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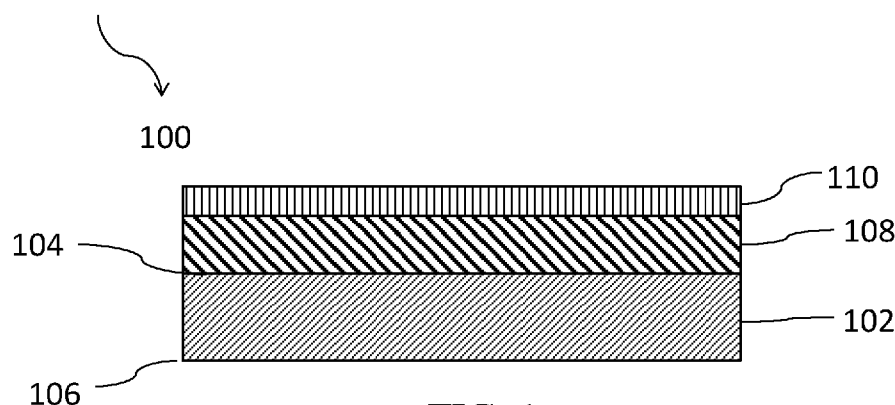


FIG. 1

(57) Abstract: A heat treatable glass is provided. The heat treatable glass includes a glass substrate comprising of a reflective stack and an enamel layer. The reflectance of the heat treatable glass is greater than at least about 20% and less than at least about 70%.

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REFLECTIVE GLASS

Technical Field

The present disclosure relates in general to a reflective glass, and more specifically to a heat treatable reflective glass.

5 Background

Reflective glass is becoming more and more popular in residential, commercial, and interior applications, e.g., as a decorative item, for façade applications etc. Conventional reflective glass products used in interior applications often comprise of silver based coatings on annealed glass. Such
10 reflective glass products based on the annealed glass are considered to be unsafe for interior applications due to their ability or tendency to break/shatter into large shards or sharp pieces

Glass substrates covered with enamel-based coating are also known in the art. In particular, enamel coated glass substrates that can be tempered are
15 also known. In conventional methods, a glass sheet may be covered with a layer of organic paint and the coated glass sheet (also called lacquered sheet) may then be cured in an oven. When such sheets covered with organic paint are treated at high temperatures greater than 200 °C, the paint burns and may result in the paint being damaged or completely destroyed. These conventional lacquered sheets
20 therefore cannot survive at temperatures higher than 200°C.

In an alternative method, a glass sheet can be tempered before being enamelled. However, this may require the glass sheet to be cut into desired dimensions before being tempered, as a tempered glass sheet is very difficult to be cut. Such a criteria may not allow continuous mass production. Moreover,
25 enamels free from organic contents need immediate tempering on the same production line, which constitutes a severe limitation from an industrial viewpoint. Various processes have been used to develop temperable glass products, which often involve coating one or more layers of enamel which is then dried and/or cured in an oven before being sent to tempering furnaces.

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Mirrors typically have a layer of protective organic paint coated on the silver layer. When heat treated at higher temperatures, the protective organic layer burns and is deteriorated which eventually leads to the oxidation/damage of the silver layer, thus causing defects in the mirror. Hence
5 conventional mirrors generally do not survive heat treatments at temperatures higher than 200 or 250 °C without suffering from some form of degradation. However the toughening temperature required for any glass is ideally more than 550 °C.

Therefore there is a need for a reflective glass product which is
10 heat treatable after processing and transporting to other location for interior applications that provide an alternate solution to conventional mirrors having reasonable aesthetics and improved durability.

Summary of the Disclosure

In one aspect of the present disclosure, a heat treatable glass is
15 provided. The heat treatable glass includes a glass substrate comprising a reflective stack and an enamel layer. The reflectance of the heat treatable glass is greater than at least about 20% and less than at least about 70%.

In another aspect of the present disclosure, a method of manufacturing a heat treatable glass is provided. The method includes providing
20 a reflective stack on the first side of a glass substrate. The method also includes coating an enamel on the second side of the glass substrate or, above the reflective stack. The second side is opposite to the first side of the glass substrate. The method further includes drying the enamel so that the enamel hardens and sticks to the glass substrate but is yet to fuse or sinter.

25 Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

Brief Description of the Drawings

Embodiments are illustrated by way of example and are not limited in the accompanying figures.

FIG. 1 illustrates a schematic cross-sectional view of a heat treatable glass, in accordance with one embodiment of the present disclosure;

FIG. 2 illustrates a schematic cross-sectional view of the heat treatable glass, in accordance with another embodiment of the present disclosure;

5 FIG. 3 illustrates a block diagram of a reflective stack on the heat treatable glass, according to one embodiment of the present disclosure;

FIG. 4 illustrates a block diagram of the reflective stack on the heat treatable glass, according to another embodiment of the present disclosure; and

10 FIG. 5 illustrates a flowchart for a method of manufacturing the heat treatable glass, according to an embodiment of the present disclosure.

Skilled artisans appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions of some of the elements in the figures may be
15 exaggerated relative to other elements to help to improve understanding of embodiments of the invention.

Detailed Description

Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or the like parts. Embodiments
20 disclosed herein are related to a heat treatable glass 100.

Certain example embodiments of this disclosure relate to a heat treatable glass 100. FIGS. 1 and 2 illustrate a schematic cross-sectional view of a heat treatable glass 100, according to two different embodiments of the present disclosure. The glass product can be heat treated e.g., heat strengthened and/or
25 thermally tempered. Further the glass product can be handled, cut into various sizes, shapes, and transported, both before and after being tempered, as needed without incurring damage because of the above said processes. The heat treatable glass of the present disclosure is also a reflective glass having a reflectance ranging between 20% and 70%. Various embodiments of the heat treatable glass
30 100 will be explained hereinafter.

The heat treatable glass 100 of certain example embodiments has a reflective stack 108. For example, the reflective stack 108 may comprise of at least one of the metal and their alloy belonging to the group consisting of niobium, chromium, nickel, tantalum or zirconium. FIGS. 3 and 4 illustrate a block diagram of the reflective stack 108 of the heat treatable glass 100, according to different embodiments of the present disclosure.

FIG. 5 illustrates a flowchart for a process that may be used to manufacture the heat treatable glass 100, in accordance with one example embodiment.

Referring to FIGS. 1 and 2, the heat treatable glass 100 includes a glass substrate 102 having a first side 104 and a second side 106 opposite to the first side 104. The heat treatable glass 100 includes a reflective stack 108 on the first side 104 of the glass substrate 102. The heat treatable glass 100 further includes an enamel layer 110. In the embodiment of FIG. 1, the enamel layer 110 is above the reflective stack 108. In the embodiment of FIG. 2, the enamel layer 110 is on the second side 106 of the glass substrate 102. In such a case, the enamel layer 110 may be in direct contact with the glass substrate 102.

The term “reflective stack 108” used herein refers to a stack of thin functional layers and optionally one or more over-layers. The term “enamel” used herein refers to an enamel composition before any drying or heat treatment and to an enamel composition which is dried but not yet sinterised and to an enamel composition after heat treatment, which is sinterised. Preferably, the enamel layer 110 may be in direct contact with the coated glass substrate 100. The thickness of the coating comprising enamel composition, once dried and before heat treatment, may be at least about 50-120 microns.

The term “coated glass substrate” 100 used herein may refer to the glass substrate 102 having the reflective stack 108 thereon. Various embodiments of the reflective stack 108 and the coated glass substrate 100 having the reflective stack 108 will be explained hereinafter. For instance, SGG Cool-lite Platinum (ST-108) from Saint-Gobain is a reflective glass product manufactured by depositing a thin stack of $\text{Si}_3\text{N}_4/\text{Nb}/\text{Si}_3\text{N}_4$ onto a clear or body-tinted float glass by a magnetically enhanced sputtering process.

Referring to FIGS. 3 and 4, different embodiments of the reflective stack 108 are illustrated. In an embodiment, the coated glass substrate 100 may be ST-108, having the reflective stack 108, in accordance with the embodiment of FIG. 3. ST-108 comprises a reflective layer having a stack of thin functional layers comprising of Si_3N_4 , Nb and Si_3N_4 .

In another embodiment, the coated glass substrate 100 may be SGG Mirastar from Saint-Gobain, having the reflective stack 108, in accordance with the embodiment of FIG. 4. The coated glass substrates 100 of certain example embodiments comprise of yet another reflective layer. For instance, SGG Mirastar from Saint-Gobain is a reflective glass product comprising the reflective layer having a stack of thin functional layers comprising of SiO_2 , Cr and SiN and Ti.

The coated glass substrates 100 of certain example embodiments comprise of yet another reflective layer comprising at least one of the metal and their alloy belonging to the group consisting of niobium, chromium, nickel, tantalum or zirconium and one or more over layers.

The coated glass substrates 100 with an enamel in certain example embodiments provide a reflective surface which may be used for interior applications. The coating of certain example embodiments comprises of an enamel having about 5 - 40 wt % of organic contents in the form of resin.

The enamels of certain example embodiments comprise of a powder made of glass frit, organic content, pigments, and a medium. The medium ensures that the solid particles are in correct suspension and allows application and temporary adhesion of the enamel to the substrate. The medium may comprise one or more alkyds, acrylic, acrylamide, polyols, melamine, acrylic-styrene, vinyl-acrylic, urethane (polyurethane), polyester, urethane alkyds, amino resins, polyamide, epoxy, epoxy ester or phenolic resins. Other mediums may be silicon resins, PVC, PVB, or water-based resins.

The coating of certain example embodiments comprises between 5 and 40% of an organic material which may be prepared by mixing, amongst others, glass frit, pigments with the desired amount of organic solvent. In a

preferred embodiment, a suitable pigment is selected to achieve a desired color on the reflective glass substrate.

In a preferred embodiment, the enamel of the current disclosure is supplied by Ferro and has an inorganic content of 69.8%, an organic content of 12-13% and the rest is in the form of a solvent used for the application. The fineness of the grind which represents the size of the particles in the enamel is less than 20 μm measured by the Hegman gauge. In an alternate embodiment, any enamel having an inorganic content of 30-80% and an organic content of 5-40% may be suitable. The solvent evaporates after drying and/or some low molecular weight polymers particularly resin are burned off during heat treatment leaving inorganic contents in the form of pigments and glass frits.

In a preferred embodiment, the enamel layer 110 of the current disclosure may be continuous and extend over substantially the whole surface of the coated glass. Reflection of the glass substrate 102 is subjective to changes during heat treatment, depending on the composition of the coating. However such changes in reflection should remain within acceptable limits such that the aesthetics and resulting functionalities are not compromised.

If the glass is heat treated, reflection may change during heat treatment, depending on the composition of the coating. If this occurs, this should be taken into account on the heat treatable glass 100 that such a reflection change is within the acceptable limit without compromising the aesthetics and functionality.

The glass substrate 102 used may be of various thicknesses (between 1.5 and 10 mm, for example) whereas the coated glass substrate 100 having the reflective stack 108 and an enamel layer 110 according to the present disclosure may have a thickness depending purely on the coating methodology such as roller, curtain or screen printing.

In one embodiment of the present invention, the enamel layer 110 may be applied by any method known in the art, for example processes of roller, curtain, spray coating or any other flow process suitable for the coating. In another embodiment of the present invention, the enamel layer 110 may be applied by screen printing method, especially if only portions of the glass are to

be coated, or by a digital printing method. When a heat treatable glass 100 according to the present disclosure is heat treated, the organic medium burns in the form of carbonaceous gases and the glass frit melts; the enamel is fused in to the coated glass. The viscosity of the enamel may be adjusted based on the
5 selected application technique and/or apparatus. For instance, if in an embodiment curtain coating is used, the viscosity of the material may be lowered, e.g., by adding diacetone alcohol or the like. Adhesion promoters in the form of cross linkers and/or the like also may be added in certain example embodiments.

The heat treatable glass 100 with the enamel layer 110 can be heat
10 treated (e.g., heat strengthened and/or thermally tempered) at high temperatures, and they can be handled and transported both before and after heat treatment without damaging the enamel layer 110. For instance, the heat treatable glass 100 with the enamel layer 110 may be cut, ground, have holes drilled therein, etc., without causing the coating to peel off or to become damaged at the borders of
15 the cutting line and drilling holes, before heat treatment. The heat treatable glass 100 also offers good water resistance, and the coatings do not peel off or degrade during edge grinding, storage, transportation, etc.

Referring to FIG. 5, a method of manufacturing the heat treatable glass 100 according to one embodiment of the disclosure may comprise the
20 following steps, in the order recited.

At step 502, the method 500 includes providing the reflective stack 108 on the first side 104 of a glass substrate 102. In a preferred embodiment, the method 500 includes providing the coated glass substrate 100 comprising a reflective layer having a stack of thin functional layers comprising of Si_3N_4 , Nb, and Si_3N_4 and one or more over-layers comprising at least one of the metal oxide
25 belonging to the group consisting of Sn, Ti, Ta or Si. At step 504, the method 500 includes coating an enamel layer 110 on one of the second side 106 of the glass substrate 102 or, above the reflective stack 108, wherein the second side 106 is opposite to the first side 104. In an embodiment, the method 500 includes
30 applying a coating of the enamel through a standard curtain coating methodology during which the glass substrate 102 passes through a continuous falling curtain of the enamel where the enamel gets deposited evenly onto the glass.

At step 506, the method 500 includes drying the enamel so that the enamel hardens and sticks to the glass substrate 102 but is not yet fused or sinterised. In an embodiment, the method 500 includes drying of the enameled coated glass substrate 100 using a two-step methodology wherein the first step
5 comprises of the coated glass substrate 100 being passing through a drying oven where the excess solvent gets evaporated giving some strength to the coating; In the second step the coated substrate goes to the final oven where final drying takes place at temperatures between 160 - 210°C. The temperature depends on the thickness of the enamel layer 110.

10 At step 506, the method 500 may also include washing, cutting, and/or grinding into any shape or size giving freedom to the customer for his requirement/application before being tempered.

At step 506, the method may further include heat treating the enameled coated glass substrate 100, wherein both convection and rendition
15 methodology can be used for the tempering. For instance, the enameled coated glass substrate 100 passes through the furnace at a certain speed and is heated in the temperature zones. The standard rule is that the glass is heated for approximately 45 sec per mm of glass substrate 102 and in a temperature ranging between 620-700°C for the tempering effects.

20 The enameled coated glass substrate 100 of the current disclosure, before heat treatment, may advantageously offer good properties in terms of mechanical resistance of the coating. Different tests were used to simulate transportation by truck and evaluate if the coating offered resistance to such transportation without deterioration or with an acceptable level of deterioration
25 without affecting the aesthetics of the glass products.

The thickness of the coating reduces by approximately 25-30% of the original thickness after the heat treatment. The reflection value of the coated glass substrate 100 may change post heat treatment. The gloss value was found to be increased post heat treatment. Scratch resistance was also found to be increased
30 post tempering.

The enameled coated glass substrate 100 of the current disclosure, once heat treated may furthermore advantageously offer properties such as better

scratch resistance, moisture resistance and abrasion resistance. The heat treatable glass 100 thus manufactured may have a reflective value greater than at least about 20% and less than at least about 70%.

Preferably, the heat treatable glass 100 according to the current disclosure, once heat treated may be used as partition glass and also for various interior applications and optionally as façades in buildings, in accordance with standard EN12150-1:2000. Preferably, the heat treatable glass 100 according to the current disclosure, once thermally toughened breaks according to the fragmentation test of standard prEN14-179-1:2001 or EN1863-1:2000.

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EXAMPLE 1:

A 300 x 300 mm, SGG Cool-lite Platinum (ST-108) sample from Saint-Gobain (magnetron coated stack of $\text{Si}_3\text{N}_4/\text{Nb}/\text{Si}_3\text{N}_4/\text{Glass}$) of thickness 4mm/6mm was used as a glass substrate 102 along with a solvent based enamel. The enamel used was supplied by Ferro having an inorganic content of 69.8%, organic content of 12-13% and the rest was in form of a solvent. Fineness of the grind was less than 20 μm measured by the Hegman gauge. Glass frits were applied to the coating side of the glass using a bar coater to create a uniform coating. The glass substrate was then allowed to cure in an oven at 180 °C for approximately 15 minutes. The coating thickness measured was approximately 40 - 125 μm . The samples were then cut into 100 mm x 100 mm and the reflectance (%) was measured. The samples were then tempered at 640 °C for approximately 8 minutes and allowed to cool. The reflectance was then measured again after heat treatment.

Durability tests were conducted to evaluate the mechanical performance of the reflective glass product having ST-108 as the substrate and having an enamel layer 110 coated on the coating side of ST-108 both before and after heat treatment. The results of the mechanical and hydrolytic performance test before tempering using ST-108 as the glass substrate with enamel coated on the coating side are tabulated in Table 1 and Table 2.

Table 1: Durability Results Covering Mechanical Performance of a Reflective Glass having Enamel on Coated Side (Pre-Tempering)

Test	Target	Reflective glass of the present disclosure
Adhesion	≤ 2	3-4
Thickness	100 μm	77-123
Abrasion (Taber)	<0.05% weight loss	0.030
Abrasion (Lucite)	No defect on glass side	No Defect
EBT	No peel off or delamination of the paint	No Defect

Table 2: Durability Results Covering Hydrolytic Performance of a Reflective Glass having Enamel on Coated Side (Pre-Tempering)

High Humidity		Target	Reflective glass of the present disclosure
		ΔE^* on glass side < 0.5	0.11; no blisters
Drying of cutting oil	Tempering after 20 min	No defect on glass side	Oil Mark
	Tempering after 24 hr	No defect on glass side	No defect
Drying of water	Tempering after 20 min	No defect on glass side	No defect
	Tempering after 24 hr	No defect on glass side	Water mark

5 A similar procedure was followed to create a reflective glass product 100 of the present disclosure using ST-108 as the glass substrate where the coating of the enamel was done on the glass side, i.e., the second side 106. Results of the mechanical performance testing performed before tempering are tabulated in Table 3.

10 Table 3: Durability Results Covering Mechanical Performance of a Reflective Glass having Enamel on Glass Side (Pre-Tempering)

Test	Target	Reflective glass of the present disclosure
Visual observations	No defects seen from/on both side	No defects
Erichsen Brush Test	No peel off or delamination of paint	No defects
Adhesion(Cross Hatch Test)	<4	2
Abrasion (Taber)	<0.05% weight loss	0.021
Erichsen Scratch Test	>4N	5N

Results of the durability tests carried out post tempering on the reflective glass having ST-108 as glass substrate wherein the enamel coated was coated on the coating side and glass side are tabulated in Table 4 and Table 5, 5 respective.

Table 4: Durability Results Covering Mechanical Performance of a Reflective Glass having Enamel on Coated Side (Post-Tempering)

Post-Temp Durability tests	Target	Reflective glass of the present disclosure
Visual Defects	No Pinholes, Scratches, Peeling off	No Pinholes, Scratches, Peeling off
High Humidity	No defects/ peeling off	No defects
Scratch test (Scelerometer)	No scratch till 14 N	No scratch

Table 5: Durability Results Covering Mechanical Performance of a Reflective Glass having Enamel on Glass Side (Post-Tempering)

Post Tempering Tests	Target	Reflective glass of the present disclosure
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Visual Defects	No Pinholes, Scratches, Slight Peeling off in corners	Peeling due to poor tempering
Accelerated Ageing -10°C to 56 °C, 0-95% R.H., 7 days	No defects/peeling off	No defects
Haze	No haze seen on reflective side	No haze
Cross Hatch (Adhesion)	0 or 1 according to standard	1
Taber Abrasion test	<0.03	0.025

The color differs based on the side of the enamel layer 110 coating on the glass substrate 102 was observed. Enamel layer when coated on the glass side exhibited a metallic gold color ($L=67.45$, $a^*=0.88$, $b^*=16.18$ for a thickness of about 90 – 100 microns). Enamel layer with three thickness viz., 50 microns, 75 microns and 100 microns having a white pigment when coated on the coating side exhibited a silver finish ($L=71.98$, $a^*=-2.5$, $b^*=1.37$ for a thickness of 100 microns). Enamel layer with two thickness viz., 50 microns and 75 microns having a grey pigment when coated on the coating side exhibited a silver finish ($L=71.84$, $a^*=-2.33$, $b^*=1.35$ for a thickness of 50 microns).

For the heat treatable glass 100 developed from SGG Cool-lite Platinum (ST-108) from Saint-Gobain, it was critical to measure and analyze the change in optical properties of the coated reflective glass product before and after tempering. Based on the side that was enamelled the data below in Table 6 and Table 7 show the important comparison of the optical properties of the reflective glass products.

Table 6: Optical Properties of a Reflective Glass having Enamel on Coated Side
(Pre and Post-Tempering)

Optical data	L	a*	b*	ΔE^* Glass side	Reflectance BT	Reflectance AT
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ST108 WHITE (50 micr)	BT	72.39	-3.08	0.23	1.30	44.24±0.02	43.7
	AT	72.027	-2.5233	1.3433			
ST108 WHITE (75 micr)	BT	72.353	-3.0233	0.2733	1.29	44.18±0.03	43.31±0.01
	AT	71.763	-2.5867	1.34			
ST 108 WHITE (100 micr)	BT	72.363	-3.0233	0.2367	1.29	44.20±0.04	43.63±0.03
	AT	71.983	-2.5433	1.37			
ST108 GREY (50 micr)	BT	72.36	-3.0467	0.5033	1.11	44.2±0.01	43.23±0.1
	AT	71.707	-2.58	1.2667			
ST108 GREY (75 micr)	BT	72.42	-3.0067	0.6267	1.04	44.29±0.02	43.42±0.12
	AT	71.84	-2.5333	1.35			

*BT- Before Tempering AT- After Tempering

Table 7: Optical Properties of a Reflective Glass having Enamel on Glass Side
(Pre and Post-Tempering)

Optical data for Gold TBT mirrors (Enamel on Glass side)		L	a*	b*	ΔE*	Reflectance BT	Reflectance AT
Enamel on glass side	Before Tempering	64.90	0.84	17.80	3.0	33.94	37.24
	After Tempering	67.45	0.88	16.18			

*BT- Before Tempering AT- After Tempering

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From Table 7 it is evident that the reflectance value of the reflective glass product post-tempering developed using ST-108 as the glass substrate and having an enamel layer coated on the glass side has increased. On the other hand, from Table-6 reflective glass product developed using ST-108 as the glass substrate and having an enamel layer coated on the coating side has remained unchanged post-tempering. A closer analysis suggests that L value increases meaning that the reflective surface becomes more bright whereas the b* value

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decreases meaning that the golden/bronze appearance of the reflective surface decreases.

EXAMPLE 2:

5 A 300 x 300 mm SGG Mirastar reflecting glass sample (magnetron coated stack on Planiclear glass//SiO₂/Cr/SiN/Ti) of thickness 8 mm was used as a glass substrate 102 along with a solvent based enamel. The enamels used were supplied by Ferro having an inorganic content of 69.8%, organic content of 12-13% and the rest was in form of a solvent. Fineness of the grind was less than 20
10 μm measured by the Hegman gauge. Approximately 27 ± 5 gms of the enamel containing glass frits was applied on the coating side of the glass using a bar coater to create a uniform coating.

The glass substrate was then allowed to cure in an oven at 180 °C for approximately 15 minutes. The coating thickness measured was approximately
15 50-125 μm . The samples were then cut into 100 mm x100 mm and the reflectance (%) was measured. The samples were then tempered at 640 °C for approximately 8 minutes and allowed to cool. The reflectance was then measured again after tempering. A similar procedure was followed to create a heat treatable reflective
20 glass product using Mirastar where the coating of the enamel was done on the glass side.

Durability tests were conducted to evaluate the mechanical performance of an enamel layer 110 coated on the glass side of the reflective glass having Mirastar as the glass substrate both before and after heat treatment. The results of the same are tabulated in Tables 8 – 11.

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Table 8: Durability Results Covering Mechanical Performance of a Reflective Glass having Enamel on Coated Side (Pre-Tempering)

Test	Target	Reflective glass of the present disclosure
Visual observations	No defects seen from/on both side	Some pinholes

Erichsen Brush Test	No peel off or delamination of paint			Some peel off from edges
Coating Adhesion (Cross Hatch Test)	<4			2
Abrasion (Taber)	<0.05% weight loss	<0.07%	<0.10%	0.021
Scratch Test (Scelerometer)	>4N	4N	<3N	5N

Table 9: Durability Results Covering Mechanical Performance of a Reflective Glass having Enamel on Glass Side (Pre-Tempering)

Test	Target	Reflective glass of the present disclosure
Visual observations	No defects seen from/on both side	No defects
Erichsen Brush Test	No peel off or delamination of paint	Some peel off from edges
Coating Adhesion (Cross Hatch test)	<4	1
Abrasion (Taber)	<0.05% weight loss	0.023
Scratch Test (Scelerometer)	>4N	4N

5 Table 10: Durability Results Covering Mechanical Performance of a Reflective Glass having Enamel on Coated Side (Post-Tempering)

Post-tempering tests	Target	Reflective glass of the present disclosure
Visual Defects	No Pinholes, Scratches, Slight Peeling off in corners	Peel off Defect due to poor tempering
Haze	No haze seen on reflective side	No haze
Cross Hatch (Adhesion)	0 or 1 according to standard	1

Taber	<0.03	0.025
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Table 11: Durability Results Covering Mechanical Performance of a Reflective Glass having Enamel on Glass Side (Post-Tempering)

Post temp tests	Target	Reflective glass of the present disclosure
High Humidity	No defects/ peeling off	No defects
Taber	<0.03	0.015

- 5 For the heat treatable glass 100 developed from SGG Mirastar from Saint-Gobain, it was critical to measure and analyzes the change in optical properties of the coated reflective glass product before and after tempering. Based on the side that was enameled the data below shows the important comparison of the optical properties of the product. Results of optical properties of SGG
- 10 Mirastar sample coated with enamel on coating side and glass side, before and after tempering are tabulated in Table 12.

Table 12: Optical Properties of a Reflective Glass having Mirastar as Glass Substrate (Pre and Post-Tempering)

Optical data		L	a*	b*	ΔE^* Glass side	Reflectance BT	Reflectance AT
Enamel on coating side	Before Tempering	78.04	-5.05	0.7	1.8	53.28	53.22
	After Tempering	78.01	-5.05	-1.126			
Enamel on glass side	Before Tempering	83.61	-1.086	2.532	1.0	63.32	62.97

	After Tempering	83.43	-0.94	1.512			
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**BT- Before Tempering AT- After Tempering*

From Table 12 it is evident that the reflectance values of the tempered reflective glass products developed using Mirastar as the glass substrate and having an enamel layer coated either on the glass side or the coating side has remained unchanged after tempering. However, a closer analysis of L, a* and b* values exhibits tangible change in b* before and after tempering meaning that on the colorimetric chart the appearance of the surface moves from yellow to bluish. However, since the values are very close to origin, no significant change in color was perceived.

Various test procedures carried out to evaluate the durability and optical property of the reflective glass products of the present invention are described below.

15 Cross Hatch Test

The tape test was used to evaluate the adhesion of a coating on a particular substrate. This test was performed as per the standards set out in ASTM Standard D 3359 – 00. A cross hatch pattern was made through the film to the substrate. Detached flakes of coating were removed by brushing with a soft substrate. Pressure Sensitive tape was applied over the cross hatch cut. Tape was smoothed into place by using a pencil eraser over the area of the incisions. Tape was then removed by pulling it off rapidly back over itself as close to an angle of 180°. Adhesion was assessed on a scale between 0 to 5.

25 Brush Test

The brush test was used to evaluate the resistance of the coating to erosion caused by scrubbing. This test was performed as per the standards set out in ASTM Standard D 2486 - 00. Samples of coated glass were submitted to Test Method A. The sample was scrubbed dry, with a bristle brush until the coating was pierced.

Lucite Test

The Lucite test was used to evaluate the scratch resistance of the coating. The sample was sprinkled on the coating side with Lucite<(R)> 4F or 47G (a quarter of a tea spoon on a sample of 15 x 25 cm), and then covered with
5 a piece of clear glass of 6 mm thick (10 x 10 cm) on which a weight of 1 kg was placed. The assembly "upper glass and weight" was subjected to a backward and forward movement during 100 cycles by placing on a lab shaker.

Hardness Test

10 The hardness test was conducted to check the surface hardness or wear/scratch resistance of a coating on a substrate. This test was performed as per the standards set out in EN 438-2. A hardness test pen having a tungsten carbide tip was drawn over the surface of a substrate having a coating with a defined constant pressure. The pressure on the tip can be changed using the slide or by
15 changing the spring. A visual mark on the surface indicates a fail of the wear/scratch resistance.

Taber Abrasion test

Taber abrasion test was used for performing accelerated wear
20 resistance testing. It involved mounting a flat sample of approximately 100 mm² to a turntable platform that rotate on a vertical axis at a fixed speed. The wear action was carried out by two rotating abrading wheels supported on a loading arm which applied 250 gram pressure against the specimen, exclusive of the weight of the wheel in contact with sample. The weight before and after the test
25 was measured to calculate the overall weight loss of the samples.

The heat treatable glass 100 according to this disclosure may have various applications. The heat treatable glass 100 may, for example be used for various interior applications of buildings including but not limited to decorative purpose, wardrobes, as doors for furniture, as partitions, in tables, shelves, in
30 bathrooms, in shops displays, as wall covering, as spandrels etc. The heat treatable glass 100 may also be used on automotive glazing panels, or at least on portions of these glazing, for example on the peripheral portions of a windscreen

or as interior portions of automobiles. More and more of these applications necessitate tempered reflective glass, as the tempered reflective glass has the advantage of being more resistant to breakage. Other heat treatments are also becoming often used: bending, for example.

5 Note that not all of the activities described above in the general description or the examples are required, that a portion of a specific activity may not be required, and that one or more further activities may be performed in addition to those described. Still further, the order in which activities are listed is not necessarily the order in which they are performed.

10 Benefits, other advantages, and solutions to problems have been described above with regard to specific embodiments. However, the benefits, advantages, solutions to problems, and any feature(s) that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential feature of any or all the claims.

15 The specification and illustrations of the embodiments described herein are intended to provide a general understanding of the structure of the various embodiments. The specification and illustrations are not intended to serve as an exhaustive and comprehensive description of all of the elements and features of apparatus and systems that use the structures or methods described
20 herein. Certain features, that are for clarity, described herein in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features that are, for brevity, described in the context of a single embodiment, may also be provided separately or in a sub combination. Further, reference to values stated in ranges includes each and every
25 value within that range. Many other embodiments may be apparent to skilled artisans only after reading this specification. Other embodiments may be used and derived from the disclosure, such that a structural substitution, logical substitution, or another change may be made without departing from the scope of the disclosure. Accordingly, the disclosure is to be regarded as illustrative rather
30 than restrictive.

 The description in combination with the figures is provided to assist in understanding the teachings disclosed herein, is provided to assist in

describing the teachings, and should not be interpreted as a limitation on the scope or applicability of the teachings. However, other teachings can certainly be used in this application.

As used herein, the terms "comprises," "comprising," "includes,"
5 "including," "has," "having" or any other variation thereof, are intended to cover a non-exclusive inclusion. For example, a method, article, or apparatus that comprises a list of features is not necessarily limited only to those features but may include other features not expressly listed or inherent to such method, article, or apparatus. Further, unless expressly stated to the contrary, "or" refers to
10 an inclusive-or and not to an exclusive-or. For example, a condition A or B is satisfied by any one of the following: A is true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

Also, the use of "a" or "an" is employed to describe elements and
15 components described herein. This is done merely for convenience and to give a general sense of the scope of the invention. This description should be read to include one or at least one and the singular also includes the plural, or vice versa, unless it is clear that it is meant otherwise. For example, when a single item is described herein, more than one item may be used in place of a single item.
20 Similarly, where more than one item is described herein, a single item may be substituted for that more than one item.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. The materials, methods, and examples
25 are illustrative only and not intended to be limiting. To the extent that certain details regarding specific materials and processing acts are not described, such details may include conventional approaches, which may be found in reference books and other sources within the manufacturing arts.

While aspects of the present disclosure have been particularly
30 shown and described with reference to the embodiments above, it will be understood by those skilled in the art that various additional embodiments may be contemplated by the modification of the disclosed machines, systems and

methods without departing from the spirit and scope of what is disclosed. Such embodiments should be understood to fall within the scope of the present disclosure as determined based upon the claims and any equivalents thereof.

List of Elements

TITLE: REFLECTIVE GLASS

100	Heat treatable glass
102	Glass substrate
104	First side
106	Second side
108	Reflective stack
110	Enamel layer
500	Method
502	Step
504	Step
506	Step

REFLECTIVE GLASSClaims

We Claim:

1. A heat treatable glass comprising:
 - a glass substrate;
 - a reflective stack on a first side of the glass substrate; and
 - an enamel layer;wherein the enamel layer is coated above the reflective stack, wherein the reflectance of the heat treatable glass is greater than at least about 20% and less than at least about 70%.
2. A heat treatable glass comprising:
 - a glass substrate;
 - a reflective stack on a first side of the glass substrate; and
 - an enamel layer;wherein the enamel layer is coated on a side opposite to the first side of the glass substrate, wherein the reflectance of the heat treatable glass is greater than at least about 20% and less than at least about 70%
3. The heat treatable glass of claim 1 or claim 2, wherein the reflective stack includes at least one functional layer and at least one over-layer.
4. The heat treatable glass of claim 3, wherein the functional layer comprises at least one of a metal and metal alloy belonging to a group consisting of niobium, chromium, nickel, tantalum or zirconium.
5. The heat treatable glass of claims 3 or claim 4, wherein the over-layer comprises at least one of metal oxide belonging to the group consisting of Sn, Ti, Ta or Si.

6. The heat treatable glass of any one of claims 3 to claim 4, wherein the thickness of the functional layer ranges between 15 nm to 50 nm.
7. The heat treatable glass of any one of claims 3 to claim 4, wherein the functional layer is in direct contact with the over layer.
8. The heat treatable glass of any one of claims 3 to claim 4, wherein the over-layer is in direct contact with the glass substrate.
9. The heat treatable glass of claim 1 or claim 2, wherein the enamel layer comprises of glass frit, an organic material and a pigment.
10. The heat treatable glass of claim 9, wherein a weight percentage of the organic material is in a range of 5-40% of the total weight of the enamel layer upon drying.
11. The heat treatable glass of claims 9 or claim 10, wherein the organic material comprises of at least one or more materials selected from the group consisting of polyols, alkyds, acrylic, polyacrylic, polyacrylates, polymethacrylates, acrylamides, melamine, polycarbonates, acrylic-styrenes, vinyl- acrylic, urethanes, polyurethanes, polyesters, polyolefins, urethane alkyds, polyurea, amino resins, polyamides, epoxies, epoxy esters, phenolic resins, silicon resins, PVC, PVB, water-based resins or reaction products of photocurable chemicals.
12. The heat treatable glass as claimed in claim 9, wherein the glass frit comprises of about 40 to 60% of a zinc-based material.
13. The heat treatable glass as claimed in claim 1 or claim 2, wherein ΔE^* on each side is ≤ 3 upon heat treatment.
14. The heat treatable glass as claimed in claim 1 or claim 2, wherein the thickness of the enamel layer ranges between 40 microns to 120 microns.

15. A method of manufacturing a heat treatable glass, the method comprising:
 - providing a reflective stack on the first side of a glass substrate;
 - coating an enamel on the second side of the glass substrate or, above the reflective stack, wherein the second side is opposite to the first side; and
 - drying the enamel so that the enamel hardens and sticks to the glass substrate but is yet to fuse or sinter.

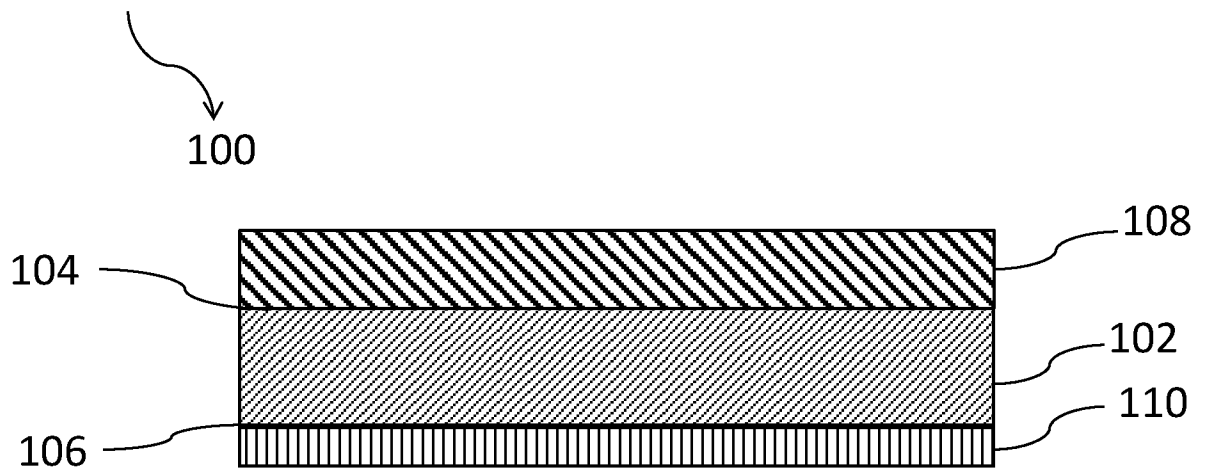
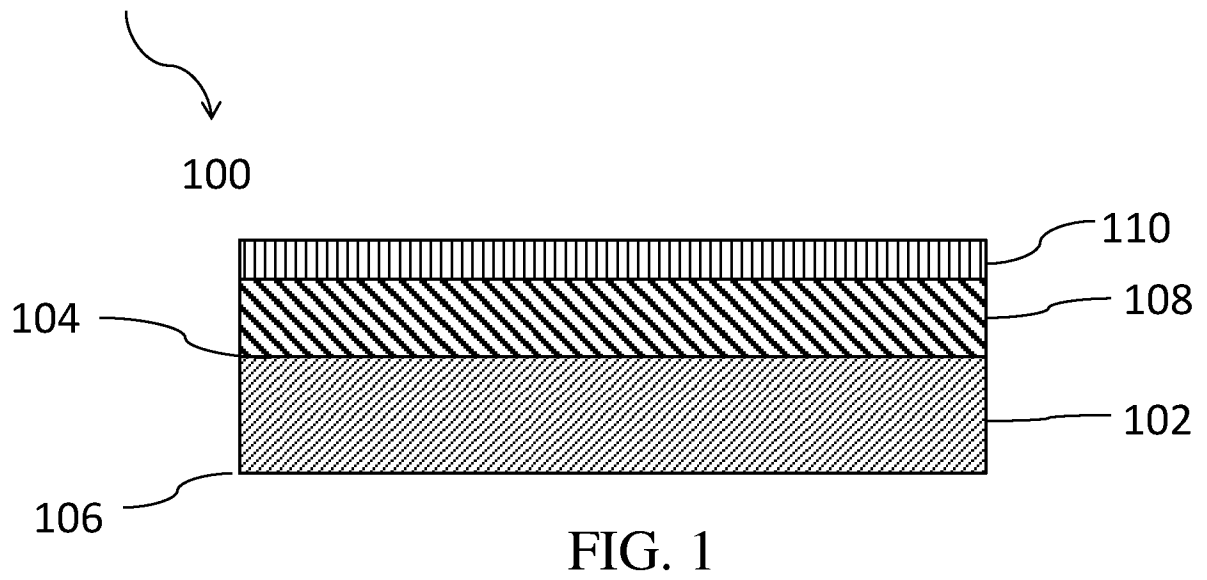


FIG. 2



108

Si_3N_4
Nb
Si_3N_4
Glass

FIG. 3



108

Ti
SiN
Cr
SiO_2
Glass

FIG. 4

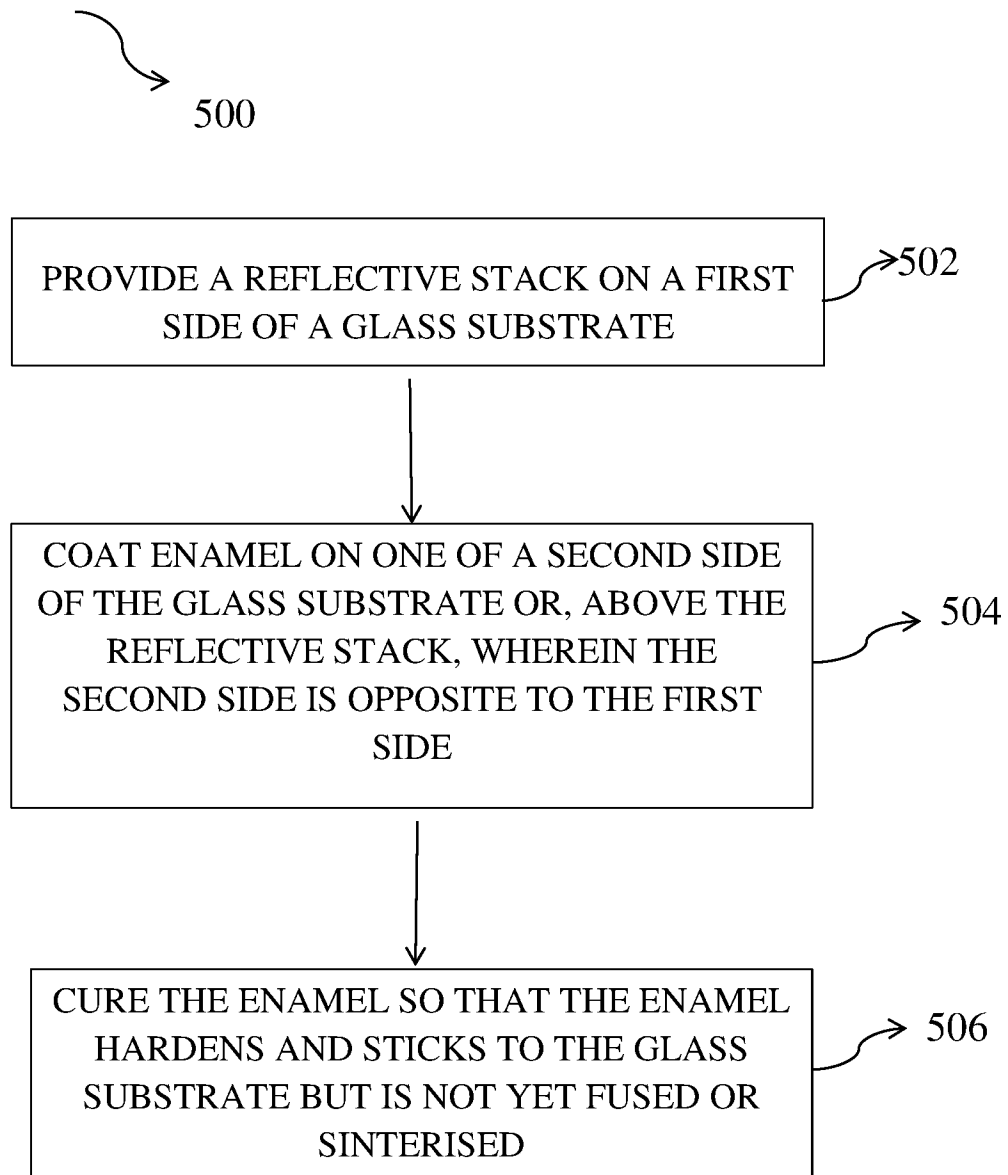


Fig.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2017/050158

A. CLASSIFICATION OF SUBJECT MATTER
C03C17/36 Version=2017.01

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)

C03C

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)

Patseer, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO2001021540 A1; [SAINT-GOBAIN GLASS FRANCE]; 29 MAR 2001 (29/03/2001) WHOLE DOCUMENT, SEE, EXAMPLE 1-6	1-15
Y	US20150072137 A1; [AGC GLASS EUROPE]; 15 MAR 2015 (15/03/2015) SEE; PARA[0024], [0025] AND [0029]	3-14
Y	WO2007135192 A1; [AGC FLAT GLASS EUROPE SA]; 29 Nov 2007 (29/11/2007) see page-6 para-2nd, and last para	3-14

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search

14-09-2017

Date of mailing of the international search report

14-09-2017

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IN2017/050158

Citation	Pub.Date	Family	Pub.Date
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