments described in paragraphs [0047] and [0048] of the patent plausibly show that the claimed use of 0.2-1.0 mass percent Ag in the Sn-based Pb-free alloy according to claim 1 prevents tombstoning. D14 cannot prove these results wrong because it deals with different Pb-containing alloys. Furthermore, the typical parameters to be chosen when reflow soldering particular chip components are part of the common general knowledge of the skilled person, reflow soldering being a well-established and widely used process in circuit board manufacture.

For the further Article 83 EPC objections raised, see point 1 above.

To conclude, the patent discloses the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art.

7.4 Article 123(2) EPC

The effect of silver in the tin-based alloy system is disclosed in paragraph [0021] of the A1 publication. For the further objections (in particular with respect to the difference between "comprising" and "consisting"), reference is made to point 2 above.

7.5 Admission of D14-D19 into the proceedings

In challenging inventive step, appellant II has relied on further prior art documents D14-D19.

These documents were provided with appellant II's statement of grounds of appeal. They provide for additional lines of attack against the patent as maintained by the Opposition Division and their filing is considered normal behaviour for a (partly) losing party. The Board sees no reason to exercise its discretion to hold these documents inadmissible and they are therefore admitted into the proceedings (Article 12(1) and (4) RPBA).

7.6 Novelty and inventive step

7.6.1 Document D3, which is still considered to represent the closest prior art, discloses the use of silver in a Pb-free tin-based solder for reducing the melting temperature simultaneously with increasing the mechanical strength (D3, paragraph [0006]). D3 does not make available to the public that silver in the claimed amount in a lead-free, tin-based solder prevents

tombstoning (by the mechanism described in paragraph [0021] of the patent). This technical effect - which according to G 2/88 has to be interpreted as a technical feature - thus further differentiates the subject-matter of claim 1 of auxiliary request 6 from the disclosure of D3 (in addition to D3 disclosing a powder but not a paste).

The technical effect of the silver preventing tombstoning is not known from the common general knowledge as evidenced in D9. Therefore, the inventive-step reasoning based on D3 and D9 cannot render the subject-matter of claim 1 of auxiliary request 6 obvious.

For the same reasons, the combination of the teaching of D1 or D4 with D9 also cannot render the subject-matter of claim 1 obvious.

7.6.2 Documents D14-D17 address the problem of tombstoning (referred to as the Manhattan phenomenon in D17). All these documents use solder alloys comprising considerable amounts of Pb. Appellant II has argued that, in order to solve problems associated with the Pb-content, the person skilled in the art would try to replace the alloy with a lead-free alloy, such as known from D3.

However, the Board agrees with appellant I that the person skilled in the art would not *a priori* have assumed that the thermal properties, and thus the effect of preventing tombstoning, remain unaffected when replacing the significant amount of Pb in the alloys.

Furthermore, D14 and D17 (abstract) suggest using a mixture of two solder alloys with different melting points and thus teach away from using the single solder alloy disclosed in D3.

D15 and D16 disclose the addition of small amounts of Ag and Sb to an Sn-comprising alloy as resulting in twin-peak DSC curves and effective for prevention of tombstoning (D15, column 3, lines 37 to 48; D16, page 1040, last para). This, however, was likewise observed in an alloy system comprising considerable amounts of Pb. Again, the person skilled in the art would have no reason to assume that the effect of silver observed in a Pb-comprising alloy composition would be equally observable in a differently composed alloy, not containing Pb and Sb. Furthermore, following the explicit teaching of D15, the person skilled in the art would not consider alloys having a melting point above 200°C, because of their detrimental thermal effects on the electronic components associated with such temperatures, these effects being explicitly mentioned in the document (D15, abstract and column 3, lines 16-26). Moreover, D3 is silent on reflow soldering and a twin-peak DSC curve, such that, starting from D15 or D16 as closest prior art, the person skilled in the art would have no reason to assume that any of the alloys disclosed therein would have the desired twin-peak behaviour.

Thus, without hindsight knowledge, the person skilled in the art would not have applied the teaching of D3 to the alloys of D14-D17. This reasoning likewise applies to a combination of the teaching of documents D15-D17 with D1 or D4.

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 in amended form on the basis of:

    - Claim 1 of the 6th auxiliary request filed during the oral proceedings
    - The description as filed during the oral proceedings
    - Drawings Fig. 1-6 of the patent specification.

The Registrar: The Chair:

C. Moser P. Acton

Decision electronically authenticated