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Datasheet for the decision
of 7 December 2007

Case Number: T 1047/04 - 3.3.07

Application Number: 00903266.5

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Language of the proceedings: EN

Title of invention:
Carbide and oxycarbide based compositions and nanorods

Applicant:
HYPERION CATALYSIS INTERNATIONAL, INC.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Relevant legal provisions (EPC 1973):
-

Keyword:
"Inventive step (no)"

Decisions cited:
-

Catchword:
-

Case Number: T 1047/04 - 3.3.07

DECISION
of the Technical Board of Appeal 3.3.07
of 7 December 2007

Appellant:	HYPERION CATALYSIS INTERNATIONAL, INC. 38 Smith Place Cambridge MA 02138 (US)
Representative:	Duckett, Anthony Joseph Mathys & Squire 120 Holborn London EC1N 2SQ (GB)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted 23 March 2004 refusing European application No. 00903266.5 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman:	S. Perryman
Members:	F. Rousseau B. ter Laan

Summary of Facts and Submissions

I. The appeal lies from the decision of the Examining Division refusing European application No. 00 903 266.5, entitled "Carbide and oxycarbide based compositions and nanorods", filed as international application No. PCT/US00/00753 on 12 January 2000 and published as WO 00/41808.

II. In the decision under appeal the Examining Division refused the application on the ground that the subject-matter of the independent claims of the main request and the first auxiliary request lacked novelty over document (1) WO 96/30570 and that the subject-matter claimed according to the second auxiliary request was not inventive over the combined teaching of document (1) and document (2) US-A-5 576 466.

III. The notice of appeal was filed on 24 May 2004, and the appeal fee paid the same day. With their statement setting out the grounds of appeal dated 29 July 2004, the appellants submitted three sets of claims, as their main request, and first and second auxiliary requests, respectively.

IV. In a communication of the Board in preparation for oral proceedings, document (3) WO 97/43116, a prior art document in the name of the present applicant, was introduced into the proceedings as being relevant for assessing inventive step. Document (4) EP-A-0 396 475 to which the present application refers and document (5) EP-A-0 474 570 discussed in document (2) were also cited. According to the provisional opinion expressed in the Board's communication, the claims then on file lacked either novelty over document (1) or an inventive step over document (3) when taken in combination with either of document (2), document (4) or document (5). Objections under Article 123(2) and 84 EPC were also raised.

V. In reply, the appellants submitted with their letter dated 14 November 2007 new claims forming the basis for their main and first to fifth auxiliary requests, replacing the requests then on file. The respective claims 1 of the main and five auxiliary requests read as follows (for ease of understanding the Board has indicated the differences in the claims of the auxiliary requests compared to claim 1 of the main request by showing additions in bold and underlined, and deletions struck out):

Main request:

"1. A rigid porous structure which comprises a composition comprising a multiplicity of:
a) oxycarbide-based nanorods having substantially uniform diameters between 1.0 nm and less than 100 nm, wherein said oxycarbide-based nanorods comprise oxycarbides;
b) carbide-based nanorods having substantially uniform diameters between 1.0 nm and 100 nm, wherein said carbide-based nanorods comprise oxycarbides; or
c) carbon nanotubes having substantially uniform diameters between 1.0 nm and 100 nm, wherein said carbon nanotubes comprise carbides;
wherein "substantially uniform" means that 95% of the values of the diameter measured along the length of a nanorod or nanotube are within ±10% of a mean value."

First auxiliary request:

"1. A rigid porous structure which comprises a composition comprising a multiplicity of:
a) oxycarbide-based nanorods having substantially uniform diameters between 1.0 nm and less than 100 nm, wherein said oxycarbide-based nanorods comprise oxycarbides **and the average distance between said oxycarbide-based nanorods is less than 0.03 microns and greater than 0.005 microns**;
b) carbide-based nanorods having substantially uniform diameters between 1.0 nm and 100 nm, wherein said carbide-based nanorods comprise oxycarbides **and the average distance between said carbide-based nanorods is less than 0.03 microns and greater than 0.005 microns**; or
c) carbon nanotubes having substantially uniform diameters between 1.0 nm and 100 nm, wherein said carbon nanotubes comprise **a** carbide~~s~~ **portion which includes carbide-based nanorods and the average distance between said carbon nanotubes is less than 0.03 microns and greater than 0.005 microns**;
wherein "substantially uniform" means that 95% of the values of the diameter measured along the length of a nanorod or nanotube are within ±10% of a mean value."

Second auxiliary request:

"1. A rigid porous structure which comprises a composition comprising a multiplicity of:
a) oxycarbide-based nanorods having substantially uniform diameters between 1.0 nm and less than 100 nm,

wherein said oxycarbide-based nanorods comprise oxycarbides;
b) carbide-based nanorods having substantially uniform diameters between 1.0 nm and 100 nm, wherein said carbide-based nanorods comprise oxycarbides; or
c) carbon nanotubes having substantially uniform diameters between 1.0 nm and 100 nm, wherein said carbon nanotubes comprise **a** carbide~~s~~ **portion which includes carbide-based nanorods**;
wherein "substantially uniform" means that 95% of the values of the diameter measured along the length of a nanorod or nanotube are within ±10% of a mean value**; and**
wherein said rigid porous structure has at least two dimensions of at least 10 microns and not greater than 2 cm."

Third auxiliary request:

"1. A rigid porous structure which comprises a composition comprising a multiplicity of:
a) oxycarbide-based nanorods having substantially uniform diameters between 1.0 nm and less than 100 nm, wherein said oxycarbide-based nanorods comprise oxycarbides;
b) carbide-based nanorods having substantially uniform diameters between 1.0 nm and 100 nm, wherein said carbide-based nanorods comprise oxycarbides; or
c) carbon nanotubes having substantially uniform diameters between 1.0 nm and 100 nm, wherein said carbon nanotubes comprise carbides **and further comprise oxycarbides**;

wherein "substantially uniform" means that 95% of the values of the diameter measured along the length of a nanorod or nanotube are within ±10% of a mean value."

Fourth auxiliary request:

"1. A rigid porous structure which comprises a composition comprising a multiplicity of:
a) oxycarbide-based nanorods having substantially uniform diameters between 1.0 nm and less than 100 nm, wherein said oxycarbide-based nanorods comprise oxycarbides; or
b) carbide-based nanorods having substantially uniform diameters between 1.0 nm and 100 nm, wherein said carbide-based nanorods comprise oxycarbides;
~~c) carbon nanotubes having substantially uniform diameters between 1.0 nm and 100 nm, wherein said carbon nanotubes comprise carbides;~~
wherein "substantially uniform" means that 95% of the values of the diameter measured along the length of a nanorod or nanotube are within ±10% of a mean value."

Fifth auxiliary request:

"1. **Use, as a catalyst or catalyst support, of** a rigid porous structure which comprises a composition comprising a multiplicity of:
a) oxycarbide-based nanorods having substantially uniform diameters between 1.0 nm and less than 100 nm, wherein said oxycarbide-based nanorods comprise oxycarbides;
b) carbide-based nanorods having substantially uniform diameters between 1.0 nm and 100 nm, wherein said carbide-based nanorods comprise oxycarbides; or

c) carbon nanotubes having substantially uniform diameters between 1.0 nm and 100 nm, wherein said carbon nanotubes comprise carbides;
wherein "substantially uniform" means that 95% of the values of the diameter measured along the length of a nanorod or nanotube are within ±10% of a mean value."

VI. Oral proceedings were held on 7 December 2007.

VII. The arguments of the appellants, submitted in writing and at the oral proceedings, as far as they are relevant to the present decision, can be summarised as follows:

(a) The claimed structures were novel as neither document (1), nor any of the other cited documents disclosed a rigid porous structure. Regarding the auxiliary requests, none of the cited documents disclosed a structure in which the average spacing between the nanotubes or nanorods was between 0.005 and 0.03 microns (first auxiliary request), a structure that had at least two dimensions of at least 10 microns and not greater than 2 cm (second auxiliary request), or a structure that comprised oxycarbides (third and fourth auxiliary request) or the use of carbide nanotubes/nanorods as a catalyst or catalyst support (fifth auxiliary request).

(b) The rigid porous structures encompassed by present claim 1, depending on the carbides or oxycarbides present in the structure, could be either catalytically inactive and be useful as catalyst support in the preparation of supported catalysts, or they could be catalytically active and be useful as self-supported catalysts. Starting from document (3) as closest prior art, the problem underlying the present invention could be identified as being to provide further catalyst supports or further catalytically active structures, as alternatives to the catalyst supports or supported catalysts of document (3).

(c) The documents cited would not provide any incentive to convert the nanofibers of the structures disclosed in document (3) into their corresponding carbides and/or oxycarbides, as none of them suggested that the claimed structures would be useful catalysts or catalyst supports.

(d) Document (4) taught how to prepare heavy metal carbides of high specific surface area by reacting a metal compound with active carbon, while document (5) disclosed the activation of those heavy metal carbides by oxidation, with a view to their use as catalysts, and document (2) disclosed a specific isomerisation process using the catalysts based on molybdenum oxycarbide. Document (1) related to a different use. There was nothing in any of the cited documents that would lead the skilled person to consider converting the nanofibers of the disclosed supports into heavy metal carbides and/or oxycarbides, as this would be tantamount to trying to turn the catalyst support into the catalyst itself. The skilled person would not have recognised that the resulting structures would be useful.

(e) Based on the contents of document (1) and on the scientifically reasonable concern that a treatment with a heavy metal compound at elevated temperature might preferentially and adversely affect the binder, the skilled person would not have reasonably expected that the conversion of carbon to carbide/oxycarbide would allow maintenance of the rigidity, the macroporosity, the substantial absence of micropores and the resistance to attrition during use of the structures of document (3). Furthermore, the problems described in document (4) suggested that the conversion to oxycarbide could lead to a loss of surface area. Therefore, the only thing suggested to the skilled person was that carbide/oxycarbide catalysts were difficult to obtain and to maintain in a high surface area condition. Hence, even if the skilled person were to consider modifying the structures of document (3) by applying the reactions disclosed in documents (2), (4) or (5), this would not have been obvious to try. Thus, the claimed subject-matter would not have been obvious in view of the prior art.

VIII. The appellants requested that the decision under appeal be set aside and that a patent be granted on the basis of the claims of the main request or, alternatively, on the basis of any one of the auxiliary requests 1 to 5, all requests as filed by letter of 14 November 2007.

IX. At the end of the oral proceedings the decision of the Board was given orally.

Reasons for the Decision

1. The appeal is admissible.

Main request

2. Amendments and novelty

The Board is satisfied that the claims according to the main request find a basis in the application as originally filed and are novel over the cited prior art documents. Detailed reasoning on this is superfluous as claim 1 fails on other grounds.

3. *Inventive step*

3.1 Closest prior art

The closest prior art for assessing inventive step is normally a prior art document disclosing subject-matter conceived for the same purpose or aiming at the same objective as the claimed invention and having the most relevant technical features in common, i.e. requiring the minimum of structural and functional modifications (Case Law of the Boards of Appeal of the European Patent Office, 5th edition, 2006, I.D.3.1 and 2.).

The present application aims at overcoming the problems linked to the use of activated carbons and charcoals as catalyst supports or catalysts (page 2, lines 9 to 16 and 30 to 32, page 3, lines 22 to 25). It addresses in particular the problem of providing a family of catalysts and catalyst supports that have high accessible surface area, porosity, resistance to attrition and purity, for the conduct of a variety of selected petrochemical and refining processes (page 3, lines 22 to 31). The claimed solution consists in the rigid porous structures defined in claim 1 of the main request which comprise a multiplicity of either:

- carbon nanotubes which comprise carbides and have substantially uniform diameters between 1.0 nm and less than 100 nm (alternative c)), or
- carbide-based nanorods which comprise oxycarbides and have substantially uniform diameters between 1.0 nm and less than 100 nm (alternative b)), or
- oxycarbide-based nanorods which comprise oxycarbides and have substantially uniform diameters between 1.0 nm and less than 100 nm (alternative a)).

The Board, in agreement with the appellants, considers document (3) to represent the closest state of the art and, hence, the starting point in the assessment of inventive step. That document relates to catalyst supports and supported catalysts for use in chemical processes in the petrochemical industry (page 6, line 33 to line 37) which overcome the problems associated with the use of carbons and charcoals (page 2, line 16 to page 3, line 30). The catalyst supports and supported catalysts of document (3) comprise a rigid porous carbon nanofiber structure (claims 1 and 2, page 30, lines 12 to 15). They have high accessible surface area (page 18, lines 18 to 19) and are exceptionally macroporous, pure and resistant to attrition (page 30, lines 16 to 19). Preferably, the carbon nanofibres have an average diameter less than 0.01 microns (i.e. less than 10 nm) (page 11, lines 26 to 30 and page 21, lines 31 to 35) and are substantially cylindrical with a substantially constant diameter (page 11, lines 26 to 34 and page 21, line 31 to page 22, line 3). The carbon nanofibres used in document (3) can be nanotubes (page 13, lines 23 to 30, claim 21).

The rigid porous structures according to document (3) are obtained by causing the carbon nanofibres to form bonds with other nanofibers at the fiber intersections (page 18, lines 27 to 31 and page 22, lines 6 to 15). The bonding can be induced by chemical modification of the surface of the nanofibers or by addition of a "gluing" agent followed by pyrolyzation (page 18, lines 31 to 35 and page 22, lines 16 to 22). Document (3) discloses in particular in example 14 the hydrogenation of nitrobenzene to aniline, using a Pd catalyst supported on a porous rigid structure obtained by pyrolyzing glued carbon nanofibers.

3.2 Problem solved

In view of this state of the art, the appellants submitted that the technical problem underlying the application consisted in providing further catalyst supports or further catalytically active structures, as alternatives to the catalyst supports or supported catalysts of document (3). The Board, in view of the examples given in the application, is satisfied that the above-identified problem has been successfully solved.

3.3 Obviousness

It remains to be decided whether or not the skilled person starting from document (3) and wishing to solve the above defined problem would have been guided towards the claimed subject-matter by the available prior art, in particular whether this suggested modifying the carbon structures of document (3) into carbide or oxycarbide.

Carbon nanotubes which comprise carbides - alternative c)

3.4 The skilled person, whose aim starting from document (3) is to provide further catalyst supports or further catalytically active structures, would be prompted to provide structures having sufficient specific surface area, as generally catalytic activity is proportional to catalyst surface area (document (3), page 2, line 4 to line 6). He would therefore only consider modifications which lead to a material having sufficient specific surface area or catalytic activity. The skilled person would therefore consider document (4) which relates to the transformation of known catalyst supports based on active carbon into a carbide based product for providing catalysts or catalyst carriers, which exhibit a specific surface area up to 300 m^2/g (page 4, lines 28 to 33). The transformation involves reacting the reactive carbon with a compound of a heavy metal in a gaseous state, at a temperature between 900 and 1400°C, preferably between 1000 and 1250°C (claim 1, page 3, lines 3 to 6 and lines 34 to 38) in order to retain a memory of the large surface area of the reactive carbon (page 3, lines 19 to 22). The rate of conversion of the active carbon is preferably between

40 and 100% (page 4, lines 8 to 10). When the transformation of the carbon into carbide is partial, particles with a central part or core made from carbon covered with at least one large surface carbide layer are obtained, as stated by the inventors of document (4) in document (5) (page 5, lines 18 to 26).

The technical knowledge of the skilled person in the field of document (3) also encompasses the chemistry of carbon nanofibres. He is therefore also well aware of the teaching of document (1) concerning the transformation of carbon nanotubes into carbide nanofibrils (claims 1 and 10 and page 4, lines 3 to 6). The carbide nanofibrils of document (1) which have diameters substantially less than about 100 nm (claim 1) are obtained by heating carbon nanotubes or nanofibrils predominantly having diameters less than about 50 nm in the presence of a gaseous metallic compound. The temperature is selected sufficiently high to cause formation of solid carbide nanofibrils, but must be sufficiently low to prevent substantial fusing together of individual carbide nanofibrils (claim 10), i.e. is preferably comprised between 1000° and 1400°C and most preferably around 1200°C (claims 11 and 12 and page 13, lines 1 to 4). Document (1) also indicates that the transformation of carbon nanofibrils to carbide nanofibrils is pseudo-topotactic (page 12, lines 29 to 31), an expression which is used to indicate that the morphology of the individual carbon nanotubes and carbide nanofibrils are similar (page 11, lines 10 to 14), or that the external structure of the nanotubes is conserved (page 10, lines 12 to 17) as a result of topotactic growth during the transformation. In example 1 of document (1) carbon nanotubes are converted into silicon carbide nanofibrils with diameters ranging from 5 to 100 nm (page 10, lines 22 to 24). A typical diameter of the silicon carbide nanofibril is about 20 nm, which is about twice the typical diameter of the starting carbon nanotubes (page 7, lines 8 to 10 and page 10, lines 17 to 21).

Hence, the skilled person looking for further catalyst supports or further catalytically active structures, as alternatives to the catalyst supports or supported catalysts of document (3), would have been aware that the reaction conditions applied in document (4), which allow retention of a memory of the large surface area of the reactive carbon, are the same as those which allow according to document (1) the transformation of the carbon nanotubes into a carbide structure having the same morphology. It follows that the skilled person, who wanted to provide further catalyst supports or further catalytically active structures, as alternatives to the catalyst supports or supported catalysts of document (3), would have been guided to apply to the porous structure of document (3) the transformation applied to the active carbon of document (4), thereby arriving in an obvious manner at embodiment c) of present claim 1.

Carbide-based nanorods which comprise oxycarbides - alternative b)

3.5 When looking for a solution to the problem stated above, the skilled person would also have considered document (5) which discloses the transformation of active carbon into catalysts for petrochemical and chemical reactions (example 1, claim 1, page 4, lines 11 to 16, page 3, lines 18 to 30). In example 1, a molybdenum carbide material having an initial specific surface of 180 m^2/g, which by reference to example 1 of document (4) is defined to be obtained by transformation of an active carbon, was treated so as to form oxycarbides on the surface of the molybdenum carbide material (page 4, line 28 to page 5, line 41). After the treatment, the product obtained had a specific surface area of 135 m^2/g and was a suitable catalyst for the reformation of n-hexane.

As pointed out in the above paragraph, document (5) explicitly refers to the process used in document (4) for the transformation of the active carbon into carbide. The skilled person is therefore aware that the reaction conditions applied in document (5) for transforming in a first step the porous active carbon into carbide, while retaining a memory of the large surface area of the active carbon, are the same which allow in document (1) to transform the carbon nanotubes into a carbide structure having the same morphology. He is further taught in document (5) that oxidation of the carbide structure provides oxycarbides having catalytic properties. Hence, the skilled person searching to provide further catalyst supports or further catalytically active structures, as alternatives to the carbon based catalyst supports or supported catalysts of document (3), would have been guided to apply to the porous structures of document (3) the transformations operated in document (5) with active carbons, arriving thereby in an obvious manner at embodiment b) of present claim 1.

3.6 The same conclusion is also arrived at on the basis of the teaching of document (2), which concerns the transformation of carbon with a large specific surface area into catalysts for the isomerization of straight chain hydrocarbons having at least seven carbon atoms (claims 1 and 2). The catalysts of document (2) may be prepared by reacting volatile MoO_3, on carbon with a large specific surface area to form molybdenum carbide and then activating the molybdenum carbide by at least surface oxidation so as to form oxycarbides present at the surface which are responsible for the catalytic activity (column 5, lines 54 to 56).

3.7 The appellants' argument that documents (2), (4) and (5) would not lead the skilled person to consider converting the nanofibers of the supports of document (3) into heavy metal carbides and/or oxycarbides, as this would be tantamount to trying to turn the catalyst support into the catalyst itself must be rejected. Not only does document (4) teach that the metal carbides obtained can be used either as catalyst carriers or as catalysts (page 2, lines 47 to 48 and page 3, line 21), but also the problem underlying the present invention encompasses the provision of further catalyst supports.

3.8 The appellants argued that it would not have been obvious to try to modify the structures of document (3) by applying the reactions disclosed in documents (2), (4) or (5) with a reasonable expectation of success, because it would not have been expected that the macroporosity and the substantial absence of micropores would survive the conversion to carbides or oxycarbides. This argument cannot be followed for the following reasons:

(a) The skilled person is first of all well aware of the unusually high internal void volume of the structures of document (3), which comprises mainly macropores allowing accessibility to the reactants and products (page 30, lines 29 to 36). The structure disclosed in example 8 exhibits in particular a 93% void volume. The macroporosity of the structures of document (3) is said to be unique and to result from the entanglement or intertwining of the nanofibres (page 30, lines 33-36), i.e. the macropores are located in the interstices and spaces created between the nanofibers. From document (1) it is furthermore known that the transformation of carbon nanotubes into carbide nanofibrils is pseudo tactic and increases the diameter of the nanotubes by at most a factor two. Thus, the skilled person would expect that the transformation of carbon nanotubes into carbides as operated in document (1) would leave enough void volume and macropores, when applied to the structures of document (3).

(b) In addition, document (4) shows that the transformation of active carbon into corresponding carbide structures results in materials having enough specific surface area for making them suitable as catalyst supports or catalysts (page 3, lines 19 to 21). Document (5) also shows the same effect for the transformation of active carbon into corresponding oxycarbide structures (see above point 3.5).

(c) It is therefore concluded, that the skilled person would not have been deterred, but on the contrary would have been encouraged to transform the carbon structures of document (3) into carbide or oxycarbide structures by applying the conditions applied in document (1), (4) and (5), in order to obtain a material, which possesses enough specific surface area and accessibility to be a suitable catalyst support or catalyst.

3.9 The appellants also affirmed that the skilled person would have a scientifically reasonable concern that the conversion reactions disclosed in documents (2), (4) and (5) might adversely affect the binder used in document (3), causing a loss of rigidity, of resistance to attrition during use or of macroporosity of the structures. The appellants, who carry the onus of proof for their allegation, however, submitted no evidence which would have shown that a prejudice existed against contemplating the transformation of the carbon structures of document (3) into carbide or oxycarbide structures. In the absence of such evidence it cannot be concluded that the skilled person was diverted away from the claimed process by a technical prejudice.

3.10 The appellants' assertion, that the importance of chemical purity for the catalyst and for the catalyst support would have deterred the skilled person from modifying the porous structures of document (3), also fails to convince, because the transformation operated in documents (4), (2) or (5) using carbon materials of lower purity (see document (3), page 3, lines 17 to 34) also provides suitable catalysts or catalyst supports.

3.11 The affirmation of the appellants, that one would not reasonably expect, in view of the knowledge of document (1), that the binding or the pore structure would be left intact when transforming the carbon structure into carbides, must be disregarded as none of these effects has been shown to be achieved for the present invention either.

3.12 The appellants also argued that the inventors of document (4) encountered problems retaining a memory of the large specific surface area of the reactive carbon substrate, and therefore that the skilled person would not apply the teaching of document (4) to the structures of document (3). The Board notes that the problem the appellants refer to, however, has been successfully solved by the inventors of document (4) in selecting appropriate experimental conditions (page 3, lines 34 to 38). Thus, this argument also fails to convince.

3.13 It is therefore concluded that the subject-matter of claim 1 of the main request does not meet the requirements of Article 56 EPC, as at least embodiments b) and c) encompassed within this subject-matter can be derived in an obvious manner from the prior art.

First auxiliary request

4. The subject-matter of claim 1 of the first auxiliary request is based on that of claim 1 of the main request, with the difference that the average distance between the nanorods of embodiments a) or b) or the nanotubes of embodiment c) has been defined to be less than

0.03 microns and greater than 0.005 microns and that the feature "said carbon nanotubes comprise carbides" in embodiment c) has been replaced by "said carbon nanotubes comprise a carbide portion which includes carbide-based nanorods".

Although the Board has some doubts concerning the meaning of an average distance between the carbon nanotubes as defined in embodiment b) or carbide-based nanorods in embodiment c), as the application does not explain how such distance is to be assessed on nanotubes or nanorods which interconnect at points, it is noted that the porous rigid structure of document (3) also preferably has an average distance between carbon nanotubes and/or nanorods that varies between 0.005 microns and 0.03 microns (page 21, lines 12 to 14). In view of the growth mechanisms reported in document (1) for the transformation of the carbon nanotubes into carbide nanorods, the average distance between the carbide-based nanorods in embodiment (b) of present claim 1 would be the inevitable result of the structures of document (3) after these had been treated in the obvious manner discussed above in point 3.5. Thus, introducing these particular limits in the claim on the average distance between the nanorods does not avoid the argumentation regarding obviousness given above for claim 1 of the main request. Hence, the subject-matter of claim 1 of the first auxiliary request must also fail (Article 56 EPC).

As claim 1 is not allowable, it is not necessary to decide on whether or not the use of the wording "said carbon nanotubes comprise a carbide portion which includes carbide-based nanorods" for defining embodiment c) of claim 1 is in accordance with the requirements of Article 84 EPC.

Second auxiliary request

5. The subject-matter of claim 1 of the second auxiliary request is based on that of claim 1 of the main request, with the difference that the rigid porous structure is defined to have at least two dimensions of at least 10 microns and not greater than 2 cm. According to the appellants, this amendment had been solely introduced to overcome an objection of lack of novelty over document (1). In view of the use of rigid porous carbon structures having such dimensions in the closest prior art (document (3) examples 13, 14 and 17), the amendment does not serve to change the conclusion that the claimed subject-matter lacks an inventive step (Article 56 EPC) already arrived at for the previous requests.

Third and fourth auxiliary requests

6. Claim 1 of the third and fourth auxiliary requests still contains embodiment b) of claim 1 of the main request, which has been found obvious (point 3.13 above). Hence, the third and fourth auxiliary requests must fail on the same ground as given for the main request.

Fifth auxiliary request

7. Claim 1 of the fifth auxiliary request is directed to the use of embodiments a), b) and c) defined in claim 1 of the main request, as catalysts or catalyst supports.

As this use, disclosed in document (3), was already part of the technical problem which was found to have been solved in an obvious manner over document (3), the amendments contained in the fifth auxiliary request do not change the conclusion arrived at for the main request. Thus, the fifth request must also be refused.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar	The Chairman
C. Eickhoff	S. Perryman