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(71) Applicant (*for all designated States except US*): **AKZO NOBEL COATINGS INTERNATIONAL B.V.**
[NL/NL]; Velperweg 76, NL-6824 BM Arnhem (NL).

(72) Inventors; and

(75) Inventors/Applicants (*for US only*): **MURRAY, Kenneth, Andrew** [GB/GB]; 35 Castle Drive, Maidenhead, Berkshire SL6 6DB (GB). **OSBORN, Barry, Norman** [GB/GB]; 3 Bramble Road, Hatfield, Hertfordshire AL10 9RZ (GB).

(74) Agent: **DE VRIES, Adriaan, Jacobus**; Akzo Nobel N.V., Legal, IP & Compliance, P.O. Box 9300, NL-6800 SB Arnhem (NL).

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(54) Title: SOLAR INFRA RED REFLECTIVE PAINTS

(57) Abstract: An Infra Red-reflective architectural paint composition comprising: i. red iron oxide pigment ii. phthalocyanine blue pigment iii. titanium dioxide and optionally yellow iron oxide wherein the composition is free of Infra Red-absorptive black pigments, Infra Red- transparent black pigments and Infra Red-reflective black pigments, has a lightness value, L*, when dry, of from 38 to 88 and the weight ratio of i:ii is from 3 : 1 to 15: 1.



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15 Solar Infra Red Reflective Paints

This invention relates to solar Infra Red reflective paints and in particular it provides infra-red reflective exterior architectural paint compositions which, when dry, have lightness value, L^* , from 38 to 88 and which are free of any black pigment. It also
20 provides a method of reducing the temperature rise of a roof or wall on exposure to solar radiation.

When the sun beats down on the surface of buildings, such as walls and roofs, the temperature of the exterior and eventually the interior of the building, unless it is
25 perfectly insulated, will rise. This is largely a consequence of the infra-red (IR) portion of the solar radiation (of wavelength from 700-2500nm) being absorbed by the exterior surfaces and thence transmitted to the interior surface of the wall. In buildings equipped with cooling equipment, such as air conditioners, the temperature can be reduced to comfortable levels, albeit at a substantial cost in energy
30 consumption and thus carbon emissions. Where air conditioners are not fitted, occupants suffer in uncomfortable ambient conditions.

One known way to limit the temperature rise is to paint the exterior of the building a pastel or light colour, in particular white. Such colours are effective at limiting the

temperature rise because they reflect not only the visible part of the solar spectrum but also the infra red (IR). White and pastel colours are effective in this way largely because they are free of carbon black, a black pigment that absorbs across the visible and IR region of the solar spectrum. Additionally, titanium dioxide is a good reflector of IR radiation.

The very strong absorption by carbon black of IR radiation also means that the deeper pastel colours and especially dark colours themselves are rarely used to paint the exteriors of buildings in hot countries, thus limiting the palette available to architects and decorators.

All colours, can be defined using the well known L^* , a^* , b^* system. In the system, any colour can be represented by:

- i. its lightness, L^* (where 0 is black and 100 is white)
- ii. its a^* value which places the colour on an opponent scale from green (negative numbers) to zero (neutral) to red (positive numbers)
- iii. its b^* value which places the colour on an opponent scale from blue (negative numbers) to zero (neutral) to yellow (positive numbers)

Lightness, L^* , is a quantitative measure of the perceived lightness of the colour, ranging from 0 to 100, with 0 representing black and 100 white.

These terms are defined scientifically by the Commission Internationale de l'Eclairage (CIE) [see 'International Lighting Vocabulary', 4th Edition, published IEC/CIE 017.4-1987. ISBN 978 3 900734 07 7].

Additionally it is useful to define the hue, h . Hue is a measure of how close the colour is to red, yellow, green and blue and is derived from the a^* and b^* values ($h = \arctan(b^*/a^*)$). It is depicted by hue angle ranging from 0 to 360° where the angle defines the position of the hue in colour space, where red, yellow, green and blue are at angles of 0, 90, 180 and 270° respectively. Angles between these 'cardinal points' indicate intermediate colours eg a hue angle of 45° is a reddish yellow (orange) colour.

We have found that, surprisingly, even pastel coloured paints having lightness values, L^* of from 38-88, suffer significant temperature rises as a result of exposure to solar radiation. Equally surprisingly, we have found that only 0.05wt% of carbon black pigment, calculated on the weight of the dried paint composition, is sufficient to cause
5 a rise in temperature of a roof or exterior wall.

International application, WO2005/095528, describes heat reflective wall paint compositions comprising heat reflective metal oxide pigments. Such metal oxide pigments include black pigments such as V-797 and V-799.

10

US 6,366,397 discloses a two part heat reflective system comprising a first IR reflective layer and a second IR transparent layer. The IR transparent layer can contain IR absorptive black pigment such as carbon black and/or IR transparent pigment such as Perylene Black S – 0084.

15

JP 2005-90042A is directed to a heat reflecting roofing material wherein the pigments are selected from a range of pigments including titanium dioxide, red iron oxide and phthalocyanine blue.

20 Attempts have been made by pigment manufacturers to replace carbon black with black pigments which are reflective in the IR region. Clearly such reflective pigments are also substantially non-absorbing in the IR region. Sheppard Color of Cincinnati, Ohio have a range of reflective pigments, known as Arctic® pigments, including a black reflective pigment 10C909. Degussa Metals Catalysts Cerdec Corp.,
25 Washington also produces a range of IR- reflective pigments known as Eclipse® including black pigments Eclipse 10201, 10202, 10203 and 10204. Other known IR reflective pigments include chrome iron oxide (pigment brown 29), sold as Xfast EH 0408 (BASF) or Sicopal K 0095 and chrome iron oxide (pigment brown 35), sold as Heucodur IR Black 940 (Heubach). US patent applications 2010/091416 and US
30 2010/091418 disclose point of sale tinting schemes incorporating such pigments in the colorants.

However, the known black reflective pigments require complicated processes to produce and are costly to manufacture. This tends to make them too expensive to be used routinely in ready-mixed architectural paints

- 5 In addition to the non-absorbing and reflective pigments are black pigments which are transparent to IR wavelengths. In other words, they neither absorb nor reflect the IR region of the spectrum. An example of such a pigment is Paliogen Black L0086.

10 Thus, eliminating carbon black from paints presents an opportunity to improve the energy efficiency of buildings. We have now found a way to formulate non-white IR reflective paints which are free of all black pigments, in particular IR-absorptive pigments such as carbon black and IR-reflective pigments such as Sicopal K 0095 and IR-transparent pigments such as Paliogen Black L0086.

- 15 In a first aspect of the invention there is provided an IR-reflective architectural paint composition comprising

- i. red iron oxide pigment
- ii. phthalocyanine blue pigment
- iii. titanium dioxide and optionally yellow iron oxide

- 20 wherein the composition is free of IR-absorptive black pigments, IR-transparent black pigments and IR-reflective black pigments, has a lightness value, L^* , when dry, of from 38 to 88 and the weight ratio of i:ii is from 3:1 to 15:1,

- 25 Preferably, the paint compositions of the invention have a colour depicted by hue angles, h^* , between 60 and 300°. The reason for this is that these hues (orange-red through yellow, yellow-green, green, green-blue and blue) usually contain carbon black pigment to provide the black component in the colour. Consequently dried paint compositions having these hues exhibit the highest temperature rises on exposure to solar radiation and thus will benefit most from the present invention, The hues in the
- 30 range 300 to 60° (blue-red to orange-red) whilst they may well contain small amounts of carbon black, may also contain some red iron oxide and phthalocyanine blue, in order to achieve the desired hue. Thus the benefit is less for this range of hues.

Phthalocyanine blue is transparent to IR radiation and red iron oxide is partially transparent. Neither, therefore, absorb IR when exposed to sunlight. Consequently, most of the incident IR radiation will pass through a paint film consisting of such pigments, strike the underlying surface, be it a wall or a roof, and heat it directly.

5 Titanium dioxide is reflective of IR radiation and its presence in paint compositions of the invention prevents the radiation reaching the substrate. Advantageously, red iron oxide is also slightly reflective of radiation in the IR. Similarly, yellow iron oxide is also reflective of IR radiation. Thus, there is no need for a separate first IR reflective layer in the present invention.

10

Preferably, the paint composition is an exterior architectural paint for coating the exterior surfaces of buildings such as domestic housing and offices.

Red iron oxide is C.I Pigment Red 101 and yellow iron oxide is C.I.Pigment Yellow

15 42. Phthalocyanine blue is available in various forms including C.I. Pigment Blue 15, 15:1, 15:2, 15:3, 15:4, 15:5, 15:6 and 16, any one of which is suitable for use in the invention.

20 Titanium dioxide exists in two common forms known as rutile and anatase. The rutile form is preferred as it has the highest refractive index and is thus a better reflector of light, including in the IR region. Suitable examples include Tioxide RTC90 and RTC92, Tiona 595 (available from Cristal)

25 The particle size of the titanium dioxide is also relevant to light reflection. Below about 100nm, the titanium dioxide particles are not efficient reflectors of the visible and IR spectrum. It is preferred therefore that the mean particles size of the titanium dioxide is at least 100nm, more preferably from 100 to 350nm and most preferably from 100 to 300nm.

30 Preferably, compositions of the invention comprise at least 2wt% of TiO_2 , more preferably at least 4wt%, even more preferably at least 6wt% and most preferably at least 8wt%. As TiO_2 is expensive and has a large carbon footprint, a minimum amount of TiO_2 is desirable in the composition and thus the practical upper limit is

between 8 and 16wt%, more preferably less than 12wt% and most preferably less than 10wt%.

5 The composition, when dry, should comprise at least 4wt% of TiO_2 , more preferably at least 8wt%, even more preferably at least 12wt% and most preferably at least 16wt%. The upper limit is between 16 and 32wt%, more preferably less than 28wt%, even more preferably less than 24wt% and most preferably less than 20wt%.

10 The red and yellow iron oxide pigment should be ground to a particle size in the same size range as for titanium dioxide

The phthalocyanine blue pigment should be ground to transparency.

15 Preferably the composition when dry has a lightness value, L^* of from 45 to 88, more preferably from 55 to 88, even more preferably from 62 to 88, yet more preferably from 65 to 88 and most preferably from 75 to 88.

20 Preferably, the composition when dry comprises red iron oxide, phthalocyanine blue, titanium dioxide and optionally yellow iron oxide. More preferably, the composition when dry comprises from 0.100 to 5.000wt% of red iron oxide and from 0.015 to 0.900wt% of phthalocyanine blue. Even more preferably, the composition when dry comprises at least 4wt% TiO_2 .

25 Preferably, the ratio of red iron oxide to phthalocyanine blue is from 4:1 to 15:1, more preferably from 5: 1 to 15:1, even more preferably from 5:1 to 11:1, still more preferably from 5: 1 to 8:1 and most preferably from 4:1 to 8:1.

30 Preferably, the paint composition is free of metallic pigments such as aluminium as these produce a metallic sheen to the colour.

Preferably, the paint develops its final properties at normal temperature such as 15 to 25°C and does not require elevated temperatures.

Preferably, the paint composition is opaque at a dry film thickness of 50µm. By opaque is meant that the contrast ratio is at least 95 when a coating of the invention is applied over a black and white opacity card and allowed to dry. The contrast ratio is the light reflectance measured over the black portion of the chart compared to the white portion, expressed as a percentage.

In a further aspect of the invention there is provided a method of reducing the temperature rise of a roof or exterior wall of a building, resulting from absorption of solar IR radiation, comprising coating the exterior surface of the wall or roof with an IR reflective paint composition according to a paint composition of the invention.

In a yet further aspect of the invention there is provided an exterior wall or roof of a building coated with a paint composition of the invention.

- 15 It is envisaged that the paint compositions of the invention can be made in both specialised manufacturing facilities in large batches, typically in volumes of at least hundreds of litres; and also in retail stores, where batch quantities no more than 50 litres are made, usually on request from a customer. In the latter case, the paints are made using compact tinting machines, comprising colorants and base paints.
- 20 Colorants are concentrated dispersions of pigments. By having a number of the colorants, typically 10 to 20, each formulated using pigments of different hues, a large number of coloured paints can be provided by simply mixing at least one of the colorant(s) with the appropriate base paint in accordance with a predetermined recipe. Even more colours can be produced by providing a plurality of base paints,
- 25 themselves varying in hue, including clear (unpigmented) base paint. A base paint differs from a ready for use (RFU) paint in that the colour has not been finally adjusted. The colorants are usually packaged in containers of up to 5l and the base paints up to 25 litres.
- 30 In a yet further aspect of the invention there is provided a point of sale tinting system comprising at least one base paint and colorants wherein the base paint and the colorants are free of Infra Red-absorptive black pigments, Infra Red-transparent black pigments and free of Infra Red reflective black pigments.

Preferably, the base paint is light coloured and/or unpigmented.

By IR reflective is meant that the paint compositions of the invention, when dry, reflect more of the sun's radiation than compositions which rely on carbon black for their black colour component. This can be determined by measuring the surface temperature of a coated substrate as described below. The more reflective the coating the lower the temperature of the panel surface. For the purposes of the invention we regard a coating as IR reflective when the temperature of a coating of the invention is at least 1°C lower than a corresponding comparative coating when tested over a white first coat as described below.

The invention will now be illustrated by the following examples.

In all examples the red iron oxide used was PR101 and the phthalocyanine blue pigment was PB15:3

Example 1

A grey paint was prepared according to the recipe below

		g	
20	12.6% TiO ₂ base paint:	25.22	
	Pigment-free base paint:	73.65	
	Red iron oxide colorant:	3.34	of which red iron oxide pigment: 2.17g
	Phthalocyanine blue colorant:	0.72	of which phthalocyanine blue pigment: 0.32g

25 The TiO₂ base paint is aqueous and has a total solids of 53.5% (by weight) consisting of 29.0% extenders, 10.1% binder polymer, 12.6% TiO₂ (Tioxide TR92 – available from Huntsman Corporation) with the remaining solids being additives. The pigment-free base paint is aqueous and has a total solids of 51.9% (by weight) consisting of 30.8% extenders, 19% binder polymer with the remaining solids being additives.

30

The colorants are pigment concentrates in liquid form and are added to the mixture of base paints in a suitably sized vessel mixed in by stirring.

In a point of sale tinting scheme, where the colorant is added to a base paint in a can, the amount of TiO₂ in the base paint would be 3.21% (by weight) – being the average of the 12.6% TiO₂ base paint and the pigment-free base paint. After the addition of the colorant to the can of base paint, the can is vigorously shaken using a Red Devil shaker.

Test panels were prepared using thin precoated steel panels. These were coated with a wire wound bar with either a black or a white undercoat and allowed to dry followed by two coats of the example matt paint (each of ca 50µm dry film weight) were applied and allowed to dry to give the following CIELAB values calculated from the spectral reflectance curve measured using a Datacolor Spectraflash SF 600 spectrophotometer in accordance with the manufacturer's instructions.

The measured L*, a*, B* were L* 40.8, a* -0.7, b* -1.5; the colour over the black panels and the white panels was almost identical (dE less than 0.3).

Comparative Example A

A comparative example A paint made using carbon black used the following formulation:

20		g	
	12.6% TiO ₂ base paint:	25.22	
	Pigment free base paint:	73.65	
	Black colorant:	0.25	of which carbon black pigment: 0.11g
	Yellow iron oxide colorant:	0.19	of which yellow iron oxide pigment: 0.10g
25	Red iron oxide colorant:	0.64	of which red iron oxide pigment: 0.42g
	Phthalocyanine blue colorant:	0.05	of which phthalo blue pigment: 0.02g

Test panels were prepared using thin precoated steel panels as before. These were coated with either a black or a white undercoat and then two coats of the example paint were applied to give the CIELab colours L* 40.8, a* -0.7, b* -2.0; the colour over black and white was almost identical (dE less than 0.3). This is within dE 1 to the example 1 formulation and is a good visual colour match.

All four panels were placed on a hardboard support and exposed to direct outdoor sunshine as before. Standard black (using carbon black pigment) and white (using titanium dioxide pigment) paints were also included in the test. The surface temperature of the panels was recorded. The average of six measurements was taken:

5

Example 1 over black: 39.0 °C

Example 1 over white: 37.7 °C

Comparative example A over black: 43.8 °C

Comparative example A over white: 44.4 °C

10 Standard black paint: 43.5 °C

Standard white paint: 25.9 °C

The standard black paint had the following CIELAB values $L^*=26.4$, $b^*=-.02$ and $b^*=-0.49$

15

A further comparative example A1 was prepared using IR reflective black Xfast EH0408 (BASF). The recipe used was:

g

9.5% *TiO₂ base paint: 25.22

20 Pigment-free base paint: 73.65

Xfast EH0408: 6.02

Yellow iron oxide colorant : 1.59 of which yellow iron oxide pigment: 0.86g

Phthalocyanine blue colorant: 0.12 of which phthalocyanine blue pigment: 0.05g

25 *Tioxide RTC90 (available from Huntsman Corporation)

Test panels were prepared using thin precoated steel panels as before. These were coated with either a black or a white undercoat and then two coats of the example paint were applied to give the CIELab colours $L^* 40.9$, $a^* -1.1$, $b^* -2.2$; the colour over black and white was almost identical (dE less than 0.3). This is within $dE 1$ to the example 1 formulation and comparative example 2 and is a good visual colour match.

30

In the same test as example 1 and comparative example A, this paint gave the following temperatures:

Comparative example A1 over black: 39.2 °C

Comparative example A1 over white: 39.2 °C

- 5 These temperatures are close to the example 1 over black results but still higher than the example 1 over white results, indicating poorer solar reflectance in the latter case.

Example 2

- 10 A pale grey paint was prepared according to the recipe below.

g

9.1% TiO₂ base paint: 99.8995

Red iron oxide colorant: 0.0825 of which red iron oxide pigment: 0.0536g

Phthalocyanine blue colorant: 0.0180 of which phthalocyanine blue pigment: 0.0080g

15

The TiO₂ base paint is aqueous and has a total solids of 50.9% (by weight) consisting of 30.4% extenders, 9.3% binder polymer, 9.5% TiO₂ with the remaining solids being additives.

- 20 Test panels were prepared using thin precoated steel panels as before. These were coated with either a black or a white undercoat, allowed to dry, after which time two coats of the example paint were applied and dried to give the CIELab colours L* 86.1, a* -1.8, b* -1.3; the colour over black and white was almost identical (dE less than 0.2).

25

Comparative Example B

A comparative example B paint made using carbon black used the following formulation:

g

30 9.1% TiO₂ base paint: 99.853

Black colorant: 0.147 of which carbon black pigment: 0.029g

Test panels were prepared using thin precoated steel panels as before. These were coated with either a black or a white undercoat after which time two coats of the

comparative example paint were applied and allowed to dry to give the CIELab L*, a*, B* values of L* 86.0, a* -1.0, b* -1.8; the colour over black and white was almost identical (dE less than 0.2). This is within dE 1 to the example 2 formulation and is a good visual colour match.

5

All four panels were placed on a hardboard support and exposed to direct outdoor sunshine as before. Standard black and white paints were also included in the test. The surface temperature of the panels was recorded. The average of four measurements was taken:

10

Example 2 over black: 28.2 °C

Example 2 over white: 27.5 °C

Comparative example B over black: 31.4 °C

Comparative example B over white: 30.5 °C

15

Standard black paint: 46.7 °C

Standard white paint: 25.8 °C

Panels coated with comparative example B are significantly higher in temperature than those coated with example 2, indicating a poorer solar reflectance of comparative example B.

20

Example 3

A pale grey paint was prepared according to the recipe below

25

	g
6.76% TiO ₂ base paint	992.800
Red iron oxide colorant	21.571 of which red iron oxide pigment: 12.57g
Phthalocyanine blue colorant	32.323 of which phthalocyanine blue pigment: 1.842g
Phthalocyanine green pigment	12.332 of which phthalocyanine green pigment: 0.863g

30

The base TiO₂ base paint is aqueous and contains 6.76% (by weight) of titanium dioxide.

A comparative paint, example C, was made according to the following recipe using carbon black.

		g
5	6.76% TiO ₂ base paint	992.800
	Black colorant	59.880 of which carbon black pigment: 4.430g
	Yellow iron oxide pigment	8.920 of which yellow iron oxide pigment: 4.950g
	Red iron oxide	3.751 of which red iron oxide pigment: 2.190g

- 10 Test panels were prepared using card panels. These were coated with either a black or a white undercoat and allowed to dry followed by two coats of paint C and allowed to dry to give the CIELab colours L* 48.71, a* 0.07, b* -0.61 for the example 3 paint and L* 48.27, a* 0.12, B* -0.51 for comparative example C. The two paints gave a good visual colour match (dE between panels of 0.45).

15

The two panels were placed on a hardboard support and exposed to direct outdoor sunshine as before. The surface temperature of the panels was recorded. The average of six measurements was taken:

20	Example 3:	42.5 °C
	Comparative example C:	49.8 °C
	Standard black paint:	53.0 °C
	Standard white paint:	29.3 °C

- 25 Panels coated with comparative example C are significantly higher in temperature than those coated with example 3, indicating a lower solar reflectance of comparative example C.

- 30 The UV/visible/IR reflectance spectra of the panels were recorded using a Perkin Elmer Lambda 950 Spectrophotometer and the total solar reflectance (TSR) calculated according to ASTM E903:

	TSR
Example 3:	39.3%

Comparative example C: 14.0%

Comparative Example C has a significantly lower TSR value indicating that a lower proportion of the incident solar radiation is reflected by comparative paint C than the
5 paint of the invention, example 3.

Claims

1. An Infra Red-reflective architectural paint composition comprising
 - i. red iron oxide pigment
 - ii. phthalocyanine blue pigment
 - 5 iii. titanium dioxide and optionally yellow iron oxidewherein the composition is free of Infra Red-absorptive black pigments, Infra Red-transparent black pigments and Infra Red -reflective black pigments, has a lightness value, L^* , when dry, of from 38 to 88 and the weight ratio of i:ii is from 3:1 to 15:1,
- 10 2. A paint composition according to claim 1 wherein the lightness value, L^* , of the composition when dry is from 65 to 88.
3. A paint composition according to claim 1 or claim 2 wherein the titanium dioxide is the rutile form.
4. A paint composition according to any one of the preceding claims wherein the
15 titanium dioxide pigment comprises at least 4wt% based on total dry paint.
5. A paint composition according to any one of the preceding claims wherein the titanium dioxide has a mean particle size of at least 100nm.
6. A paint composition according to any one of the preceding claims wherein the phthalocyanine blue pigment is selected from the group consisting of CI
20 Pigment Blue 15, 15:1, 15:2, 15:3, 15:4, 15:5, 15:6 and 16.
7. A paint composition according to any one of the preceding claims wherein the red iron oxide comprises from 0.100 to 5.000wt% and the phthalocyanine blue comprises 0.015 to 0.900wt% of the composition when dry.
8. A paint composition according to any one of the preceding claims wherein a
25 50 μ m dry coat of the composition is opaque.
9. A paint composition according to any one of the preceding claims wherein the composition, when dry, has a colour defined by a hue angle between 60 and 300°.
10. A roof or exterior wall of a building coated with the paint composition
30 according to any one of the preceding claims.
11. A roof or exterior wall of a building according to claim 10 coated with a sufficient amount of the Infra Red-reflective paint composition to provide a dry paint coat of at least 50 μ m.

12. A method of reducing the temperature rise of a roof or exterior wall of a building exposed to solar Infra Red radiation comprising coating the exterior surface of the wall or roof with an Infra Red-reflective paint composition according to any one of claims 1 to 9.
- 5 13. A method according to claim 12 wherein the roof or exterior wall is coated with a sufficient amount of the Infra Red-reflective paint composition according to any one of claims 1 to 7 to provide a dry paint coat of at least 50µm.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/058849

A. CLASSIFICATION OF SUBJECT MATTER INV. E04D1/28 E04F13/00 C09D7/00 C09D7/12 C09D5/00 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) E04D E04F C09D		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2005/095528 A2 (TEXTURED COATINGS OF AMERICA I [US]; HAINES JAY A [US]) 13 October 2005 (2005-10-13) paragraphs [0001], [0018], [0026], [0030] - [0031], [0038] - [0041] examples 1-3; tables 1, 2 -----	1-13
X	US 6 366 397 B1 (GENJIMA YASUHIRO [JP] ET AL) 2 April 2002 (2002-04-02) column 1, lines 47-54 column 3, lines 3-44 column 4, lines 3-58 claims 1, 2 ----- -/-	1-13
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents :		
"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 31 August 2012	Date of mailing of the international search report 06/09/2012	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Mayer, Anne	

INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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