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**Datasheet for the decision
of 18 November 2010**

Case Number: T 0011/08 - 3.3.05

Application Number: 01958635.3

Publication Number: 1286918

IPC: C01F 7/00

Language of the proceedings: EN

Title of invention:

Improved mechanical strength of hydrotalcite-based oxides

Patentee:

Statoil ASA

Opponent:

Albemarle Catalysts B.V.

Headword:

Hydrotalcite/STATOIL

Relevant legal provisions:

EPC Art. 54(1)(2), 56, 83, 100(b)

Keyword:

"Sufficiency of disclosure (yes)"

"Novelty - Main request (yes)"

"Inventive step - Main request (yes): Non-obvious improvement"

Decisions cited:

T 0247/91

Catchword:

-



Case Number: T 0011/08 - 3.3.05

D E C I S I O N
of the Technical Board of Appeal 3.3.05
of 18 November 2010

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Decision under appeal: Interlocutory decision of the Opposition
Division of the European Patent Office posted
31 October 2007 concerning maintenance of the
European patent No. 1286918 in amended form.

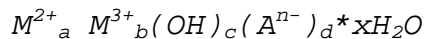
Composition of the Board:

Chairman: B. Czech
Members: J.-M. Schwaller
S. Hoffmann

Summary of Facts and Submissions

I. The appeal is from the decision of the opposition division concerning maintenance of European patent No. 1 286 918 in amended form on the basis of the main request filed with letter dated 02.06.2006, independent claims 1, 5, 11, 12 and 15 of which read as follows:

"1. A hydrotalcite-based material having an improved mechanical strength, said hydrotalcite having the following general formula:



wherein M^{2+} is Mg; M^{3+} is Al; A is an n-valent anion, n is 1 or 2 and a and b are positive numbers, $a > b$, which hydrotalcite is deposited on alumina or an alumina precursor by coprecipitation in a liquid suspension of alumina or an alumina precursor."

5. A method for the preparation of a hydrotalcite as defined in any one of claims 1 to 4 characterized in that the hydrotalcite is coprecipitated in an intimate contact with alumina or an alumina precursor in a liquid suspension.

11. Use of a hydrotalcite-based material of any one of claims 1-4 as a catalyst support material.

12. A catalyst for use in the dehydrogenation of alkanes, said catalyst comprising a catalytic active metal being impregnated on the hydrotalcite-based material of any one of claims 1-4.

15. A process for the catalytic dehydrogenation of propane, wherein propane is contacted with the catalyst of claims 12-14 at the standard pressure, temperature and space velocity conditions for such dehydrogenation reactions."

II. In the contested decision the opposition division concluded that the patent as amended was not objectionable under Article 100(b) and (c) EPC and that the claimed subject-matter was novel and inventive in view of the cited prior art, which included the following documents:

D1: GB 1 462 059

D2: WO 99/41197

D4: US 5 507 980

D5: GB 2 311 790

D7: Translation into English of the Norwegian patent with the publication number NO 316440 B1 (D6), granted from the Norwegian patent application NO 20002543, from which the contested patent also claims priority.

More particularly, the opposition division found that the subject-matter of claim 1 was novel over D2.

Starting from D2 as representing the closest prior art, the subject-matter of claim 1, and of claims 2 to 15 referring back to claim 1, was inventive since "neither D2 nor the prior art discussed in passage [0008] of the

patent in suit disclosed a co-precipitation step as claimed in claim 1 of the patent in suit as being useful for increasing the SCS [side crushing strength] of the product".

III. In its statement of grounds of appeal, the opponent (hereinafter the "appellant") raised objections under Article 100(a) and 100(b) EPC and alleged in particular lack of novelty in the light of document D2 and lack of inventive step over documents D2 and D4. In this respect, it referred to D7 as regards the side crushing strength ("SCS" hereinafter) values missing in certain examples of the contested patent.

IV. With its reply dated 15 September 2008, the patent proprietor (hereinafter the "respondent") submitted the new document:

D8: Catalysis Today, vol. 11 (1991), pages 173 to 177

along with four sets of amended claims as auxiliary requests 1 to 4, respectively, and rebutted the objections raised by the appellant.

V. The parties having been summoned to oral proceedings, the appellant declared that it would not attend the oral proceedings and asked the board to decide on the basis of the arguments in the grounds of appeal.

VI. At the oral proceedings, which were held on 18 November 2010 in the absence of the appellant, the issues of disclosure of the invention, novelty and inventive step were extensively dealt with.

VII. The arguments of the parties can be summarised as follows:

With respect to sufficiency of disclosure the appellant argued that in view of claims 3, 4 and 12, the wording of claim 1 was ambiguous, as the expression "improved mechanical strength" in claim 1 did not mention any comparative material or measuring method. Moreover, according to the description, the improved mechanical strength was only obtained after calcination of the material. However, claims 3, 4 and 12 appeared to suggest that claim 1 also covered the material before calcination.

Taking the SCS values missing in the patent suit from document D7, it appeared that the material in example 9 of the patent did not have the required increased mechanical strength. Hence it was unclear to the skilled person what technical measures should be taken to reliably obtain the improved mechanical strength defined in the claims.

Moreover, considering the indications given in the examples, one would expect that the final products consisted of hydrotalcite formed in part by reaction of excess Mg^{2+} with the small alumina particles used. Therefore, none of products described and tested was within the scope of the claims.

It was further questionable whether the patent contained sufficient information as to how hydrotalcite materials having compositions throughout the broad general formula defined in claim 1 could be obtained.

Regarding novelty, the appellant argued that D2 disclosed the in-situ deposition of hydrotalcite in the presence of a slurry of alumina by a process that could be regarded as coprecipitation. The skilled person would seriously contemplate the use of soluble sources of magnesium and aluminium taught by D2. Furthermore, in accordance with decision T 0247/91 of 30 March 1993, the teaching of a prior art reference was not limited to its examples. So, the material according to claim 1 at issue lacked novelty over the disclosure of D2 as a whole.

The appellant further held document D2 to represent the closest state of the art, and contested the presence of an improvement in mechanical strength in comparison to the products of D2. The claimed invention was merely an alternative way of preparing the materials of D2. In view of the information comprised in D4 concerning the necessity of forming bonds between hydrotalcite and the inorganic carrier, the skilled person would immediately appreciate that a process as disclosed in D2 would be beneficial to the mechanical strength of the material. To the extent that claim 1 also covered uncalcined material, the problem of increasing mechanical strength was not solved.

The respondent argued that the invention as claimed could be carried out by a skilled person based on the information contained in the patent. Claim 1 covered both the calcined and the uncalcined materials. Hence there was no discrepancy between claim 1 and claims 3, 4 or 12. The feature "improved mechanical strength" had no limiting effect on claim 1. Hydrotalcites differing from those exemplified and falling under the formula

recited in claim 1 could be obtained by varying the ratios of the reagents and ascertaining the presence of a hydrotalcite phase by means of X-ray diffraction ("XRD" hereinafter). The respondent also held that alumina particles present in the material that were too small or rendered amorphous may not be detectable by XRD. In this connection it held that claim 1 even covered materials which no longer comprised alumina or an alumina precursor after calcination.

Having regard to novelty, the respondent considered that there was no direct and unambiguous disclosure in D2 as a whole of a coprecipitation step in the sense of claim 1 at issue. It also argued that several choices had to be made within the disclosure of D2 to arrive at a product according to claim 1. Furthermore, the examples of D2 did not disclose coprecipitation of soluble magnesium and aluminium salts. At the oral proceedings, it pointed out that coprecipitation in a suspension of alumina or a precursor thereof led to a specific morphology with very small crystallites (reference was made to D4, column 2, lines 7 to 10) deposited onto particles of alumina or an alumina precursor - as opposed to the material grown onto aluminium trihydrate particles by reaction under hydrothermal conditions (several hours at elevated temperature) according to D2. Calcination led to a material having an increased mechanical strength resulting from its specific microstructure.

Having regard to inventive step, it could be inferred from a juxtaposition of the examples of the patent in suit and of D7 that the problem underlying the patent in suit which consisted in increasing the mechanical

strength of hydrotalcite materials was solved by the claimed materials. Neither D2 nor D4, nor any of the other documents cited, suggested that materials prepared by coprecipitation of an Mg-Al hydrotalcite in the presence of alumina or an alumina precursor suspension would provide materials which, when calcined, displayed increased mechanical strength in comparison to composite materials obtained from conventional mixtures of hydrotalcite with alumina or an alumina precursor.

VIII. The appellant requested in writing that the decision under appeal be set aside and that the European patent be revoked in its entirety.

The respondent requested that the appeal be dismissed (main request) or, in the alternative, that the patent be maintained on the basis of one of the sets of claims according to auxiliary requests 1 to 4 filed under cover of its letter dated 15 September 2008.

Reasons for the Decision

1. *Amendments*

The board is satisfied that the amendments to the claims are of a restricting nature and find a basis in the application as filed. Therefore, it sees no reason for calling into question the finding of the opposition division concerning the allowability of the amended claims under Article 123(2) and (3) EPC, which was not challenged by the appellant.

2. *Meaning of the terms used in claim 1*

2.1 In the technical field of the patent in suit, a coprecipitation of magnesium and aluminium as referred to in claim 1 requires a soluble magnesium source, a soluble aluminium source and conditions leading to the simultaneous precipitation of magnesium and aluminium cations, e.g. by addition of a precipitating agent such as alkali. Having regard to the meaning of the term coprecipitation in the technical field concerned, reference can for instance be made to D2, comparative example 2, and D4, column 2, lines 7 to 10. Accordingly, in the examples of the patent in suit (paragraphs [0034] and [0037]), the coprecipitation of magnesium and aluminium is brought about by mixing an alkaline solution as precipitating agent with dissolved salts of magnesium and aluminium.

2.2 The expression "*hydrotalcite-based material*" according to claim 1 designates a coprecipitated compound having the formula recited in claim 1 deposited on alumina or alumina precursor particles, the compound being identifiable as hydrotalcite-like e.g. by means of X-ray diffraction ("XRD" hereinafter), whereas the supporting alumina or alumina precursor particles may or may not be visible in XRD after the precipitation and deposition steps, depending on their initial size (see paragraph [0040] and page 6, lines 2 and 3).

Moreover, in view of dependent claim 3, the expression "*hydrotalcite-based material*" must be understood as also designating the material obtained when subsequently drying and calcining said coprecipitated material. In the absence of corresponding information

in the description, the board does not, however, accept the appellant's view that the alumina or alumina precursor particles may be fully consumed during the subsequent drying or calcination steps. For the board, a material no longer comprising detectable alumina or a detectable alumina precursor is thus not covered by the wording of claim 1.

2.3 The wording of present claim 12 ("*...catalyst comprising a catalytic active metal being impregnated on the hydrotalcite-based material of any one of claims 1-4*") unambiguously leaves open the possibility of impregnating the active material either before or after the drying and calcination steps.

2.4 Claim 1 specifies neither the basis of the comparison to be made nor the method used for measuring the mechanical strength of the claimed products. Hence the relative expression "*having an improved strength*" in its broadest technical meaning implies no further limitation of the claimed subject-matter, i.e. in addition to those limitations - in terms of product properties - already implied by the other features of claim 1.

2.5 Consequently, present claims 1, 3, 4 and 12 are not ambiguous, as alleged by the appellant.

3. *Sufficiency of disclosure*

3.1 Based on the above understanding of claim 1, the board does not accept the appellant's contention that the invention was not sufficiently disclosed for it to be

carried out by a skilled person, for the following reasons.

- 3.2 The patent specification (paragraphs [0013] to [0024]) describes in detail the process for preparing a hydrotalcite-based material as claimed. It furthermore contains three examples (namely the two different runs according to example 1, and example 9) which illustrate in detail the preparation of three different such materials. Under these circumstances and in the absence of evidence to the contrary, the board has no reason to consider that the claimed materials cannot be prepared without undue burden by a person skilled in the art.
- 3.3 The board does not accept the appellant's argument that since magnesium is in molar excess in the examples of the contested patent, one would expect - owing to the teaching of D2 - that the suspended alumina would totally disappear as a consequence of a quantitative reaction of the excess magnesium with the suspended alumina so as to form additional hydrotalcite. As pointed out by the respondent, the operating conditions in the examples of the patent in suit (contact time of 45 minutes at a temperature of 60°C) are far from being as severe in terms of contact time and temperature as those described in examples 7 (65°C, overnight), 8 (90°C, 24 h), 9 (65°C, 24 h) and 10 (hydrothermal conditions with 1 hour at 170°C). Hence, the board considers it plausible that a substantial reaction of the suspended alumina with the magnesium in excess does not occur in the examples of the patent in suit.
- 3.4 Concerning the statement in paragraph [0040] of the contested patent that "when alumina particles smaller

than 90 micrometers were used, no alumina phase was present in the XRD pattern after the reaction", the board accepts the respondent's explanation - not contested by the appellant - that the alumina particles might be rendered amorphous during the coprecipitation and metal deposition steps (page 6, lines 2 to 3 of the contested patent) and/or, as pointed out during the oral proceedings, too small to be identified by XRD.

- 3.5 The appellant also argued that there was no disclosure in the patent in suit of how the coprecipitation conditions would have to be changed for preparing hydrotalcite-based materials with Mg/Al ratios differing from the typical ratio of 6:2, with different anions from CO_3^{2-} and OH^- , or with a $\text{CO}_3^{2-}/\text{OH}^-$ ratio other than the ratio 1:16.

The board, however, has no doubt that other "hydrotalcite-based materials" may be prepared without undue burden by a person skilled in the art, e.g. by simply varying the proportions of reactants, as explained by the respondent. Furthermore, it can easily be assessed whether or not a hydrotalcite-like material has been successfully prepared by comparing the XRD diagram with that of a reference hydrotalcite.

- 3.6 For the above reasons, the board concludes that the patent in the amended version held allowable by the opposition division is not objectionable under Article 100(b) EPC.

4. *Main request - Novelty*

4.1 D2 discloses (see page 9, lines 11 to 22) the preparation of an anionic clay-containing composition. The process comprises reacting a magnesium source and an aluminium trihydrate or its thermally treated form in aqueous suspension to obtain the anionic clay and an unreacted aluminium-containing composition. The magnesium source may be composed of a solution of a magnesium salt, a solid magnesium-bearing compound or a mixture of the two, but preferably it is used in the form of a slurry of MgO (page 11, line 3; examples 7 to 10). Reaction between the magnesium source and aluminium trihydrate or its thermally treated form results in the formation of an anionic clay with a layered structure having the formula $[Mg_m^{2+}Al_n^{3+}(OH)_{2m+2n}]_c(X_{n/z}^{z-}) \cdot bH_2O$, wherein X may be CO_3^{2-} , OH^- or any other anion normally present in the interlayers of anionic clays, and wherein it is particularly preferred that m/n has a value close to 3 (page 10, line 22, to page 11, line 3). Part of the aluminium source remains unreacted and ends up in the anionic clay-containing composition.

4.2 It is also mentioned in D2 (page 12, lines 13 to 21) that a soluble aluminium source may be used as an additional aluminium source. However, D2 does not directly and unambiguously disclose a coprecipitation (see point 2.1 above) of magnesium and aluminium salts. On the contrary, in all the examples (7 to 10) actually illustrating the invention according to D2, the anionic clay-containing composition is formed by reaction of a suspension of MgO with gibbsite (a crystalline aluminium trihydrate). The reaction product is "a

mixture of a carbonate-containing anionic clay and unreacted gibbsite". It was common ground between the parties that the material formed according to these examples comprised an Mg-Al hydrotalcite and an alumina precursor.

4.3 During the oral proceedings, the respondent submitted that the hydrotalcite-based material defined in claim 1 at issue could be distinguished from the products obtained according to Examples 7 to 10 of D2, since a coprecipitation of magnesium and aluminium led to a specific micro-morphology differing from the one obtained when reacting aluminium trihydrate particles with a suspension of MgO as the magnesium source. The passages of D4 (column 2, lines 7 to 24; column 4, lines 9 to 14) that the respondent invoked in support of its argument confirm that the microstructure of hydrotalcite depends on its method of preparation. In the absence of evidence to the contrary, the board thus accepts that the hydrotalcite-based material as defined in claim 1 at issue differs from the products obtained according to the examples of D2 by virtue of its microstructure.

4.4 As correctly pointed out by the appellant, D2 (page 12, lines 18 to 19 and 25 to 28) also mentions the possibility of using a soluble aluminium salt - as a second source of aluminium - and the possibility of using a soluble magnesium salt. However, the board does not accept the appellant's conclusion that in this manner a product was inevitably generated by coprecipitation, as the latter requires (see point 2.1 above) the use of a soluble Mg source, a soluble Al source **and** precipitation conditions, brought about e.g.

by using an alkaline precipitating agent. However, neither the above passages cited by the appellant nor D2 taken as whole refer expressly or implicitly to the simultaneous addition of soluble salts of both magnesium and aluminium, let alone under precipitating conditions. Therefore, D2 does not directly and unambiguously disclose a coprecipitation step in the sense of claim 1, and hence a green (i.e. not dried and calcined) material as claimed.

4.5 Having regard to the oxidic "hydrotalcite-based" material obtained by drying and calcining the green hydrotalcite/alumina, which is also covered by claim 1 at issue, the board notes that examples 7 to 10 of D2 as such do not describe a drying or calcination step. Moreover, in view of the experimental data in the patent in suit, the board accepts that the particular microstructure of the green product leads to a specific microstructure of the dried and calcined product which is reflected in its high mechanical strength (see point 5.5.4 below), and which makes calcined products as defined in present claims 3 and 4 distinguishable from products prepared according to the examples of D2, even if the latter were calcined according to the general teaching in e.g. claim 15 of D2.

4.6 Hence, D2 does not directly and unambiguously disclose materials according to claim 1. The materials are thus novel over the disclosure of D2.

4.7 The board is satisfied that none of the other documents cited in the appeal and opposition procedures discloses in combination all the features of claim 1 at issue.

4.8 Independent claims 5, 11, 12 and 15 relate, respectively, to a method for the preparation of the material according to claim 1, the use of said material, a catalyst comprising said material, and a process making use of said catalyst.

4.9 For the above reasons, the board is satisfied that the subject-matter of claims 1 to 15 at issue is novel (Article 54(1) and (2) EPC).

5. *Main request - inventive step*

5.1 The contested patent (paragraphs [0001] and [0011]) relates to a hydrotalcite-based material having an improved mechanical strength, to a method for its preparation and to specific uses of said material.

5.2 For the board, the closest prior art is represented by document D4, since this document discloses similar materials comprising hydrotalcite and inorganic metal oxide(s) and moreover deals with the problem of achieving good mechanical (crush) strength.

5.2.1 More particularly, D4 discloses (see claim 1) a process of making inorganic composite materials having good mechanical strength, comprising contacting
(i) an effective amount of a hydrotalcite-like material, in the form of a plurality of sheets having the composition $(Mg_{1-x}Al_x)(OH)_2 \cdot xA^- \cdot nH_2O$, wherein A^- is a mono carboxylic anion,
(ii) at least one inorganic material and
(iii) an effective amount of water,
and then drying.

5.2.2 The "hydrotalcite-like material" referred to under (i) above is made by contacting an aluminium compound with a magnesium compound in water, together with a carboxylic acid. The aluminium source can be in the form of a reactive oxide, hydroxide, anionic salt or a mono carboxylic acid salt, preferably sodium aluminate or pseudoboehmite, with pseudoboehmite being the most preferred (D4, column 4, lines 57 to 64).

In the embodiment illustrated in Example 1 of D4, hydrotalcite is prepared from pseudoboehmite and magnesium oxide in the presence of acetic acid.

5.2.3 The "inorganic material" referred to under point 5.2.1 (ii) above is selected from the group consisting of single metal oxides, mixed metal oxides, and physical mixtures of metals from groups IIA to IVA and the transition metal series (D4, claim 6).

As aluminium belongs to group IIIA of the periodic table of elements, alumina thus falls under the "inorganic material" contemplated in D4.

5.2.4 D4 explicitly discloses that using an aluminium salt as the aluminium compound is "not preferred" (column 4, lines 64 to 66). Similarly, it also explicitly discloses that using a magnesium salt as the magnesium source is "not preferred" (column 5, lines 1 to 3).

So, D4 does not teach coprecipitation (in the usual meaning of the term, see point 2.1 above) of these two cations. Moreover, it may be noted that D4 (column 4, lines 9 to 11 in conjunction with column 2, lines 7 to 9 and 13 to 15) expressly points out that the

hydrotalcite to be used differs from the one obtained by coprecipitation.

5.3 Starting from the closest state of the art according to D4, the technical problem can be seen in providing hydrotalcite-based composite materials which after drying and calcining give rise to an improved mechanical strength (expressed as SCS), as well as calcined hydrotalcite-based composite materials of improved strength (see also sections [0001] and [0009] of the patent in suit).

5.4 As a solution to this technical problem the patent in suit proposes the hydrotalcite-based green or calcined materials according to claim 1, which are characterised in that hydrotalcite having the formula $M^{2+}_a M^{3+}_b(OH)_c(A^{n-})_d \cdot xH_2O$, wherein M^{2+} is Mg, M^{3+} is Al, A is an n-valent anion, n is 1 or 2 and a and b are positive numbers with $a > b$, is deposited on alumina or an alumina precursor by coprecipitation in a liquid suspension of alumina or an alumina precursor.

5.5 The board is satisfied that the problem is solved by the claimed green or calcined hydrotalcite-based materials.

5.5.1 It can be gathered from the patent in suit, in conjunction with the information provided in the corresponding parts of document D7, that catalyst pellets made from a calcined Mg-Al hydrotalcite according to claim 1 at issue have an SCS of from 158 N (see example 9 of the patent in suit and example 7 of D7) up to 441 N (Example 1 of the patent in suit, catalyst 2 in Table 2). More specifically, the pellets

prepared with 0.38 mol suspended pseudo-boehmite have an SCS of 436 N (Example 1, catalyst 1 in Table 2), while those prepared with a much lower quantity (0.076 mol) of suspended pseudo-boehmite still have an SCS of 158 N (Example 9). As can be seen from the two runs carried out in Example 1 of the patent in suit (Table 2, catalysts 1 and 2), pellets made from composite material comprising comparable amounts of aluminium either in the form of an alumina precursor (0.38 mol $\text{AlO}(\text{OH})$) or alumina (0.23 mol theta-alumina) both have high SCS values (436 N and 441 N, respectively).

5.5.2 In comparison, catalyst pellets prepared using a dry or wet mix of coprecipitated Mg-Al hydrotalcite with pseudo-boehmite as alumina precursor (comparative examples 7 and 8 in the patent in suit)- i.e. using a mix comparable to the one disclosed in document D4 - have an SCS of only 138 N and 135 N, respectively, as can be gathered from the corresponding comparative examples 1 and 2 in document D7. These SCS values are significantly lower than those of pellets made from a hydrotalcite-based material in accordance with claim 1 at issue, even when the latter only comprises a comparatively much smaller amount of alumina or alumina precursor (0.076 mol pseudo-boehmite in example 9; 0.38 mol in comparative examples 7 and 8 of the patent in suit).

5.5.3 The board thus accepts that the calcined hydrotalcite-based materials covered by claim 1 have SCS values which are increased in comparison to those achieved with materials obtainable by wet or dry mixing and calcination of corresponding amounts of hydrotalcite

and alumina or an alumina precursor, as suggested by the closest prior art D4 or the prior art acknowledged in paragraph [0008] of the description. The products of claim 1, to the extent that they are calcined, thus solve the stated technical problem.

5.5.4 Having regard to the green material obtained directly after the coprecipitation operation (i.e. not dried and calcined), which is also covered by claim 1, it is plausible that the particular microstructure responsible for the high mechanical strength of the calcined material is already foreshadowed in the microstructure of the intermediate green material, as submitted by the respondent. Since said intermediate green product makes a structural contribution to and permits the preparation of the improved calcined product by usual drying and calcination steps, it also solves the stated technical problem.

5.6 The appellant argued that no improvement could be acknowledged for the materials claimed because the SCS value (158 N, as reported in example 7 of D7) of the material prepared in Example 9 of the contested patent was lower than the SCS values (174 N and 196 N, respectively) of the materials prepared according to the comparative examples A and B and referred to as "Catalyst 3 (C440-104)" and "Catalyst 4 (ACAT-1443)", respectively, in Table 2 of the contested patent.

The board cannot accept this argument for the following reasons:

- The Mg-Al hydrotalcite material according to comparative example B has been prepared according to

a procedure described in document D5, which concerns exclusively **Ni-Al** and **Ni-AlCr** hydrotalcites. So, the comparative method used in this example does not even belong to the relevant state of the art. A comparison with this material does not permit drawing conclusions concerning the level of mechanical strength achievable with **Mg-Al** hydrotalcite-based materials.

- According to Table 2 of the contested patent, catalyst 3 is based on a material referred to as "C440-104" which is prepared by coprecipitation **in the absence of AlO(OH)** as described in Comparative Example A. The board acknowledges that the SCS value (174 N) reported for this catalyst 3 contradicts a statement made on page 6, lines 23 to 25, of the patent in suit in the context of Comparative Example 7 (also referred to as Comparative example 1 in D7 and reporting an SCS value of 138 N). According to the latter, an Mg-Al catalyst was prepared by **dry-mixing** the hydrotalcite material from example 1 with pseudo-boehmite and calcining the composite. The statement in question reads "*dry mixing the calcined hydrotalcite with alumina significantly enhances the mechanical strength of the final material compared with calcined hydrotalcite alone*". This statement is technically plausible in view of the acknowledgement of prior art on page 2, lines 36 to 39 of the patent in suit, wherein mention is made of an increased strength when material is made from hydrotalcite **mixed** with alumina. Moreover, a much lower SCS value (102 N) is reported in D7 (Table 2) for catalyst 3 based on a material prepared in the same manner (see "*Example 3. Comparative Example A*" in D7) as the

material referred to as C440-104 in "*Example 3. Comparative example A*" in the patent in suit. Under these circumstances, the board has strong doubts concerning the validity of the value of 174 N reported for catalyst 3 in the patent in suit. The board considers it to be likely that this value is erroneous and/or that it has not been measured on the catalyst prepared from material C440-104 but - as asserted by the respondent during the oral proceedings - on a catalyst made from a "commercial HT sample without additive," as referred to in Figure 2, lowermost graph, of the patent in suit. Accordingly, since the validity of the SCS value of 174 N is more than questionable, the appellant's argument cannot be retained.

5.7 Hence, it remains to be decided whether the proposed solution is obvious in view of the state of the art.

5.7.1 As already addressed under point 5.2.4 above, D4 itself expressly advises against the use of solutions of magnesium and/or aluminium in the preparation of the hydrotalcite-like material and thus teaches away from coprecipitation.

As pointed out by the appellant, document D4 (column 6, lines 59 to 63) expressly mentions that for creating mechanical strength, it was important to form bonds between the hydrotalcite and the inorganic oxide carrier by rehydration and subsequent dehydration during a drying process. However, D4 does not suggest obtaining such bonds by coprecipitation of the hydrotalcite in a liquid suspension of alumina or an alumina precursor. Moreover, the skilled person could

not derive from D4 that the latter method would lead to a further improved mechanical strength of the calcined material, compared to a method comprising mixing of wet, undried coprecipitated hydrotalcite with alumina or an alumina precursor.

Hence, D4 taken alone does not lead in an obvious manner to the subject-matter of claim 1 at issue.

5.7.2 D1 discloses the preparation of a hydrotalcite by coprecipitation, optionally on a ceramic support such as alumina or an alumina precursor in an aqueous suspension (page 3, lines 115 to 125). This prior art is, however, restricted to the preparation of a **Ni**-Al hydrotalcite, which is subsequently calcined and reduced in a stream of hydrogen, in order to obtain a nickel catalyst to be used in the steam cracking of hydrocarbons. Hydrated alumina is preferably used as support material and permits controlling the nickel content of the final catalyst (page 4, lines 3 to 8).

Hence, D1 does not suggest that modifying the method for the preparation of composite materials comprising mixing **Mg**-Al hydrotalcite and metal oxide as disclosed in D4 by carrying out coprecipitation of magnesium and aluminium in a suspension of alumina or an alumina precursor, would lead to an increased mechanical strength of the oxidic materials so obtained after calcination.

5.8 The board does not, for the following reasons, accept the appellant's line of argument that the subject-matter of claim 1 at issue lacked an inventive step

over the disclosure of D2 taken in combination with the teaching of document D4.

- 5.8.1 Firstly, the board does not accept that D2 may be considered as representing the closest state of the art document since it neither discloses coprecipitation of magnesium and aluminium in a liquid suspension of alumina or an alumina precursor, nor addresses the issue of the mechanical strength of the materials formed. There is also no evidence in the file that a hydrotalcite-like material having a good mechanical strength is implicitly obtained when a composite material is prepared according to the teaching of D2 and then calcined.
- 5.8.2 Secondly, as mentioned under point 5.2.4 above, D4 actually teaches away from a coprecipitation of magnesium and aluminium.
- 5.8.3 Therefore, a combination of the teachings of D2 and D4 cannot possibly lead to the subject-matter of claim 1 in an obvious manner.
- 5.9 The board is also convinced, and it was not disputed, that the other prior art documents cited by the parties do not contain additional information rendering the claimed subject-matter obvious.
- 5.10 In view of the above findings, the board concludes that the subject-matter of claim 1 and of claims 2 to 4 dependent thereon, involves an inventive step within the meaning of Article 56 EPC.

5.11 The further claims relate to a method (claims 5 to 10) for the preparation of the inventive materials of claims 1 to 4, to a use (claim 11) of said material, to a catalyst (claims 12 to 14) comprising said material, and to a catalytic process (claim 15) making use of said catalyst. Therefore, their subject-matter also involves an inventive step (Article 56 EPC).

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

C. Vodz

B. Czech