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(54) **Title:** WATER-BASED TEMPORARY PROTECTIVE COATING FOR HEAT TREATABLE COATED GLASS ARTICLES

(57) **Abstract:** Temporary protective coating for heat treatable coated glass article comprising a water-based suspension, dispersion or emulsion of polyurethane, acrylic polymers, epoxy polymer or their combinations thereof is disclosed. The temporary protective coating of the present disclosure is completely devoid of any organic solvents, curing agent, surfactants or photo initiators. The temporary protective coating is applied directly over a functionally coated transparent substrate to protect the coated substrate during heat treatment and handling of the coated substrate before heat treatment. The temporary protective coating is completely removed during the heat treatment leaving behind no residues thereby keeping the physical properties of the functionally coated substrate intact. A method of making a heat treatable coated article illustrated in FIG. 1 that can be handled before heat treatment is also disclosed.

WATER-BASED TEMPORARY PROTECTIVE COATING FOR HEAT TREATABLE COATED GLASS ARTICLES

Technical Field

The present disclosure relates, in general to temporary protection of coated glass substrates, and more specifically to a water-based temporary protective coating for heat treatable glass substrates provided with a functional coating.

Background

Glass surfaces remain an enduring area of scientific and technological challenges for applications of glass, and approaches to understand and customize its surface. Interfacial behaviors with glass modifications and functional coatings represent a critical direction for glass' future. Glass substrates are increasingly being deposited with functional coatings to improve performance and durability. Widely used and popular functional coatings include solar control, conductive, antireflective and/or low emissivity coatings. Other coatings that modify the various physical properties of glass substrates such as optical, thermal or mechanical properties are also common.

Such coated glass substrates are usually shipped from manufacture sites to fabricator locations for further processing such as cutting, grinding, bending etc. There are well known shipping methods in the art for transporting a plurality of glass substrates. However, the known shipping methods are inadequate for transporting glass substrates deposited with functional coatings without causing any damage to these coatings. For example, the functionally coated surface of one coated glass substrate during handling, processing, shipping or storage could possibly damage or scratch the functional coating of an adjacent coated glass substrate.

Historically, these functional coatings cannot survive temperatures higher than 200 °C or 250 °C without suffering some form of degradation and also cannot be subjected to further processing steps post coating due to the susceptibility of these coatings to such processing steps. As a result, these

functionally coated glass substrates need to be shaped, sized, cut, ground, edge grinded and/ or processed prior to the coating process as, such processing are not possible post the coating process as well as post the heat treatment. This constraint posts significant challenges while trying to achieve a continuous production process.

As an example, a functionally coated glass substrate may be covered with a layer of IR or UV curable enamel, cured and then heat treated. However, such a curing process does not provide mechanical resistance and water resistance sufficient for allowing the coated glass substrate to be transported, cut, edge-worked, stocked, and/or otherwise processed, before the heat treatment. Hence such an enameled functionally coated glass substrate also needs to be heat treated immediately after production, thereby limiting possibilities of having the functionally coated glass substrates transported to fabricator locations where they could be cut-to-size, grind etc. and heat treated before being installed.

Temporary protective coatings that enable such functional coated glass substrates to be transported and further processed are also known in the art. Referring to PCT publication number 2007104752 discloses a temporary protection for a to-be-tempered glass surface having a base layer comprising enamel and a top layer comprising resin. Referring to the US publication 20160194516 assigned to the assignee of the present disclosure uses a mixture of expansive urethane acrylate oligomer for temporary protection of heat treatable functionally coated glass substrates. Referring to yet another US granted patent 6682773 discloses a removable protective coating comprising polyvinyle alcohol, poly ethelene oxide, polymeric emulsion, dispersion, cellulose for protecting functionally coated articles. The protective coating is later removed by washing.

Notwithstanding all the past experience and technology which are available for temporary protection of functionally coated glass substrates, it has been discovered that although these temporary coatings are effective to some extent, they involve expensive acrylic oligomers, organic solvents and/ or complex mixture of chemicals. Further these temporary coating may result in environment and health issues due to the presence of organic solvent.

Furthermore, temporary coatings that are not completely removed post heat treatment interfere in the optical, functional and aesthetic characterisation of the functionally coated glass substrates. Hence there is scope for providing a simpler solution for protecting functionally coated glass substrates during transport and post processing steps. And further to provide an environment friendly yet inexpensive solution.

The proposed temporary protective coating is a water-based polymeric solution containing self-crosslinking polymers which do not warrant any organic solvent, curing agent or initiators generally present in most of the temporary coating compositions found in the prior art. Additionally, the temporary protective coating composition of the present disclosure can be removed completely during the heat treatment of the functionally coated glass substrate without the need for any targeted treatments for their removal.

The temporary protective coating provided by the proposed disclosure enables functionally coated glass substrates to be handled, transported and processed further (cutting, bending, edge grinding etc.) before being subjected to heat treatment. Further the self-crosslinking polymers present in the temporary protective coating composition are chemically cross-linked and polymerized thereby remaining non-reactive with any functional coating provided on the glass substrate.

The present disclosure relates to a temporary protective coating comprising water-based suspension, dispersion or emulsion of polyurethane, acrylic polymers, epoxy polymers or their combinations thereof. This temporary protective coating protects a functionally coated article during heat treatment and handling of the coated article before heat treatment. Coated articles comprising functional coatings ranging from single to multilayer coatings selected from magnetron deposited coatings, sputter deposited coating or chemical vapor deposited coatings are protected by depositing the temporary protective coating composition of the present disclosure directly over the functional coating of the coated article. The disclosure thus enables a transparent substrate to be manufactured and coated in one location, transported without any mechanical,

chemical or weathering damages to multiple locations for various post-processing procedures and finally to another location for heat treatment and use. Further the self cross-linked polymers contribute to excellent hardness and scratch resistance of the functionally coated articles.

Summary of the Disclosure

In one aspect of the present disclosure, a heat treatable coated article comprising a substrate having a first surface, a functional coating deposited over the first surface and a temporary protective coating deposited directly over the functional coating is disclosed. The temporary protective coating comprising water-based suspension, dispersion or emulsion of polyurethane, acrylic polymers, epoxy polymers or their combinations thereof protects the functional coating during heat treatment and handling of the heat treatable coated article before heat treatment.

In one other aspect of the present disclosure, a coating composition for forming a temporary protective coating over a heat treatable coated substrate having a functional coating is disclosed. The coating composition comprises of water-based suspension, dispersion or emulsion of polyurethane, acrylic polymers, epoxy polymer or their combinations thereof. The acrylic polymer is selected from the group consisting of pure acrylic polymer, styrene-acrylic copolymer or acrylic-epoxy hybrid polymer or acrylic-polyurethane hybrid polymer. The epoxy polymer is selected from the group consisting of bisphenol A or bisphenol F or their combination thereof.

In another aspect of the present disclosure, a method of protecting a heat treatable coated article during heat treatment and handling of the heat treatable coated article before heat treatment is disclosed comprising the steps of providing a substrate having a first surface provided with a functional coating over at least a portion of the first surface, providing a temporary protecting coating over at least a portion of the functional coating, curing the coated substrate, handling the coated substrate and heating the coated substrate at a temperature ranges above 150 °C and below 800 °C for removing the temporary protective coating composition.

In yet another embodiment of the present disclosure, a method of making a heat treatable coated article that can be handled before heat treatment is disclosed comprising the steps of providing a transparent substrate, depositing a functional coating on one surface of the substrate, curing or drying the substrate coated with the functional coating, providing a temporary protective coating over the functional coating and thermally curing the substrate coated with the temporary protective coating.

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 to those shown in the accompanying figures.

FIG. 1 illustrates a heat treatable coated article, according to one 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 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 similar parts. Embodiments disclosed herein are related to heat treatable coated article provided with a water-based temporary protective coating.

A heat treatable coated article 100 according to one embodiment of the present disclosure is illustrated in **FIG. 1**. The heat treatable coated article 100 comprises of a transparent substrate 110 having a first surface 101 and a second surface 102. The first surface 101 of the transparent substrate 110 is provided with a functional coating 120. Directly provided over the functional coating 120 is a temporary protective coating 130 that protects the functional

coating 120 from chemical, mechanical and weathering damages. The temporary protective coating 130 protects the functional coating 120 during heat treatment and handling of the heat treatable coated article 100 before heat treatment.

In one embodiment of the present disclosure, the temporary protective coating 130 comprises of water-based suspension, dispersion or emulsion of polyurethane, acrylic polymers, epoxy polymers or their combinations thereof. In all embodiment of the present disclosure, the temporary protective coating 130 is completely devoid of any organic solvents, curing agent, surfactants or photo initiators. In one aspect of the embodiment, the acrylic polymer is selected from the group consisting of pure acrylic polymer, styrene-acrylic copolymer, acrylic-epoxy hybrid polymer or acrylic-polyurethane hybrid. In another aspect of the embodiment, the epoxy polymer is bisphenol A or bisphenol F or their combination thereof.

In embodiments of the present disclosure where the temporary protective coating 130 comprises acrylic polymers, the concentration of acrylic polymer ranging between 30% and 50%. In embodiments of the present disclosure where the temporary protective coating 130 comprises polyurethane, the concentration of polyurethane ranging between 25% and 45%. In embodiments of the present disclosure where the temporary protective coating 130 comprises epoxy polymers, the concentration of epoxy polymer ranging between 40% and 60%. The thickness of the temporary protective coating 130 ranges between 2 microns and 100 microns. In multiple embodiments, the temporary protective coating 130 is substantially a continuous or a non-continuous coating that is completely devoid of any organic solvents, curing agent, surfactants or photo initiators.

The polymers present in the temporary protective coating 130 are chemically cross-linked and polymerized thereby providing a temporary protective coating composition that is non-reactive with adjacent coatings present in the heat treatable coated article 100. Further, the temporary protective coating composition in all embodiments of the present disclosure is water-based and

hence is easily cured by heating methods post their coating on the heat treatable coated article 100. Furthermore, because the temporary protective coating composition in all embodiments of the present disclosure is composed of organic polymers, the polymeric film formed by the temporary protective coating 130 atop the functional coating 120 of the heat treatable coated article 100 can be easily removed by heat treatment at a temperature ranging between 150 °C and below 400 °C. Alternatively, the temporary protective coating 130 can also be removed during the tempering process of the heat treatable coated article 100 at temperatures ranging between 550 °C to 800 °C.

In an optional embodiment of the present disclosure, the temporary protective coating 130 may contain adhesion promoters at a concentration ranging between 1% and 3%. Adhesion promoters selected from the group consisting of 3-glycidyloxypropyl trimethoxysilane, γ–minopropyltriethoxysilane, epoxy silane oligomer or vinyltrimethoxysilane can be used in the temporary protective coating composition.

In one embodiment, the functional coating 120 provided on the first surface 101 of the transparent substrate 100 may be a single layer or multilayer coating comprising one or more metals, non-metals, alloys, composites, compounds or their derivatives or combinations thereof. In another embodiment, the functional coating 120 may be provided by a method selected from the group consisting of magnetron deposited coatings, sputter deposited coating or chemical vapor deposited coatings. In one other embodiment, the functional coating 120 may be low emissivity coatings, solar energy reflective or absorptive coatings, thermal infrared reflective or absorptive coatings or their combinations thereof.

In one embodiment, the transparent substrate 110 may be a flat glass or a curved glass selected from the group consisting of non-tempered glass, annealed glass or strengthened glass. In yet another embodiment, the transparent substrate 110 may be a clear glass or a tinted glass. The heat treatable coated article 100 can be heated to a temperature above 150 °C and below 800 °C without damaging the functional coating 120 due to the presence of the

temporary protective coating 130. During heat treatment of the heat treatable coated article 100 the temporary protective coating 130 is completely removed without leaving behind any residue on the functional coating 120 thereby keeping the physical and optical properties of the heat treated coated article unaltered. This is a crucial feature as the performance of the functional coating 120 remains unchanged during the steps of coating and removing the temporary protection coating 130. In multiple embodiments of the present disclosure, the heat treatable coated article 100 can be heated to a temperature ranging between 150 °C and 400 °C such that the temporary protective coating is completely removed without damaging the functional coating 120.

In another embodiment of the present disclosure the heat treatable coated article 100 comprising the temporary protective coating 130 can also be handled before heat treatment. Handling of the heat treatable coated article 100 involves post-processing procedures not limiting to cutting, edge grinding, beveling, drilling, sizing, finishing, storing and transporting. Thus handling and heat treatment of the heat treatable coated article 100 neither affects its physical properties nor result in any damage to the functional coating 120.

Example 1

Preparation of Water-based Temporary Protective Coating Composition

The polymers shown in table 1 were added in a glass beaker at specified concentrations along with 1% adhesion promoters and mixed thoroughly using a magnetic stirrer. The contents were then allowed to stay for a period of 10 minutes to ensure absence of bubbles. Thus prepared compositions were then applied on functionally coated glass substrates using a Meyer rod at thicknesses ranging between 15 microns and 20 microns. The coated glass substrates were then cured in an oven at a temperature of 110 °C for about 0.5 – 1 hour such that the temporary protective coating is completely cured. The adhesion promoter used in the below compositions is 3-glycidyloxypropyl trimethoxysilane.

Table 1: Water-based Temporary Protective Coating Composition

Composition	Components
Composition 1	100 % Polyurethane dispersion
Composition 2	99 % Polyurethane dispersion and 1 % adhesion promoter
Composition 3	100 % Polyurethane dispersion
Composition 4	99 % acrylic emulsion and 1 % adhesion promoter
Composition 5	100 % acrylic emulsion
Composition 6	99 % styrene-acrylic polymer and 1 % adhesion promoter
Composition 7	99 % Bisphenol A emulsion and 1 % adhesion promoter
Composition 8	99 % acrylic emulsion polyurethane dispersion hybrid and 1 % adhesion promoter

Example 2

Durability Studies

The following durability studies were performed on the functionally coated glass substrates provided with the temporary protective compositions described in Table 1.

Erichsen Scratch Test (EST):

3-100 mm x 100 mm samples were rotated in a circular manner on the machine using a sc indenter. It was observed that no scratch could be seen on the functional coating up to 5N for all above coating. Temporary protective compositions 1 and 2 were observed to show scratch resistance up to 8N and 9N, respectively. EST was done minimum 30 minutes after the curing.

Erichsen Scratch Test Then Tempering (ESTTT):

The above tested samples were then subjected to the tempering process (samples were kept in a Nabertherm Tempering furnace) at 690 °C for 8 minutes to remove the temporary protective layer. It was observed that no residue or corrosion could be seen on the coated glass substrates indicating that the temporary protective layer had been completely removed. No scratches up to 5 N could be seen based on the Erichsen scratch test conducted.

Erichsen Brush Test (EBT):

Samples coated with the temporary protective layer were subjected to a brush test in water. This test was conducted to understand and check the adhesion of the temporary protective layer to the coated glass substrates which would be critical during the washing step during processing. All the above mentioned samples showed no delamination of the temporary protective layer after the conclusion of the test.

Results of the durability studies are summarized in table 2.

Table 2: Results of Durability Tests

Composition	EST	EBT	ESTTT
1	Pass @ 8, 8, 9N	No pinholes, scratches or delamination observed	Pass @ 8, 8, 8N
2	Pass @ 9, 9, 9N	No pinholes, scratches or delamination observed	Pass @ 9, 9, 9N
3	Pass @ 9, 9, 9N	No pinholes, scratches or delamination observed	Pass @ 9, 9, 9N
4	Pass @ 6, 6,6N	No pinholes, scratches or delamination observed	Pass @ 6, 7,6N
5	Pass @ 8, 7, 7N	No pinholes, scratches or delamination observed	Pass @ 7, 7,7N
6	Pass @ 6, 6, 6N	No pinholes, scratches or delamination observed	Pass @ 6, 6, 6N
7	Pass @ 7, 6, 7N	No pinholes, scratches or delamination observed	Pass @ 6, 6, 7N
8	Pass @ 5, 5, 5N	No pinholes, scratches or delamination observed	Pass @ 5, 5, 5N

Industrial Applicability

The heat treatable coated article 100 of the present disclosure can be transported to a distant location and be processed before being heat treated to obtain a heat treated coated article. Hence heat treatable coated article 100 of the

present disclosure has the advantage of being able to be manufactured and coated in one location, transported without any mechanical or chemical damages to multiple processor locations for various post-processing procedures and finally to a fabricator location for heat treatment and use. The temporary protective coating is completely removed during the heat treatment of the heat treatable coated article 100 without leaving behind any residue deposition. This helps in retaining the optical and performance properties of the functionally coated glass.

The friction between adjacent functional coated substrates when being stacked up for transport is reduced by the presence of the temporary protective layer thereby reducing mechanical damage during transport and storage of the functionally coated substrates. In more than one embodiments of the present disclosure the self cross-linking polymers present in the temporary protective coating 130 provides for mechanical and chemical protection to the functional coated substrates. The temporary protective coating being a water-based composition and completely devoid of any organic solvent further makes it environmental friendly. Furthermore, the temporary protective coating has a simple chemistry that is again devoid of any complex chemistries and additives such as curing agent, surfactants or photo initiators.

Although the temporary protective coating is envisaged herein to protect functional coatings on glass substrates, protection of non-functional coatings on glass substrates including but not limiting to enameled glass and lacquered glass and glass substrates without any such coatings using the temporary protective coating composition of the present disclosure shall also fall within the scope of the present disclosure.

A method of protecting a coated article during heat treatment and handling of the coated article before heat treatment is also disclosed. The method comprises the steps of providing the temporary protective coating 130 of the present disclosure over the surface of a coated glass article. In one embodiment, the temporary protective coating may be provided on at least a portion of the surface of the coated article in a continuous or a non-continuous process. The coated article provided with the temporary protective coating can be stored and

transported to distant locations without damaging the functional coating before being heat treated. Further the coated article may also be subjected to post-processing procedures not limiting to cutting, edge grinding, beveling, drilling, sizing, finishing etc. The coated article is finally heat treated at 650 °C after transport, handling and/ or desired post-processing procedures.

The present disclosure also discloses a method of making the heat treatable coated article 100 of the present disclosure that can be handled before heat treatment. The method comprises the steps of cleaning the surface of the coated article to remove dust and other contaminations including finger prints. The temporary protective coating composition of the present disclosure is then prepared as illustrated in example 1 and applied on the surface of the cleaned functionally coated article using a Meyer Rod. The thickness of the temporary protective coating ranges between 2 to 100 microns. The coated article is then subjected to thermal curing process where the self crosslinking polymers present in the temporary protective coating 130 forms a protective layer over the functional coating of the coated article. The resulting heat treatable coated article 100 can be further handled and heat treated to a temperature ranging above 600 °C and below 800 °C to completely remove the temporary protective coating.

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.

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.

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 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 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 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," "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 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 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. 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 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 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: WATER-BASED TEMPORARY PROTECTIVE COATING FOR HEAT TREATABLE COATED GLASS ARTICLES

100 Heat Treatable Coated Article

101 First Surface

102 Second Surface

110 Glass Substrate

120 Functional Coating

130 Temporary Protective Coating

Claims

We claim,

1) A heat treatable coated article comprising:

a transparent substrate having a first surface;

a functional coating deposited over at least a portion of the first surface;

a temporary protective coating deposited over at least a portion of the functional coating;

wherein the temporary protective coating comprising water-based suspension, dispersion or emulsion of polyurethane, acrylic polymers, epoxy polymers or their combinations thereof protects the functional coating during heat treatment and handling of the heat treatable coated article before heat treatment.

2) The heat treatable coated article as claimed in claim 1, wherein the acrylic polymer is selected from the group consisting of pure acrylic polymer, styrene-acrylic copolymer, acrylic-epoxy hybrid polymer or acrylic-polyurethane hybrid.

3) The heat treatable coated article as claimed in claim 1, wherein the epoxy polymer is bisphenol A or bisphenol F or their combination thereof.

4) The heat treatable coated article as claimed in claim 1, wherein the functional coating consists of single layer or multilayer coating comprising one or more metals, non-metals, alloys, composites, compounds or their derivatives or combinations thereof.

5) The heat treatable coated article as claimed in claim 1, wherein the functional coating may be selected from the group consisting of magnetron

deposited coatings, sputter deposited coating, chemical vapor deposited coatings.

6) The heat treatable coated article as claimed in claim 1, wherein the functional coating comprises of low emissivity coatings, solar radiation reflective or absorptive coatings, thermal infrared reflective or absorptive coatings or their combinations thereof.

7) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating comprising acrylic polymer has a concentration ranging between 30 % and 50 %.

8) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating comprising polyurethane has a concentration ranging between 25 % and 45 %.

9) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating comprising epoxy polymer has a concentration ranging between 40 % and 60 %.

10) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating has a thickness ranging between 2 microns and 100 microns.

11) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating is substantially a continuous or a non-continuous coating that is devoid of any organic solvents, curing agent, surfactants or photo initiators.

12) The heat treatable coated article as claimed in claim 1, wherein the transparent substrate may be a flat glass or a curved glass.

13) The heat treatable coated article as claimed in claim 1, wherein the transparent substrate is selected from the group consisting of non-tempered glass, annealed glass or strengthened glass.

14) The heat treatable coated article as claimed in claim 1, wherein handling of the heat treatable coated article includes cutting, edge grinding, beveling, drilling, sizing, finishing, storing and transporting of the heat treatable coated article.

15) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating is completely removed during the heat treatment.

16) The heat treatable coated article as claimed in claim 1, wherein the heat treatment involves heating to a temperature ranging above 150 °C and below 800 °C.

17) A temporary protective coating composition for forming a temporary protective coating over a heat treatable coated article as claimed in claim 1 having a functional coating, wherein the coating comprises:

a water-based suspension, dispersion or emulsion of polyurethane, acrylic polymers, epoxy polymer or their combinations thereof, wherein the acrylic polymer is selected from the group consisting of pure acrylic polymer, styrene-acrylic copolymer or acrylic-epoxy hybrid polymer or acrylic-polyurethane hybrid polymer and wherein the epoxy polymer is bisphenol A or bisphenol F or their combination thereof.

18) The coating composition as claimed in claim 17 optionally comprises adhesion promoters selected from the group consisting of 3-glycidyloxypropyl trimethoxysilane, γ–minopropyltriethoxysilane, epoxy silane oligomer or vinyltrimethoxysilane.

19) A method of protecting a coated article during heat treatment and handling of the coated article before heat treatment, comprising the steps of:

providing a transparent substrate having a first surface provided with a functional coating over at least a portion of the first surface;

providing a temporary protecting coating composition as claimed in claim 16 over at least a portion of the functional coating;

curing the coated substrate;

handling the coated substrate; and

heating the coated substrate for removing the temporary protective coating composition, wherein the temperature ranges above 150 °C and below 800 °C.

20) The method as claimed in claim 19, wherein the self-crosslinking polymers present in the temporary protective coating act as spacers that protects the functional coating of the heat treatable coated article from mechanical and chemical damages during heat treatment and handling.

21) A method of making a heat treatable coated article that can be handled before heat treatment, comprising the steps of:

providing a transparent substrate;

depositing a functional coating on one surface of the substrate;

curing or drying the substrate coated with the functional coating;

providing a temporary protective coating composition as claimed in claim 16 over the functional coating; and

thermally curing the substrate coated with the temporary protective coating composition.

22) The method as claimed in claim 21 further involves handling the substrate coated with the temporary protective coating composition and heat treating

the handled substrate to a temperature ranging above 150 °C and below 800 °C to completely remove the temporary protective coating composition.

AMENDED CLAIMS
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1) A heat treatable coated article comprising:

a transparent substrate having a first surface;
a functional coating deposited over a portion of the first surface;
a temporary protective coating deposited over a portion of the functional coating;
wherein the temporary protective coating comprising water-based suspension, dispersion or emulsion of polyurethane, acrylic polymers, epoxy polymers or their combinations thereof protects the functional coating during heat treatment and handling of the heat treatable coated article before heat treatment.

2) The heat treatable coated article as claimed in claim 1, wherein the acrylic polymer is selected from the group consisting of pure acrylic polymer, styrene-acrylic copolymer, acrylic-epoxy hybrid polymer or acrylic-polyurethane hybrid.

3) The heat treatable coated article as claimed in claim 1, wherein the epoxypolymer is bisphenol A and/or bisphenol F.

4) The heat treatable coated article as claimed in claim 1, wherein the functional coating consists of single layer or multilayer coating comprising one or more metals, non-metals, alloys, composites, compounds or their derivatives or their combinations thereof.

5) The heat treatable coated article as claimed in claim 1, wherein the functional coating is selected from the group consisting of magnetron deposited coatings, sputter deposited coating, chemical vapor deposited coatings.

6) The heat treatable coated article as claimed in claim 1, wherein the functional coating comprises of low emissivity coatings, solar radiation reflective or absorptive coatings, thermal infrared reflective or absorptive coatings.

7) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating comprising acrylic polymer has a concentration ranging between 30 % and 50 %.

8) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating comprising polyurethane has a concentration ranging between 25 % and 45 %.

9) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating comprising epoxy polymer has a concentration ranging between 40 % and 60 %.

10) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating has a thickness ranging between 2 microns and 100 microns.

11) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating is a continuous or a non-continuous coating that is devoid of any organic solvents, curing agent, surfactants or photo initiators.

12) The heat treatable coated article as claimed in claim 1, wherein the transparent substrate is a flat glass or a curved glass.

13) The heat treatable coated article as claimed in claim 1, wherein the transparent substrate is selected from the group consisting of non-tempered glass, annealed glass or strengthened glass.

14) The heat treatable coated article as claimed in claim 1, wherein handling of the heat treatable coated article includes cutting, edge grinding, beveling, drilling, sizing, finishing, storing and transporting of the heat treatable coated article.

15) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating is completely removed during the heat treatment.

16) The heat treatable coated article as claimed in claim 1, wherein the heat treatment involves heating to a temperature ranging above 150 °C and below 800 °C.

17) A temporary protective coating composition for forming a temporary protective coating over a heat treatable coated article as claimed in claim 1 having a functional coating, wherein the coating comprises:

a water-based suspension, dispersion or emulsion of polyurethane, acrylic polymers, epoxy polymer or their combinations thereof, wherein the acrylic polymer is selected from the group

consisting of pure acrylic polymer, styrene-acrylic copolymer or acrylic-epoxy hybrid polymer or acrylic-polyurethane hybrid polymer and wherein the epoxy polymer is bisphenol A and/or bisphenol F.

18) The coating composition as claimed in claim 17 comprises adhesion promoters selected from the group consisting of 3-glycidyloxypropyl trimethoxysilane, γ–minopropyltriethoxysilane, epoxysilane oligomer or vinyltrimethoxysilane.

19) A method of protecting a coated article during heat treatment and handling of the coated article before heat treatment, comprising the steps of:

providing a transparent substrate having a first surface provided with a functional coating over at least a portion of the first surface;
providing a temporary protecting coating composition as claimed in claim 17 over at least a portion of the functional coating;
curing the coated substrate;
handling the coated substrate; and
heating the coated substrate for removing the temporary protective coating composition, wherein the temperature ranges above 150 °C and below 800 °C.

20) The method as claimed in claim 19, wherein the self-crosslinking polymers present in the temporary protective coating act as spacers that protects the functional coating of the heat treatable coated article from mechanical and chemical damages during heat treatment and handling.

21) A method of making a heat treatable coated article that can be handled before heat treatment, comprising the steps of:

providing a transparent substrate;
depositing a functional coating on one surface of the substrate;
curing or drying the substrate coated with the functional coating;
providing a temporary protective coating composition as claimed in claim 17 over the functional coating; and
thermally curing the substrate coated with the temporary protective coating composition.

22) The method as claimed in claim 21 further involves handling the substrate coated with the temporary protective coating composition and heat treating
the handled substrate to a temperature ranging above 150 °C and below 800 °C to completely remove the temporary protective coating composition.

Claims

We claim,

1) (Currently Amended) A heat treatable coated article comprising:

a transparent substrate having a first surface;

a functional coating deposited over ~~at least~~ a portion of the first surface;

a temporary protective coating deposited over ~~at least~~ a portion of the functional coating;

wherein the temporary protective coating comprising water-based suspension, dispersion or emulsion of polyurethane, acrylic polymers, epoxy polymers or their combinations thereof protects the functional coating during heat treatment and handling of the heat treatable coated article before heat treatment.

2) (Original) The heat treatable coated article as claimed in claim 1, wherein the acrylic polymer is selected from the group consisting of pure acrylic polymer, styrene-acrylic copolymer, acrylic-epoxy hybrid polymer or acrylic-polyurethane hybrid.

3) (Currently Amended) The heat treatable coated article as claimed in claim 1, wherein the epoxypolymer is bisphenol A and/or bisphenol F ~~or their combination thereof.~~

4) (Currently Amended) The heat treatable coated article as claimed in claim 1, wherein the functional coating consists of single layer or multilayer coating comprising one or more metals, non-metals, alloys, composites, compounds or their derivatives or their combinations thereof.

5) (Currently Amended) The heat treatable coated article as claimed in claim 1, wherein the functional coating ~~may be~~ is selected from the group consisting of magnetron deposited coatings, sputter deposited coating, chemical vapor deposited coatings.

6) (Currently Amended) The heat treatable coated article as claimed in claim 1, wherein the functional coating comprises of low emissivity coatings, solar radiation reflective or absorptive coatings, thermal infrared reflective or absorptive coatings ~~or their combinations thereof~~.

7) (Original) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating comprising acrylic polymer has a concentration ranging between 30 % and 50 %.

8) (Original) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating comprising polyurethane has a concentration ranging between 25 % and 45 %.

9) (Original) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating comprising epoxy polymer has a concentration ranging between 40 % and 60 %.

10) (Original) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating has a thickness ranging between 2 microns and 100 microns.

11) (Currently Amended) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating is ~~substantially~~ a continuous or a non-continuous coating that is devoid of any organic solvents, curing agent, surfactants or photo initiators.

12) (Currently Amended) The heat treatable coated article as claimed in claim 1, wherein the transparent substrate ~~may be~~ is a flat glass or a curved glass.

13) (Original) The heat treatable coated article as claimed in claim 1, wherein the transparent substrate is selected from the group consisting of non-tempered glass, annealed glass or strengthened glass.

14) (Original) The heat treatable coated article as claimed in claim 1, wherein handling of the heat treatable coated article includes cutting, edge grinding, beveling, drilling, sizing, finishing, storing and transporting of the heat treatable coated article.

15) (Original) The heat treatable coated article as claimed in claim 1, wherein the temporary protective coating is completely removed during the heat treatment.

16) (Original) The heat treatable coated article as claimed in claim 1, wherein the heat treatment involves heating to a temperature ranging above 150 °C and below 800 °C.

17) (Currently Amended) A temporary protective coating composition for forming a temporary protective coating over a heat treatable coated article as claimed in claim 1 having a functional coating, wherein the coating comprises:

a water-based suspension, dispersion or emulsion of polyurethane, acrylic polymers, epoxy polymer or their combinations thereof, wherein the acrylic polymer is selected from the group consisting of pure acrylic polymer, styrene-acrylic copolymer or acrylic-epoxy hybrid polymer or acrylic-polyurethane hybrid polymer and wherein the epoxy polymer is bisphenol A and/or bisphenol F~~or their combination thereof.~~

18) (Currently Amended)The coating composition as claimed in claim 17 ~~optionally~~ comprises adhesion promoters selected from the group consisting of 3-glycidyloxypropyl trimethoxysilane, γ–minopropyltriethoxysilane, epoxysilane oligomer or vinyltrimethoxysilane.

19) (Currently Amended) A method of protecting a coated article during heat treatment and handling of the coated article before heat treatment, comprising the steps of:

providing a transparent substrate having a first surface provided with a functional coating over at least a portion of the first surface;
providing a temporary protecting coating composition as claimed in claim ~~16~~ 17 over at least a portion of the functional coating;
curing the coated substrate;
handling the coated substrate; and
heating the coated substrate for removing the temporary protective coating composition, wherein the temperature ranges above 150 °C and below 800 °C.

20) (Original) The method as claimed in claim 19, wherein the self-crosslinking polymers present in the temporary protective coating act as spacers that protects the functional

coating of the heat treatable coated article from mechanical and chemical damages during heat treatment and handling.

21) (Currently Amended) A method of making a heat treatable coated article that can be handled before heat treatment, comprising the steps of:

providing a transparent substrate;
depositing a functional coating on one surface of the substrate;
curing or drying the substrate coated with the functional coating;
providing a temporary protective coating composition as claimed in claim ~~16~~ 17over the functional coating; and
thermally curing the substrate coated with the temporary protective coating composition.

22) (Currently Amended) The method as claimed in claim 21 further involves handling the substrate coated with the temporary protective coating composition and heat treating the handled substrate to a ~~temperatme~~ temperature ranging above 150 °C and below 800 °C to completely remove the temporary protective coating composition.

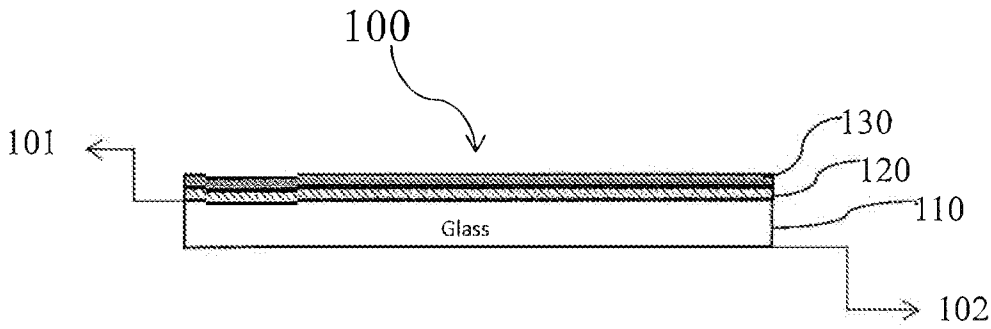

FIG. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2020/050095

A. CLASSIFICATION OF SUBJECT MATTER
C09D5/00,C03C17/00 Version=2020.01

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, 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)

TotalPatent One, 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	IN201641015929A (SAINT-GOBAIN GLASS FRANCE) 10 November 2107 (10-11-2017) (claims 3-4, claim 9 and claim 11)	1-18
Y	IN201641015929A (SAINT-GOBAIN GLASS FRANCE) 10 November 2107 (10-11-2017) (claims 3-4, claim 9 and claim 11)	19-22
Y	US 2016194516 A1 (SAINT GOBAIN) 7 July 2016 (07-07-2016) (abstract, claim-1, claim-4, claim-6).	1-22
Y	US 2009044897 A1 (GUARDIAN INDUSTRIES) 19 December 2009 (19-12-2009) (abstract, page-3, para-0033, claim 1)	1-22
Y	US20150072137 A1 (AGC GLASS EUROPE) 15 MAR 2015 (15-03-2015) [see para 0024, see para 0025, see para 0029]	1-22

☐ 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
"D" document cited by the applicant in the international application
"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	Date of mailing of the international search report
21-04-2020	21-04-2020
Name and mailing address of the ISA/ Indian Patent Office Plot No.32, Sector 14,Dwarka,New Delhi-110075 Facsimile No.	Authorized officer Srikanta Karmakar Telephone No. +91-1125300200

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IN2020/050095

Citation	Pub.Date	Family	Pub.Date
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