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Datasheet for the decision of 9 January 2025

Case Number: T 0169/23 - 3.3.09

Application Number: 17749143.8

Publication Number: 3475241

IPC: C08J9/16, C08K3/34, C04B28/00, C08J9/228, C04B103/63

Language of the proceedings: EN

Title of invention:
USE OF GEOPOLYMERIC ADDITIVE IN COMBINATION WITH NON-BROMINATED FLAME RETARDANT IN POLYMER FOAMS

Patent Proprietor:
Synthos Dwory 7 spolka z ograniczona odpowiedzialnoscia

Opponent:
versalis S.p.A.

Headword:
Geopolymeric additive/SYNTHOS

Relevant legal provisions:
EPC Art. 100(a), 100(b), 52(1), 56, 84
EPC R. 76(2)(c)

Keyword:
Grounds for opposition - insufficiency of disclosure (no)
Inventive step - main request and auxiliary requests 1 to 5 (no) - auxiliary request 7 (yes)
Claims - clarity - auxiliary request 6 (no)

Decisions cited:
G 0003/14

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Case Number: T 0169/23 - 3.3.09

D E C I S I O N
of Technical Board of Appeal 3.3.09
of 9 January 2025

Appellant: (Opponent)	versalis S.p.A. Piazza Boldrini 1 20097 San Donato Milanese (IT)
Representative:	Bottero, Carlo Barzanò & Zanardo S.p.A. Via Borgonuovo, 10 20121 Milano (IT)
Respondent: (Patent Proprietor)	Synthos Dwory 7 spolka z ograniczona odpowiedzialnoscia ul. Chemikow 1 32-600 Oswiecim (PL)
Representative:	Eisenführ Speiser Patentanwälte Rechtsanwälte PartGmbB Johannes-Brahms-Platz 1 20355 Hamburg (DE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 18 November 2022 rejecting the opposition filed against European patent No. 3475241 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chairman	A. Haderlein
Members:	C. Meiners
	R. Romandini

Summary of Facts and Submissions

I. This decision concerns the appeal filed by the opponent (appellant) against the opposition division's decision to reject the opposition filed against the European patent.

II. In its notice of opposition, the opponent had requested revocation of the patent on the basis of, *inter alia*, Article 100(a) EPC for lack of inventive step and Article 100(b) EPC.

III. In its decision, the opposition division decided, *inter alia*, that the ground for opposition under Article 100(b) EPC did not prejudice maintenance of the patent. Moreover, the subject-matter claimed was novel and involved an inventive step in view of document D16 as the closest prior art. By contrast, *inter alia* documents D9 and D12 could not be considered suitable starting points for assessing inventive step. Thus, the ground for opposition under Article 100(a) EPC in conjunction with Article 56 EPC did not prejudice maintenance of the patent.

IV. The following documents are relevant to this decision:

D1 K. De Weerdt, COIN Project Report 37, 2011

D2 P. Duxon et al., Journal of Materials Science (2007), 42(9), 2917-2933

D3 F. Skvara, Ceramics Silikaty (2007), 51(3), 173-177

D7 WO 2015/191817 A1

D9 US 2007/0112082 A1

D12 KR101431002 B1
D16 KR20110065707 A
D21b Annex B to the declaration of Dr. Filip Kondratowicz/Sedimentation of 13 July 2021

V. *Wording of the relevant claims*

Claim 1 of the main request (as granted) reads:

"Use of
i) one or more geopolymer additives selected from

a) a geopolymer;
b) a combination of a geopolymer with an athermanous additive; and
c) a geopolymer composite derived from geopolymer and comprising athermanous additive,

and
ii) one or more non-brominated flame retardants selected from

a) phosphorus-based flame retardants,
b) nitrogen-based flame retardants, and
c) phosphorus/nitrogen-based flame retardants,

for improving the self-extinguishing properties of a composition comprising vinyl aromatic polymer."

Claim 14 as granted reads:
"A process for the production of expandable polymer granulate by an extrusion or a suspension process, the process comprising the addition of

i) one or more geopolymer additives selected from

a) a geopolymer;
b) a combination of a geopolymer with an athermanous additive; and
c) a geopolymer composite derived from geopolymer and comprising athermanous additive,

and
ii) one or more non-brominated flame retardants selected from
a) phosphorus-based flame retardants,
b) nitrogen-based flame retardants, and
c) phosphorus/nitrogen-based flame retardants;

into the polymer, wherein the polymer is a vinyl aromatic polymer."

Independent claim 15 as granted is directed towards a composition comprising one or more polymers, the composition further comprising the aforementioned components i) and ii), wherein the composition is in the form of an expandable granulate, wherein the polymer is a vinyl aromatic polymer, the granulate further comprising one or more propellants.

Independent claim 16 as granted relates to a composition comprising one or more polymers, the composition further comprising said components i) and ii), wherein the composition is in the form of expanded vinyl polymer foam, and the vinyl polymer is vinyl aromatic polymer, the foam having

- a density of from 8 to 30 kg/m^3, and
- a thermal conductivity, as measured according to ISO 8301, of from 25 to 35 $mW/K \cdot m$.

Independent claims 1, 14 and 15 of the first and second auxiliary requests are identical to claims 1, 14 and 15 as granted.

Independent claims 1, 13 and 14 of the third, fourth and fifth auxiliary requests correspond to claims 1, 14 and 15 of the main, first and second auxiliary requests, respectively, save for the insertion "[,] wherein the geopolymer or geopolymer composite has an average particle size (D50) in the range of 0.1 to 10 µm". This additional limitation is taken from claim 13 as granted.

Independent claims 1 and 14 to 16 of the sixth auxiliary request correspond to granted claims 1 and 14 to 16, except for the additional limitation "[,] wherein the composition comprises c) geopolymer composite derived from geopolymer and comprising athermanous additive".

Independent claims 1 and 14 to 16 of the seventh auxiliary request differ from the corresponding granted claims in that the definition of component i) reads "one or more geopolymer additives, wherein the geopolymer additive is a geopolymer composite derived from geopolymer and comprising athermanous additive". This limitation corresponds to option c) for component i) in granted claims 1 and 14 to 16.

VI. The appellant's arguments relevant to the present decision can be summarised as follows.

- It followed from additional experiments carried out by the appellant that self-extinguishing properties had not been attained over the full scope claimed. Hence,

if the effect called for in claim 1 required passing the EN ISO 11925-2 and/or DIN 4102 B2 flammability test, the subject-matter of claim 1 would be insufficiently disclosed.

- As to inventive step, no particular technical effect had been achieved across the whole scope claimed. Moreover, the independent claims did not exclude the presence of intumescent materials, and various examples of intumescent materials were provided in the patent itself. In view of this, the subject-matter of independent claims 1 and 14 to 16 of the main request lacked inventive step in view of each of documents D9, D12 and D16 as respective starting points for assessing inventive step. Starting from D9, the distinguishing feature in independent claims 1 and 14 to 16 resided in the use of a geopolymer. The resulting objective technical problem was the provision of alternatives. The use of geopolymers as flame retardants was, however, proposed in D7.

- Similarly, the claimed subject-matter of the first to seventh auxiliary requests lacked an inventive step. The objections raised in relation to the main request applied *mutatis mutandis*. The limitation regarding the average particle size of the geopolymers and geopolymer composites in the third to fifth auxiliary requests did not confer any inventive merit either. This feature was even explicitly disclosed in all the examples of D7, such as e.g. in example 1. A skilled person would use a particle size distribution according to requirements, and no unusual technical effect was associated in the patent with this feature.

- As to the sixth auxiliary request, the amendment introduced a lack of clarity.

- Having regard to the seventh auxiliary request, a technical difference associated with the feature "geopolymer composite" over "geopolymer" had not been proven, and no technical effect could be related to that feature. The resulting objective technical problem in light of D9 as closest prior art was merely the provision of an alternative. A skilled person would not expect that the incorporation of non-flammable athermanous additives, such as silica, into the geopolymers would reduce flame retardancy. Likewise, D9 already comprised in e.g. claim 8 a phosphorus-based flame retardant and an athermanous additive.

Even the patent proposed modifying the geopolymers using e.g. silanes, and D7 proposed a modification of the geopolymers in paragraph [0013] using e.g. nanoparticles to impregnate the pores completely or partially. A skilled person would consider adding a known flame retardant (geopolymer) to be obvious, irrespective of whether or not this geopolymer was added as a separate component or arbitrarily as a geopolymer composite comprising an athermanous additive.

VII. The respondent's (patent proprietor's) arguments relevant to the present decision can be summarised as follows.

- The ground for opposition under Article 100(b) EPC should not have been admitted by the opposition division since it had not been substantiated in the notice of opposition.

- The opponent had not discharged its burden of proof when it came to showing that the claimed subject-matter

was not associated with the advantages of the invention. Thus, the claimed subject-matter was sufficiently disclosed.

- As to *inventive step*, the claimed subject-matter of the main request was inventive regardless of the starting point. Document D16, however, represented the closest prior art. By contrast, there was no direct and unambiguous disclosure in D9 that the products obtained in examples 24 to 27 do indeed pass the flame retardancy test according to DIN 4102 B2. D9 relied specifically on intumescence for flame retardancy and did not disclose geopolymers as additives. Hence, document D9 was not a suitable starting point for the assessment of inventive step. Likewise, D12 did not qualify as the closest prior art.

D7 did not provide the missing link needed to use geopolymers as flame retardant fillers but taught "everything and nothing". The mentioning of fire propagation retardation in D7 was just as speculative and therefore meaningless as other proposed uses. There was merely a passing reference in paragraph [0013] of D7 that somehow a modification of the geopolymer could be achieved to modify the porous surfaces. Regarding D12 as a secondary document, there was no guidance in that document regarding using geopolymer as an additive in vinyl aromatic polymers for maintaining mechanical stability during a fire.

Thus, the subject-matter of the granted claims involved an inventive step in view of D9 or D16 as the closest prior art.

- This held equally true for the subject-matter of the auxiliary requests, which also involved an inventive

step. The limitation of the geopolymer's particle size in the third to fifth auxiliary requests brought about improved dispersion in the polymer material and thus contributed to inventive merit. With regard to the seventh auxiliary request, incorporating the athermanous additive into the geopolymers of D7 would go against the core teaching of D9 and would thus not have been implemented by the person skilled in the art.

VIII. Final requests

The appellant (opponent) requested that the opposition division's decision be set aside and the patent be revoked.

The respondent (patent proprietor) requested, as its main request, that the appeal be dismissed. As an auxiliary measure, it requested that the patent be maintained on the basis of one of auxiliary requests 1 to 15 as identified in the reply to the statement of grounds of appeal or one of auxiliary requests 16 (Set C" "-1A) or 17 (Set C" "-1B) filed with the reply to the appeal.

Reasons for the Decision

Main request

1. Sufficiency of disclosure

1.1 The opposition division considered the ground for opposition under Article 100(b) EPC to be sufficiently substantiated in the notice of opposition and therefore admissible.

1.2 According to the respondent, the opposition division should not have admitted the ground under Article 100(b) EPC into the proceedings.

The notice of opposition comprises pertinent arguments and evidence to support the opponent's attacks under Article 100(b) EPC. In this context, the board observes that the assessment of sufficiency of disclosure is not restricted to the question of whether or not the examples of a patent can be reworked, but also whether the invention can be carried out across the full scope claimed without undue burden. The attacks have thus been properly submitted and substantiated. The question of whether the objections and evidence adduced would ultimately succeed before the competent body is another issue, independent of the question of whether the requirement of Rule 76(2)(c) EPC is met. The opposition division thus correctly considered the ground for opposition under Article 100(b) EPC admissible.

1.3 The appellant presented a conditional attack under Article 100(b) EPC against claim 1 as granted. It followed from experiments carried out by the appellant that self-extinguishing properties as a technical effect had not been attained by the compositions tested therein. These fell within the scope of claim 1 as granted. Hence, if this effect called for in claim 1 required passing the EN ISO 11925-2 and/or DIN 4102 B2 flammability test, the subject-matter of claim 1 would be insufficiently disclosed. Given that no test was identified in the claim which had to be passed to qualify as "self-extinguishing", that term merely meant an arbitrarily defined degree of flame retardancy (first interpretation). If that interpretation was not shared by the board and was construed as meaning

passing the EN ISO 11925-2 and/or DIN 4102 B2 flammability test, then claim 1 would be insufficiently disclosed (second interpretation).

1.4 As to this conditional objection, the board observes as follows. Claim 1 as granted does not require any specific test to be passed for a specimen to qualify as "self-extinguishing". Likewise, the examples of the patent show that the foam compositions tested in the comparative examples are not self-extinguishing. Improving the self-extinguishing properties of a composition comprising a vinyl aromatic polymer thus means - from the perspective of the patent - improving the flame retardancy of compositions comprising vinyl aromatic polymers.

1.5 Since the board concludes that this (first interpretation) of the effect required in claim 1 is to be applied and is the correct one, the appellant's objection under Article 100(b) EPC is irrelevant. Consequently, the ground for opposition under Article 100(b) EPC does not prejudice maintenance of the patent.

2. Inventive step

2.1 Closest prior art

2.1.1 In the decision under appeal, the opposition division held that document D16 represented the closest prior art for assessing inventive step. By contrast, *inter alia*, documents D9 and D12 were not promising starting points. The latter conclusion was shared by the respondent in the appeal proceedings.

2.1.2 The board only agrees insofar as document D12 is concerned but not in relation to D9. D12 discloses the use of micaceous "geopolymer" powder for improving flame retardancy (see paragraph [0050] and claim 1). However, the "geopolymers" referred to in D12 are not (partially) amorphous condensation products of silicates and aluminates as described in the patent and in D1 to D3. Rather, the geopolymers of D12 are crushed mica or sericite materials. Consequently, adding an additional flame retardant would not lead to the claimed subject-matter.

2.1.3 However, like the patent, document D9 is also directed towards expandable polystyrene insulation material. The compositions can comprise a flame-retardant mixture of phosphorus compounds and e.g. expandable graphite (see examples 24 to 27 and claim 8 of D9). To reduce thermal conductivity, infrared-absorbing filler particles are preferably added to the foamable compositions (see paragraph [0039]). Moreover, compression strength values of the foamed/expanded materials are determined and displayed in table 4. Examples 24 to 27 of D9 feature foamed polystyrene compositions comprising a phosphorus-containing flame retardant, chalk and expandable graphite particles. These compositions pass the flame retardancy test according to DIN 4102 B2. The reference to examples 1 to 4 rather than to examples 24 to 27 is clearly a typographical error.

2.1.4 The respondent also submitted that D9 relied, unlike the patent, specifically on intumescence for flame retardancy. D9 was thus not a suitable starting point for assessing inventive step. Intumescent materials, such as expandable graphite, acted as an intumescent and thus brought about the expansion and hence destruction of the building material that they are part

of after ignition. This, however, was associated with danger to human life and hence to be avoided.

As to this argument, however, the board observes that the independent claims of the patent do not exclude the presence of intumescent material, such as expandable graphite, in the compositions comprising vinyl aromatic polymer. As correctly stated by the appellant, the patent mentions various examples of intumescent materials in the patent itself.

2.1.5 By contrast, expandable graphite disclosed in D9 also qualifies as an athermanous additive within the meaning of the patent, see paragraphs [0045] and [0046].

The board thus agrees with the corresponding line of argument presented by the appellant. They held that the fact that the particle size of the expandable graphite used in examples 24 to 27 of D9 was 350 µm did not change the fact that it was an infrared radiation-absorbing material and thus qualified as an athermanous additive. This component is not even required in the independent claims such as claim 15. This was correctly observed by the appellant.

2.1.6 Likewise, the respondent's argument that - unlike the patent - D9 did not address the mechanical properties in a fire situation is not persuasive. Firstly, the mechanical properties and the thermal conductivity of the foams in the patent are only tested before ignition. Secondly, both documents feature compositions passing the flame retardancy test according to DIN 4102 B2. Thus, the board concurs with the appellant's corresponding line of argument.

2.1.7 Further, the respondent's argument that D9 did not disclose geopolymers does not speak against its qualification as the closest prior art. Evidently, the closest prior art does not need to disclose all the features of the claim in question.

2.1.8 The respondent also submitted that the patent was concerned with using small amounts of non-brominated flame retardants (up to 10 wt%). By contrast, D9 only achieved flame retardancy using small amounts of flame retardants in examples employing brominated flame retardants (see table 6). Examples 24 to 27 of D9, however, in which only non-brominated flame retardants were used, contained significantly larger amounts of flame retardants. Hence, for this reason too, D9 was not a suitable starting point for assessing inventive step.

This argument is not convincing because, as correctly observed by the appellant at the oral proceedings, the amounts and ratios of flame retardants/functional components is not limited in the independent claims at all.

2.1.9 Consequently, D9 qualifies as a suitable starting point for assessing inventive step.

2.2 Distinguishing technical feature

The *difference* between the subject-matter of each of independent claims 1 and 14 to 16 and examples 24 to 27 of D9 as the starting point for assessing inventive step is the presence of a geopolymer as a flame retardant. In this context, the appellant correctly submitted that example 26 of D9 also has a density and a thermal conductivity as required in claim 16.

Moreover, the examples feature expandable/expanded polystyrene compositions comprising a phosphorus-containing flame retardant, as well as chalk and expandable graphite. n-Pentane is used as propellant (see paragraph [0118] and table 7).

2.3 Technical effect and resulting objective technical problem

2.3.1 No technical effect has been demonstrated that would be obtained across the full breadth of the independent claims. In this regard, comparative examples 3 and 4 of the patent are not representative of the compositions of examples 24 to 27, with the latter also comprising calcium carbonate and additionally expandable graphite as a second flame retardant (and a compound qualifying as "athermanous additive", see paragraphs [0045] and [0046] of the patent and remarks above). By contrast, comparative examples 3 and 4 of the patent in suit comprise neither a second flame retardant nor a compound that could be considered to be an "athermanous additive".

It should also be noted that examples 24 to 27 are bromine-free and are shown to have passed the DIN 4102 B2 fire test in D9. The board is convinced that the context of paragraph [0121], discussed during the oral proceedings before the board, makes it clear that the reference to examples 1 to 4 in that paragraph is an obvious typographical error, examples 24 to 27 clearly being meant.

2.3.2 Consequently, in view of the absence of pertinent comparative examples vis-à-vis examples 24 to 27 of D9, the *objective technical problem* underlying independent claim 1 is that of providing *further* combinations of

flame retardants while the *objective technical problem* underlying claims 14 to 16 is that of providing *alternative* expandable and expanded granulates.

The respondent's formulation of the objective technical problem in the oral proceedings before the board, namely as that of providing a bromine-free flame retardant system that can be used in small amounts in vinyl aromatic foams is for these reasons not conclusive.

2.4 Obviousness

2.4.1 Document D7 proposes the use of geopolymers as described in the patent as a flame/fire retardant (see paragraphs [0020] and [0055]). They can be used in polystyrene foams (see claim 24). Obviously, the function of the geopolymer in the polystyrene foams would be that of a flame retardant.

2.4.2 In this regard, it is correct that D7 proposes many different areas of application for the geopolymers and that the properties and effects of those geopolymers have not been corroborated by experimental evidence in D7. Nevertheless, it is set out in paragraph [0055] that the aluminosilicate aggregates may retard fire propagation. That paragraph [0019] discloses a *material* (comprising the geopolymer), rather than the geopolymer itself, to be used as a fire retardant is not at variance with this statement.

2.4.3 Regarding this question of substantiation of the properties and proposed uses of the geopolymers in D7, the board holds, as correctly submitted by the appellant, that a skilled person would, having the intrinsic properties of the geopolymers/porous

aggregates in mind, have expected that they could be used in the areas of application proposed in D7.

2.4.4 A skilled person merely wishing to provide alternative flame-retarded polystyrene foam compositions would thus have been prompted, with a reasonable expectation of success, to add geopolymers, proposed for use as flame retardants in D7, to the compositions of D9. Starting from examples 24 to 27, the salient point is not substitution of the existing flame retardant system but rather the use of an *additional* flame retardant (the geopolymer), proposed in D7 to provide flame retardancy and thus expected by a skilled person to contribute to that property.

2.4.5 Hence, the subject-matter of claims 1 and 14 to 16 is obvious to a skilled person in view of D9 as the closest prior art. The ground for opposition under Article 100(a) EPC in conjunction with Articles 52(1) and 56 EPC thus prejudices the maintenance of the patent.

Auxiliary requests

3. First and second auxiliary requests - inventive step

3.1 In Claim Set A (first auxiliary request), claims 1, 14 and 15 remain unchanged. As to claim 16, the foamable compositions of D9 are also obtained from expandable granulates. Hence, the above conclusions as to a lack of inventive step apply for the reasons indicated above.

3.2 Claim Set A' (second auxiliary request) also includes granted claims 1, 14 and 15. Hence, the objections

under Article 56 EPC against the main request apply *mutatis mutandis*.

4. Third to fifth auxiliary requests - inventive step

4.1 As to Claim Sets B, B' and B'' (third to fifth auxiliary requests), the respondent submitted that it was self-explanatory that the required average particle size range (D50) of 0.1 to 10 µm was associated with a better dispersion of the particles. This additional feature made D9 an even less suitable starting point.

4.2 This argument is not persuasive. No effect has been demonstrated to be associated with this particular average particle size for the geopolymers in question. This arbitrary range includes the typical particle size range of polymer additives and fillers. No effect is associated with this particle size range in the patent either.

4.3 The average particle sizes of the geopolymers/porous aggregates disclosed in D7 likewise fall within this range, see e.g. page 13, line 4 to which the appellant referred, which discloses, for instance, an average particle size of 300 nm.

4.4 The respondent's argument that the particle size for the *expandable graphite* used in examples 24 to 27 was well above this value range, namely 350 µm, does not change this conclusion since said size concerns the expandable graphite rather than the geopolymers as featured in D7.

4.5 Hence, a skilled person would have considered implementing the aforementioned additional feature in an obvious way when starting from D9 as the closest

prior art, and therefore, the above conclusions as to a lack of inventive step apply *mutatis mutandis*.

5. Sixth auxiliary request - clarity of the claims

5.1 As to Claim Set C, the board concludes that the requirement of clarity of the claims (Article 84 EPC) is not met. Concerning claim 1, it is not clear how the self-extinguishing properties of a composition comprising vinyl aromatic polymers that already contain a geopolymer composite c) can be improved by using a geopolymer additive a) to c). Hence, the amendment "wherein the composition comprises c) geopolymer composite derived from geopolymer and comprising athermanous additive" infringes the requirements of Article 84 EPC. This amendment did not form part of the granted claims and is therefore open to examination as to the requirements of Article 84 EPC (G 3/14).

5.2 The corresponding counter-argument presented by the respondent that claim 2 as granted focused on a geopolymer composite is not persuasive. The respondent conceded that the amendment introduced into the independent claims is not literally present in the granted claims.

However, while granted claim 2 comprises the feature that the composition comprises a geopolymer composite, various other limitations are present in claim 2 that do not form part of independent claim 1 as amended. There is thus no basis for the amendment made in the granted claims.

5.3 Consequently, the subject-matter of claim 1 exhibits a lack of clarity caused by the aforementioned amendment.

Thus, the subject-matter of claim 1 does not meet the requirements of Article 84 EPC.

6. Seventh auxiliary request – inventive step

6.1 This request requires the mandatory presence of a geopolymer *composite* derived from geopolymer and comprising an athermanous additive in the flame retardant system used in the claimed subject-matter.

6.2 Closest prior art

At the oral proceedings before the board, the discussion on inventive step was based on document D9. For the above indicated reasons, this document is a suitable starting point for assessing inventive step.

6.3 Distinguishing technical feature, resulting technical effect and objective technical problem

6.3.1 The appellant submitted at the oral proceedings that the distinguishing feature was the use of a geopolymer, but that there was no proven technical difference between a geopolymer and an athermanous filler, which was present in D9, and a geopolymer composite derived from geopolymer and comprising an athermanous additive as claimed. The particle size of the petroleum coke in paragraph [0128] of the patent was 3 µm and that of the resulting composite material 2.7 µm. There was thus no real difference between contact of the geopolymer with a neighbouring coke particle in a physical mixture and in the composite. There were open flanks of geopolymer and coke in the composite as in their physical mixture. It was totally unresolved whether there was a real difference or whether geopolymer and coke were merely associated in the composite.

6.3.2 As to the alleged absence of a technical difference between a geopolymer composite derived from geopolymer and comprising an athermanous additive on the one hand, and a mixture of geopolymer and the athermanous additive (such as coke particles) on the other hand, the board observes as follows. The sedimentation experiments documented in D21b demonstrate that the geopolymer, coke particles, their physical mixture, and the geopolymer composite derived from geopolymer and comprising an athermanous additive have different dispersion and sedimentation behaviour in the given solvent used in D21b. A geopolymer composite as claimed thus differs technically from a mere mixture of the components, and a composite is not a physical mixture.

6.3.3 Thus, the distinguishing technical feature in claims 1 and 14 to 16 vis-à-vis D9 is the presence of a geopolymer composite.

6.3.4 For the reasons set out above in point 2.3, the objective technical problem solved across the whole range claimed is the provision of *further* combinations of flame retardants for the subject-matter of claim 1 and for claims 14 to 16 so as to provide *alternative* expandable and expanded granulates.

6.4 Obviousness

6.4.1 Document D7 as a secondary information source does not disclose geopolymer composites derived from geopolymer and comprising an athermanous additive as flame retardants, and D12 does not relate to geopolymers as understood by a skilled person and as specified in the patent at all. Instead, the "geopolymers" disclosed in D12 are micaceous layer silicates. D7 and D12 thus do

not disclose the missing link needed to arrive at the subject-matter of claims 1 and 14 to 16.

6.4.2 While the appellant's submission is correct that the patent also proposes modifying or varying the geopolymers using e.g. silanes, this teaching concerns the patent rather than the prior art.

6.4.3 It is correct that D7 proposes an optional modification of the porous aggregates/geopolymers. According to paragraph [0013], the pores can be covered or impregnated partially or completely by modifying the geopolymers with e.g. organic molecules and/or nanoparticles. This passage does, however, not propose or suggest preparing a composite comprising an athermanous additive for use as a flame retardant. In the opinion of the board, a generic and passing reference to the possibility of modifying the geopolymers using e.g. "nanoparticles" is not sufficient in this regard. The appellant's arguments that it was common general knowledge to modify particles using e.g. silanes and that the athermanous agent to be incorporated into the geopolymer can itself be non-combustible and would hence not be expected to influence the geopolymers' flame-retardant properties does not change this conclusion.

6.4.4 This holds all the more true since D9 stipulates integration of the athermanous additive in the form of a mixture into the flame-retarded polystyrene compositions (see e.g. table 6 and claim 8). In this context, the respondent correctly stressed in the oral proceedings before the board that incorporating the athermanous additive into the geopolymer would have meant deviating from this core teaching of D9.

In the opinion of the board, the skilled person would thus not have been prompted by D9 to modify its teaching towards something falling within the scope of claims 1 and 14 to 16. For essentially the same reasons, in view of the board's conclusion that neither D7 nor D12 discloses geopolymer composites comprising an athermanous agent as flame retardants, the claimed subject-matter would not have been obvious when starting from D16.

6.5 Hence, the subject-matter of Claim Set C-1, the seventh auxiliary request, involves an inventive step.

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 based on claims 1 to 17 according to auxiliary request 7 submitted as SET C-1 with the letter dated 14 July 2022 and a description and drawings to be adapted where necessary.

The Registrar: The Chairman:

K. Götz-Wein A. Haderlein

Decision electronically authenticated