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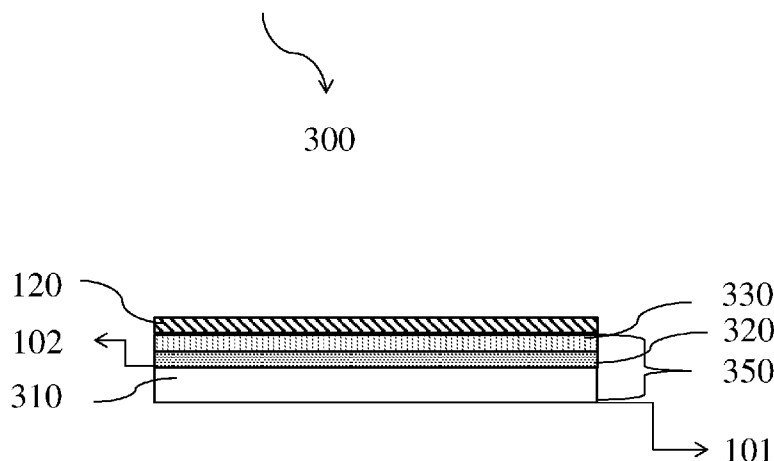


FIG. 3

(57) **Abstract:** A splinter-proof coating composition for glass comprising 30 to 60 wt % of one or more elastomers based on block copolymers containing polymer blocks formed from vinylaromatics (A blocks), preferably styrene, and those formed by polymerization of 1,3-dienes (B blocks), preferably butadiene or isoprene or their hydrogenation products or grafted products; 20 to 50 wt % of aliphatic hydrocarbons, preferably C5 aliphatic hydrocarbons and 10 to 30 wt % of aromatic hydrocarbons, preferably C9 aromatic hydrocarbons dissolved in a solvent is disclosed. The splinter-proof coating composition prevents scattering of glass pieces at the time of breakage of the glass substrate. The present disclosure also relates to a method of obtaining a fragmentation retention glass substrate and a fragmentation retention mirror. The glass substrate may be a clear glass, functionally coated glass or a lacquered glass that is annealed, tempered or heat strengthened.



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A SPLINTER-PROOF COATING COMPOSITION

Technical Field

The present disclosure relates, in general to a coating composition, and more specifically to a splinter-proof coating composition for glass and a
5 method of obtaining a fragmentation retention glass substrate.

Background

The past few years have seen several highly publicized incidents involving window and balcony glass breaking spontaneously and falling from high-rise buildings. While such episodes are rare, the danger they pose has forced
10 building code writers, architects, government officials, and related industry professionals to reconsider which types of glass should be specified for glass applications where strength and protection of passers-by are paramount. The term ‘safety glazing’ generally refers to any type of glass engineered to reduce the potential for serious injury when it comes into human contact.

15 The development of toughened glass has to be one of the most significant architectural advancements of the modern age. Used in a vast array of applications, from windows and doors, to furniture, flooring and cookware, in many ways toughened glass has helped revolutionize the way we build and the way we live. Toughened or tempered glass is up to five times stronger than
20 regular plate glass, can withstand surface compression of more than 10,000 psi and is highly resistant to thermal breakage. Nevertheless, they are not indestructible either.

When a tempered glass is broken, it shatters into thousands of tiny pebbles. In many respects these pebbles are far safer than the razor-sharp shards
25 of a regular annealed glass. This is why a toughened glass is classed as a safety glass and is specified in areas where safety is a concern. However, in certain circumstances these tiny pebbles can still pose a danger. For example, a glass balustrade, spandrel or overhead glazing that shatters and falls from its frame could cause significant injury to passers-by underneath these structures.

From time to time, these tempered glasses are known to break, seemingly without any reason, hence rightly termed as spontaneous glass breakage. Ideally the spontaneous glass breakage could be triggered by microscopic internal defects in the glass, minor damages caused during installation, tight binding of the glass in the frame and inadequate glass thickness to resist wind load.

It is known to apply a safety film to the outer surface of a tempered glass substrate to prevent its breakage and thus prevent the shattering or scattering of broken glass pieces in case of glass breakage. Similarly, usage of a laminated glass in place of tempered glass are also prevalent in the market. The interlayer sandwiched between the two layers of glass holds the glass pieces together upon breakage. Although laminated glass is most commonly associated with windshield glass for automobiles, it is increasingly being specified for storefronts, curtain walls and windows. However, the lamination process can be cumbersome and uneconomical.

Applying an adhesive coating to the surface of glass substrates that allow adherents to be instantly fixed to each other are also not uncommon. One such adhesive coating is disclosed in U.S Publication number 20140004331 that relates to a pressure-sensitive adhesive layer convertible into an adhesive layer that exhibits pressure-sensitive adhesive property before being sinstered and adhesive property after being sinstered. Referring to German publication number 19906333 discloses single-layer coatings of polymers on display glasses that protect the surface of the glass substrate from the production to the final stage of processing including transportation. The removable coating comprises polyvinyl alcohol and can be removed by washing with organic solvent. Such shatter proofing coatings using PET or vinyl chloride as a raw material are vulnerable to flame or heat and burns when exposed to a high-temperature atmosphere such as one in a fire.

Referring to PCT publication number 2003018701 discloses a self-adhesive protective film for painted surfaces that provides protection to glass, ceramic, VA steel, polycarbonate or acrylic glass during transportation.

The self-adhesive protective film comprises a polyolefinic support layer and a self-adhesive layer made of block copolymers comprising butadiene and isoprene and adhesive resins. The above mentioned coatings or films are associated with difficulties such as pasting of film after cutting the glass into small pieces, bubble
5 formation during film application, delamination, exposed edges prone to edge corrosion, low productivity rate and high production and installation cost. Further, although block copolymers comprising butadiene and isoprene provide high tensile strength and elongation, the adhesion properties of these compounds are significantly low due to their lower surface tension. Furthermore, these
10 compounds exhibit low solubility in solvents and hence require a high solvent content as high as 80% in order to achieve low viscosity.

Notwithstanding all the past experience and technology which are available for preventing the shattering or scattering of broken glass pieces in case of glass breakage, it has been discovered that all available solutions are provided
15 post manufacturing of the glass substrate. None of the available solutions offer application of such a coating composition during a mirror processing. Further none of the solutions are compatible to be applied on a lacquered glass substrate. Furthermore, none of the solutions offer a coating composition that is resistant to post-processing steps such as heating, cutting etc. after the application of such
20 coatings on glass surfaces. For a coating composition to achieve the above mentioned features, the need of the coating composition to exhibit a high thermal degradation resistance, higher adhesion and non-reactivity with the paint layers present on the mirror are crucial. Thus there is scope for novel coating compositions that overcome all the above mentioned disadvantages of available
25 solutions/ compositions in the market for preventing the shattering or scattering of broken glass pieces in case of glass breakage.

The present disclosure relates to a simple, cost-effective coating composition for glass and mirror that prevents scattering of glass pieces at the time of breakage of the glass substrate and mirror. The splinter-proof coating
30 composition comprises 30 to 60 wt. % of one or more elastomers based on block copolymers, 20 to 50 wt. % of aliphatic hydrocarbons and 10 to 30 wt. % of

aromatic hydrocarbons. Further the coating composition does not contain any flammable compounds such as PET or vinyl chloride and exhibits high thermal degradation resistance, high solubility, low viscosity and possesses Newtonian rheology even with 50% solid content. The present disclosure also relates to a method for obtaining a fragmentation retention glass substrate and mirror using the coating composition described in the present disclosure.

Summary of the Disclosure

In one aspect of the present disclosure, a splinter-proof coating composition for glass is disclosed. The splinter-proof coating composition comprises 30 to 60 wt. % of one or more elastomers based on block copolymers containing polymer blocks formed from vinyl aromatics (A blocks), preferably styrene, and those formed by polymerization of 1,3-dienes (B blocks), preferably butadiene or isoprene or their hydrogenation products or grafted products; 20 to 50 wt. % of aliphatic hydrocarbons, preferably C5 aliphatic hydrocarbons; and 10 to 30 wt. % of aromatic hydrocarbons, preferably C9 aromatic hydrocarbons dissolved in a solvent. The splinter-proof coating composition withstands heat treatments as high as 310 °C.

In another aspect of the present disclosure, a method of obtaining a fragmentation retention glass substrate is disclosed. The method comprises the steps of: physical activation of a glass substrate, optionally treating the activated glass substrate with adhesion promoters, providing a layer of the splinter-proof coating composition over the surface of the glass substrate and curing the coated glass substrate below 310 °C.

In another aspect of the present disclosure, a method of obtaining a fragmentation retention mirror is disclosed. The method comprises the steps of: physical activation of a glass substrate, chemical activation of the physically activated glass substrate, sensitization of the chemically activated glass substrate, providing a metallic coating on the surface of the activated glass substrate, passivating the metal coated glass substrate, optionally pre-heating the passivated metal coated glass substrate to a temperature below 80 °C, overlying the passivated metal coated glass substrate with a corrosion protective paint,

optionally curing the painted glass substrate at a temperature ranging between 40 °C and 100 °C, providing a layer of the splinter-proof coating composition as claimed in claim 1 over the painted glass substrate and curing the coated glass substrate at a temperature below 310 °C.

5 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.

10 FIG. 1 illustrates a cross-sectional view of a fragmentation retention glass 100, according to one embodiment of the present disclosure;

 FIG. 2 illustrates a cross-sectional view of a fragmentation retention lacquered glass 200, according to one embodiment of the present disclosure;

15 FIG. 3 illustrates a cross-sectional view of a fragmentation retention mirror 300, according to one embodiment of the present disclosure;

 FIG. 4 depicts the steps involved in obtaining a fragmentation retention glass substrate, according to one embodiment of the present disclosure; and

20 FIG. 5 depicts the steps involved in obtaining a fragmentation retention mirror, 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
25 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 a splinter-proof coating composition for glass that prevents scattering of glass pieces at the time of breakage of the glass substrate.

FIG. 1 illustrates a fragmentation retention glass 100, in accordance with an embodiment of the present disclosure. The fragmentation retention glass 100 comprises of a glass substrate 110 provided with a splinter-proof coating composition 120 over the surfaces 102 of the glass substrate 110. The splinter-proof coating composition 120 comprises of 30 to 60 wt. % of one or more elastomers based on block copolymers containing polymer blocks formed from vinyl aromatics (A blocks) and polymerization of 1,3-dienes (B blocks), or their hydrogenation products or grafted products, 20 to 50 wt. % of aliphatic hydrocarbons and 10 to 30 wt. % of aromatic hydrocarbons dissolved in a solvent.

In one aspect of the embodiment, the vinyl aromatic is styrene. In one another aspect of the embodiment, the polymerization products of 1,3-dienes (B blocks) can be selected from butadiene or isoprene or their hydrogenation products or grafted products. In yet another embodiment, the block copolymer can be styrene butadiene styrene (SBS) or styrene isoprene styrene (SIS). In still yet another embodiment, the block copolymer can be styrene ethylene butadiene styrene (SEBS) or styrene isoprene butadiene styrene (SIBS).

In another aspect of the embodiment, the aliphatic hydrocarbons are C5 aliphatic hydrocarbons selected from the group consisting of trans-1,3-pentadiene, cis-1,3-pentadiene, 2-methyl-2-butene, dicyclopentadiene, cyclopentadiene, cyclopentene or their combinations thereof. In still another embodiment, the aromatic hydrocarbons are C9 aromatic hydrocarbons selected from the group consisting of vinyl toluenes or their isomers, dicyclopentadiene, indene, methyl styrene, styrene, methylindenes or their combinations thereof. The solvent for the coating composition 120 may be any one of xylene, hexane, heptane, cyclohexane, ethyl benzene, toluene, ketones (unbranched), acetone, esters, glycol esters, ethyl alcohol, butyl alcohol or ethyl hexanol.

The splinter-proof coating composition 120 is made in a reactor by first adding a required amount of solvent in a reflex cleaned reactor. The solvent

may optionally be heated for better and faster dissolution. About 30 to 60 wt. % of one or more elastomers based on block copolymers are added to the solvent and mixed until complete or partial dissolution of the block copolymers. Following which about 20 to 50% C5 aliphatic hydrocarbon is added and mixed well. Finally, 10 to 30 % C9 aromatic hydrocarbon is added and mixed until complete dissolution.

The splinter-proof coating composition 120 forms a protective top coat over the glass substrate 110 and prevents scattering of glass pieces on breakage of the glass substrate 110. The splinter-proof coating composition 120 forms a transparent self-adhesive film on the surface 101 and/or 102 of the glass substrate 110 and the glass pieces formed on breakage of the glass adheres to the film thereby preventing them from scattering. In multiple embodiments, the splinter-proof coating composition 120 has a viscosity ranging between 350 cps and 5000 cps with Brookfield viscometer spindle no.28 at ambient temperature. In multiple embodiments, the splinter-proof coating composition 120 has Newtonian rheology with up to 50% solid content. In multiple embodiments, the thickness of the splinter-proof coating composition 120 varies from 30 μ to 300 μ . In a preferred embodiment, the thickness of the splinter-proof coating composition 120 ranges between 50 μ and 100 μ .

In a particular embodiment, the SEBS provides increased tensile strength and elongation to the splinter-proof coating composition 120 and makes it viscoelastic. However, when SEBS is used alone in a composition, it cannot be coated at room temperature and requires an increased amount of solvent to achieve Newtonian rheology. The splinter-proof coating composition 120 of the present disclosure has Newtonian rheology with 45% solid content. Whereas the composition with only SEBS has a Newtonian rheology with only 30% solid content.

The C5 aliphatic hydrocarbons present in the splinter-proof coating composition 120 of the present disclosure increases the adhesion property of the coating composition 120 and decreases the viscosity thereby enabling the splinter-proof coating composition 120 to be compatible for coating on the

surface 101 and/or 102 of the glass substrate 110. In addition, the C5 aliphatic hydrocarbons also help in achieving Newtonian rheological behavior and increase the solid content of the splinter-proof coating composition 120. However, the C5 aliphatic hydrocarbons increases the surface tackiness of the splinter-proof coating composition 120 thereby rendering the composition sticky and non-transportable.

The C9 aromatic hydrocarbons present in the splinter-proof coating composition 120 of the present disclosure aids in decreasing surface tackiness that compensates for the increase in surface tackiness caused by the C5 aliphatic aromatics in the splinter-proof coating composition 120 of the present disclosure. Further the C9 aromatic hydrocarbons increase adhesion property of the splinter-proof coating composition 120.

Although the SEBS in the coating composition provides high tensile strength and elongation which is paramount for developing a coating composition that prevents the scattering of glass pieces at the time of breakage of the glass substrate, SEBS does not exhibit good adhesion property owing to its low surface tension. Further SEBS exhibits low solubility in solvents and hence to achieve a low viscosity and Newtonian rheology, solvent levels of up to 80% are required. C5 aliphatic hydrocarbons when added, reduce the viscosity of the splinter-proof coating composition 120 but however makes the coated surface of the glass substrate sticky thereby rendering a coated glass substrate non-transportable. Finally, when C9 aromatic hydrocarbons are added to the composition, these compounds not only reduce the viscosity of the splinter-proof coating composition 120 but also increases the adhesion properties of the splinter-proof coating composition 120 without making the surface of the coated glass substrate sticky. Thus the block copolymer, the C5 aliphatic hydrocarbons, the C9 aromatic hydrocarbons and the solvent present in the splinter-proof coating composition 120 of the present disclosure individually contribute for achieving the desired properties of the splinter-proof coating composition 120 of the present disclosure viz., adhesion Class 0-2, 750 cps -1440 cps viscosity with Brookfield viscometer spindle no. 28 at ambient temperature and stickiness and

transportability. Thus the block copolymer, the C5 aliphatic hydrocarbons, the C9 aromatic hydrocarbons and the solvent work in synergy to obtain the above mentioned desired property of the splinter-proof coating composition 120.

Illustrated in **FIG. 2** is a fragmentation retention lacquered glass 200, according to one embodiment of the present disclosure. The fragmentation retention lacquered glass 200 of the present disclosure comprises of a lacquered glass substrate 250 that contains a glass substrate 210 coated with a lacquer or paint 220 on one of its surface 202. Any conventional lacquer or paint available in the market could be used for this embodiment of the present disclosure. Further the lacquer or paint may contain any pigment. Provided over the lacquer 220 is a layer of the splinter-proof coating composition 120 of the present disclosure. In one embodiment of the present disclosure, the splinter-proof coating composition 120 is provided to a completely cured lacquered glass substrate 250. In another embodiment of the present disclosure, the splinter-proof coating composition 120 can be provided to a partially cured lacquered glass substrate 250.

In embodiments where the splinter-proof coating composition 120 is applied to a half cured lacquered glass substrate 250, there exists a miscible region between the lacquer or paint 220 and the layer containing the splinter-proof coating composition 120. The miscible region provides for intermixing or diffusion between the lacquer and the splinter-proof coating composition 120. In such an embodiment, the curing process may be performed intermittently at temperatures ranging between 50 °C to 100 °C for a period of 0.5 to 5 minutes between the curing step performed after coating the lacquer or paint 220 and the curing step performed after providing the splinter-proof coating composition 120. In still another embodiment of the present disclosure, the splinter-proof coating composition 120 can be provided directly on an uncured lacquered glass substrate. In such an embodiment, the curing step is performed only after the coating of the splinter-proof coating composition 120 thereby reducing the number of processing steps involved in the manufacture of a fragmentation

retention lacquered glass substrate 200. This embodiment illustrates the economic advantage of the product produced from the present disclosure.

FIG. 3 illustrates a fragmentation retention mirror 300, according to one embodiment of the present disclosure. The fragmentation retention mirror 5 300 of the present disclosure comprises of a mirror 350 that contains a glass substrate 310 provided with a metallic coating 320 and a protective paint layer 330 in sequential order away from the glass substrate 310. The metallic coating 320 comprises of one or more metals selected from silver or aluminum. Any conventional mirrors available in the market could be used for this embodiment 10 of the present disclosure. Provided over the protective paint layer 330 is a coating of the splinter-proof coating composition 120 of the present disclosure.

In one embodiment of the present disclosure, the splinter-proof coating composition 120 is provided to a completely cured mirror 350. In another embodiment of the present disclosure, the splinter-proof coating composition 120 15 can be provided to a partially cured mirror 350. In embodiments where the splinter-proof coating composition 120 is applied to a partially cured mirror 350, there exists a miscible region between the protective paint layer 330 and the layer containing the splinter-proof coating composition 120. The miscible region provides for intermixing or diffusion between the protective paint and the 20 splinter-proof coating composition 120. In such an embodiment, the curing process may be performed intermittently between the curing step performed after coating the protective paint layer 330 and the curing step performed after the coating of the splinter-proof coating composition 120. In still another embodiment of the present disclosure, the splinter-proof coating composition 120 25 can be provided directly on an uncured mirror. In such an embodiment, the curing step is performed only after the coating of the splinter-proof coating composition 120 thereby reducing the number of processing steps involved in the manufacture of a fragmentation retention mirror 300.

In multiple embodiments of the present disclosure, the 30 fragmentation retention glass 100, fragmentation retention lacquered glass 200 and the fragmentation retention mirror 300 exhibit corrosion resistance against

chemicals whereby the splinter-proof coating composition 120 that forms the top coat of the fragmentation retention glass 100, fragmentation retention lacquered glass 200 and the fragmentation retention mirror 300 is resistant to both acidic and alkaline solutions with an exemption to aliphatic hydrocarbon, amyl acetate, 5 amyl alcohol, amyl chloride, aromatic hydrocarbon, benzaldehyde, benzene, benzoic acid, benzyl alcohol, butane, butyl acetate, carbon disulfide, chlorobenzene, chlorobromomethane, chloroform, cyclohexane, cyclohexanone, ethers, gasoline, kerosene, lacquer solvents, linseed oil, methane, naphtha, natural gas, nitrobenzene, phenol, phthalic acid, styrene, toluene (toluol), 10 trichloroethylene, turpentine, vinyl plastisol and xylene (xylol). Further the splinter-proof coating composition 120 exhibits moisture resistance which in turn prevents corrosion.

The splinter-proof coating composition 120 may be coated using any of the coating techniques selected from the group consisting of spray coating, 15 bar coating, curtain coating, brush coating or other wet coating techniques. Furthermore, the fragmentation retention glass 100, fragmentation retention lacquered glass 200 and the fragmentation retention mirror 300 can be subjected to post processing steps including, cutting, transporting, edge grinding and heat treatment at temperatures below 310 °C. The fragmentation retention glass 100, 20 fragmentation retention lacquered glass 200 and the fragmentation retention mirror 300 exhibit superior scratch resistance.

Examples

Example 1

Preparation of Splinter-proof Coating Composition

25 A reactor was cleaned by reflex cleaning using a solvent. About 55% of xylene was added to the reactor. Xylene was heated to a temperature of 40-100 °C to speed-up dissolution rate. About 30% to 60% SEBS to the overall solid content of the splinter-proof coating composition was added into the reactor and mixed until complete dissolution of SEBS in xylene. About 20% to 50% C5 30 aliphatic hydrocarbon viz., Rishitac Q1100 of overall solid content was added into the reactor until completely dissolved. Then about 10% to 30 % C9 aromatic

hydrocarbon viz., GA 115B of overall solid content was added into the reactor and mixed well.

Example 2

Properties of Components of the Splinter-proof Coating Composition

5 Properties such as adhesive strength, viscosity, transportability and elongation are critical to the development of a splinter-proof coating composition. SEBS when used as a stand-alone composition was found to lack in transportability and viscosity. Various tackifier solutions including C5 and C9 hydrocarbons were used along with SEBS to reduce viscosity and improve
10 transportability of SEBS. On the other hand, when the tackifier solutions were used as a stand-alone composition, they were found to fail in shatterproof performance testing. Thus an optimized splinter-proof composition possessing the desired adhesive strength, viscosity, transportability and elongation was developed through a trial and error method. The results of the experiments are
15 summarized in Table 1 and compared with results of formulation containing only SEBS and formulation containing only tackifier. The following experiments were carried out:

Tensile Strength & Film Elongation:

 50 μ thick splinter-proof coating composition was coated on a
20 300x300 mm mirror and placed in an oven at 200 °C for about 7 minutes. The coated mirror sample was then removed and cut into 100x25 mm pieces after cooling down the sample to ambient temperature. The mirror pieces were then scored in the middle and snapped to the Universal tensile strength equipment without damaging the coating. The rate of loading was maintained at 50 mm/min.

25 Adhesion Test:

 The adhesion of the coating compositions on glass substrates was measured by cross-hatch (ASTM standard D 3359-00, 6 teeth, 2mm, with brushing and with adhesive tape peel). The adhesion values ranged between 0 and
5.

30 Peel Test:

Coating composition of the present disclosure coated on 100 x 20 mm mirror samples were scored and snapped at the center of the samples. The peel test was performed at an angle of 90° to the surface of the samples at a rate of 50 mm/ minute.

5 Stickiness Test: Clamp Test

Five 100x100 mm splinter-proof coated mirror samples were placed one over the other in such a way that the coating side of one mirror sample faced the glass side of another mirror sample except for the top most mirror sample which was placed such that the coating side of the fourth sample faced the
10 coating side of the fifth sample. This stack of glass samples was clamped and kept in ambient temperature for seven days. The clamp diameter was maintained at 20 mm, thread diameter at 13.75 mm and pitch of thread at 1.5 mm.

Stickiness Test: Probe Tack Test

100 g of load is applied on the coated mirror samples using
15 rheometer at 50 μ /s constant linear rate using 8 mm PP geometry. Measurement of axial force against the displacement indicated the tackiness of the splinter-proof coating.

Transportability interleaving powder test:

Samples of 50 x 50 mm were placed over a 100 x 100 glass
20 substrate in such a way that the coating composition of the present disclosure touched the glass substrate. 2 gm of Lucite powder was sprayed in between the samples and the substrate. The above set up was placed in a IKA shaker with a load of 10 N at 400 motions per minutes (mot/min) for 1 hr.

CASS Test:

25 The chemical resistance of the coating compositions was tested using ASTM Standard B117. The coating composition of the present disclosure was coated on glass samples and exposed to a highly acidic condition for 120 hours. An acidic solution was prepared by dissolving 5% NaCl in 0.26 g/liter of $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$ and added with acetic acid until the pH of the solution reaches 3.0 –
30 3.1. Post which the surface and edge corrosion of the coated samples were measured using stereo microscope.

High Humidity Testing:

The resistance of the samples to high humidity conditions was tested by the Standard EN1036. The samples were exposed to 40°C and >95% relative humidity for a period of 20 days for mirror samples and a period of 21
5 days for lacquered glass samples. The samples were then tested for appearance of surface corrosion, edge corrosion and further ΔE^* values of the samples were also measured.

Quick Corrosion Test:

Corrosion test was carried out on a 50 x 50 mm sample by immersing the
10 sample in Cupro-hydrochloric salt solution (100 g/L of NaCl, 10 g/L of $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$ and 10 ml of HCl) for 1.5 h at 60°C by placing the paint side facing downwards. The sample was later cut by CNC on the paint side and corrosion levels of these samples were compared with the corrosion level of samples cut manually on the glass side.

15 Acid Soaking Test:

50 x 50 mm samples were soaked it in H_2SO_4 for $\frac{1}{2}$ an hour by placing the paint side facing upward the solution and percentage of paint removal was observed visually.

Sulfide H_2S Test

20 50 X 50 mm samples were dipped in 10% H_2S in water solution and exposed for 10 days. The corrosion levels of the samples were measured using microscopic technique.

Shear Adhesion Test & Glue compatibility test:

The shear adhesion of 20 mm x 100 mm lacquered glass samples and
25 mirror samples coated with the coating composition of the present disclosure was measured by ASTM Standard D 3163. A sealant quantity of 0.5 g was applied on the samples for an adhesion area of 20 mm x 50 mm and a weight of 100 grams was placed above and left at room temperature for 7 days and then soaked in water for 21 days. The sample was then tested according to the standard test
30 speed of 1mm/minute after 1 day of dwell time and after 21 days of soaking period.

Table 1: Results of Experiments Comparing the Components of the Coating
Composition 120

Property	Test		Comparative Sample 1	Comparative Sample 2	Splinter-proof Coating Composition
			SEBS 100%	C5 Aliphatic Hydrocarbons + C9 Aromatic Hydrocarbons	SEBS (40-50%) + C5 Aliphatic Hydrocarbons (36%) + C9 Aromatic Hydrocarbons (24%)
Coating Viscosity	Viscosity with 40% solid content		>10000	C5- 100 cps	750-900 cps
Shatterproof Performance	EN12600 Pendulum impact with 50 μm coating thickness		2B2 - Pass	Fail	2B2 – Pass
Product property with mirror	Peel strength		Fail <3N	Not applicable – No film formation	10 to 50 N
	Tensile Strength (Mpa)		15 – 30	Not applicable – No film formation	15 – 30
	Elongation (%)		300 – 1000		300 – 1000
	Glue compatibility	24 hrs.	Fail - 18-20 Kpa	Pass - >250 Kpa	Pass - > 250 Kpa
		21 days water soak			300 to 600 Kpa Depending on adhesive/ tape
	Tape compatibility	24 hrs.	Fail 18-20 Kpa	Pass - >250 Kpa	Pass - >250 Kpa
		21 days water soak	Fail 18-20 Kpa	Pass - >250 Kpa	Pass - >250 Kpa
Stickiness Test	Clamp Test (7 days)	Glass to Coating side	No Peeling of coating or other defects		
		Coating to Coating side	No Peeling of coating or other defects		
	Probe Tack Test	Axial force in grams (g)	0	0	10 – 50

Chemical durability	CASS	Surface corrosion – 0 Edge corrosion >1000 µm	Surface corrosion - 0 Edge corrosion ~ 500 µm	Surface corrosion – 0 Edge corrosion ~300 µm
	Quick corrosion Test	Surface corrosion – 0 Edge corrosion >1200 µm	Surface corrosion - 0 Edge corrosion ~500 µm	Surface corrosion – 0 Edge corrosion ~300 µm
	Sulfide Test	Surface corrosion – 0 Edge corrosion >1200 µm	Surface corrosion - 0 Edge corrosion ~500 µm	Surface corrosion – 0 Edge corrosion ~300 µm
	Acid soaking test	Paint removal at edges	Paint removal	No paint removal
	High humidity HH	Complete peel off	No Defect	No defect
Mechanical durability	Cross Hatch	Class 4-5	Class 0-2	Class 0-2
	Stickiness	Ok – Spec to be defined	Ok – Spec to be defined	Ok – Spec to be defined
	Transportation test	Ok		

Table 1 clearly depicts that while the comparable samples fail in most of the experiments the splinter-proof coating composition of the present disclosure clears the specification of all the tests.

5 Example 3

Evaluation of Coating Composition

Next level of experiments were conducted to optimize the quantity of SEBS and tackifiers required to obtain the splinter-proof composition of the present disclosure having the desired shatterproof performance. Results of the

10 testing carried out are summarized in Table 2.

Table 2: Evaluation of Coating Composition

Property	Test	Comparative Sample 1	Comparative Sample 2	Comparative Sample 3	Splinter-proof Coating Composition
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		SEBS 100%	SEBS <35% C5 + C9 - >65%	SEBS - 40% C5 - 65%	SEBS (40-50%) + C5 Aliphatic Hydrocarbons (36%) + C9 Aromatic Hydrocarbons (24%)	
Coating Viscosity	Viscosity with 40% solid content	>10000	<750 cps	<800 cps	750-900 cps	
Shatterproof Performance	EN12600 Pendulum impact with 50µ m coating thickness	2B2 - Pass	2B2 failed	2B2 pass	2B2 - Pass	
Product property with mirror	Peel strength	Fail <3N	No/ low film formation	10 to 50 N	10 to 50 N	
	Glue compatibility	24 hrs.	Fail - 18-20 Kpa	Pass - > 250 Kpa	Pass - > 250 Kpa	Pass - > 250 Kpa
		21 days water soak		300 to 600 Kpa Depending on adhesive/ tape		
Chemical durability	CASS Surface Corrosion - SC Edge Corrosion - EC	SC - 0 EC >1000 µm	SC - 0 EC ~ 300 µm			
	Quick Corrosion Test	SC - 0 EC >1200 µm	SC - 0 EC ~ 300 µm			
	Sulfide Test	SC - 0 EC >1200 µm	SC - 0 EC ~ 300 µm			
	Acid soaking test	Paint removal at edges	No paint removal			
	High humidity HH	Complete peel off	No defect			

Mechanical durability	Cross Hatch	4-5	Class 0-2	Class 0-2	Class 0-2
	Transportation test	OK	Failed	Failed	Ok

Table 2 illustrates that the splinter-proof coating composition of the present disclosure achieves all the desired properties compared to all the comparative samples.

5 Example 4

Performance Testing

The performance of the splinter-proof coating composition was tested using the Standard EN12600 (Pendulum impact testing). The penetration proof of glass substrates coated with splinter-proof coating composition of the present disclosure was measured by the Standard EN12600. The results of the performance testing are summarized in Table 3.

Table 3: Pendulum impact testing according to EN12600

Performance Test	Results
Pendulum impact testing according to EN12600	2B2 – Pass

In accordance with EN12600 2B2 safety performance is achieved with 50µm coating thickness.

Example 5

Durability Testing

Lacquered glass substrates of 100 x 100 mm and 100 x 100 mm mirror substrates were coated with the splinter-proof coating composition of the present disclosure and tested for their durability performance. The results of the durability testing are summarized in Table 4. The following tests were performed to evaluate the durability performance of glass substrates coated with the splinter-proof coating composition of the present disclosure.

High Temperature Testing:

The samples were exposed to a temperature of 65 °C for a period of 7 days, post which color change in the samples was measured.

Neutral Salt Spray (NSS):

The resistance of the glass and mirror samples was tested using ASTM Standard B117. The glass samples were exposed to a neutral salty condition for a period of 20 days. A neutral solution of 5% NaCl was used for this test. Post which the surface and edge corrosion of the coated samples were measured using stereo microscope.

Scratch Test:

The scratch resistance of the lacquered glass samples and mirror samples was measured by ISO Standard 4586-2. Samples were rotated in a circular manner on the machine and using a diamond tip.

Tensile Strength:

The tensile strength of 100 x 20 mm mirror samples was measured by scoring and snapping the mirror samples in the center at a rate of 10 mm/minute.

15

Table 4: Durability Testing Results

Durability	Tests	Results
Chemical Durability	High Humidity	Edge Corrosion: 0 Surface Corrosion: <0.2 μm in 1dm^2 Color Change on Glass Side: $\Delta E^* < 1.4$ for 21 days
	High Temperature	Color Change on Glass Side: $\Delta E^* < 0.5$ for 7 days
	CASS	Edge Corrosion: 1200 μm Surface Corrosion: <0.2 μm in 1dm^2
	NSS	Edge Corrosion: 1000 μm Surface Corrosion: <0.2 μm in 1dm^2
Mechanical Durability	Scratch	>300 g
	Cross Hatch	<2
	Peel Test	> 10 N
Gluing Compatibility	Tensile Strength	Tensile strength >10 MPa Elongation >100%
	Shear Adhesion	Failure strength more than 250 kPa

The splinter-proof coating composition of the present disclosure was found to exhibit good durability.

Example 6

20 Corrosion Resistance Testing

Corrosion resistance of a mirror provided with a splinter-proof coating composition of the present disclosure was measured and compared with the corrosion resistance of a conventionally available mirror. Results of the tests are summarized in Table 5.

5

Table 5: results of Corrosion Resistance Testing

	CASS Test		Acid resistance Soaking in H ₂ SO ₄
	Surface corrosion	Edge corrosion	
Comparative Sample Mirror	Spot <0.2mm=1 Spot <3mm = 9-10 counts	85 to 250 mm	Complete Paint removal in ½ an hour
Fragmentation Retention Mirror	0	250 to 500 mm	No paint even after 2 hrs

Industrial Applicability

With the implementation of the splinter-proof coating composition 120 of the present disclosure, any glass substrates including annealed, tempered, heat strengthened, mirrored and lacquered glass substrates can be converted into a safety glass substrate, wherein the substrates coated with said splinter-proof coating composition prevents scattering of glass pieces at the time of breakage of the glass substrate. Further the splinter-proof coating composition 120 of the present disclosure can be applied as a temporary coating on glass substrates that protects the glass substrates from scratches during transportation. Furthermore, the splinter-proof coating composition 120 offers the coated glass substrates resistance against a wide range of acidic and alkaline solutions and moisture thereby preventing corrosion.

With the increasing use of glass substrates for both interior and exterior applications in buildings, safety features associated with such glass substrates becomes critical. The lacquered glass substrates, mirror and clear glass substrates coated with the coating composition of the present disclosure can be readily used for interior applications in a building not limited to wall cladding,

curtain walling, furnitures, flooring, cookware, railing etc. Similarly, these can be used for exterior applications in a building not limited to window glazing, insulated glazing, spandrels, balusters etc.

The present disclosure further discloses a method 400 depicted in
5 **FIG. 4** of obtaining a fragmentation retention glass substrate, according to one embodiment of the present disclosure. The method 400 comprises of steps 410 to 440. In multiple embodiments of the present disclosure, the fragmentation retention glass 100 illustrated in **FIG. 1** may be obtained by performing all or selected steps of the method 400 in the same or an altered order depicted in **FIG.**
10 **4**. In step 410 the glass substrate is physically activated. In this step the glass substrate is cleaned with DI water and polished with ceria powder in order to remove any surface contamination that may be present on the surface of the glass substrate. In multiple embodiments of the present disclosure, the glass substrate may be selected from a clear glass, a tinted glass or a lacquered glass substrate.

15 In step 420 the physically activated glass substrate is treated with adhesion promoters such as silane, organosilane, oligomeric silane, chlorinated and non-chlorinated polyolefin, organotitanates, organozirconates or organoaluminate. In alternate embodiment, step 420 may be skipped if the coating composition of the present disclosure is to be applied as a temporary
20 coating on the glass substrate. Nevertheless, treating the glass substrate with adhesion promoters improves the adhesion property of the glass substrate and thereby enables better adhesion between the glass substrate and the coating composition of the present disclosure.

In step 430, the splinter-proof coating composition of the present
25 disclosure is coated on the glass substrate by curtain coating. In alternate embodiments, the splinter-proof coating composition may also be coated using other coating techniques such as spray coating, dip coating, wet coating techniques, bar coating and spin coating. The viscosity of the splinter-proof coating composition is selected and optimized according to the coating technique
30 selected for performing this step. The thickness of the splinter-proof coating composition ranges between 50 μ and 100 μ . In the final step 440 the coated glass

substrate is cured at a temperature below 250 °C for a period of 1 to 15 minutes. On curing the splinter-proof coating composition forms a thin transparent film on the surface of the glass substrate.

In optional additional embodiments, the coated glass substrate
5 obtained from performing method 400 may be further treated with adhesion promoters listed earlier and provided with a protective top coat comprising acrylate solutions. This top coat improves the resistance of the glass substrates against hydrophilic solutions and solvents. In embodiments where a lacquered
10 glass substrate is used for performing the steps of method 400, the splinter-proof coating composition of the present disclosure may either be applied as the outermost layer over the paint layer of the lacquered glass substrate or may be applied between the glass substrate and the paint layer. In the latter case the paint layer forms the outermost layer of the fragmentation retention lacquered glass substrate.

15 In yet another embodiment of the present disclosure, the curing step involved in obtaining a fragmentation retention lacquered glass substrate may be performed once after subsequent coating of the paint layer and the coating composition layer of the present disclosure in any sequential order. This embodiment is advantageous in that it brings down the number of processing
20 steps and production time involved in obtaining a fragmentation retention lacquered glass substrate. In still another embodiment of the present disclosure, the curing step may be performed sequentially once after application of the paint layer and repeated again after the application of the coating layer of the present disclosure. In still another embodiment, the curing temperature and time involved
25 in obtaining a fragmentation retention lacquered glass substrate may be balanced and performed intermittently both after the application of the paint layer and application of the coating layer of the present disclosure.

The present disclosure further discloses a method 500 depicted in
30 **FIG. 5** of obtaining a fragmentation retention mirror, according to one embodiment of the present disclosure. The method 500 comprises of steps 510 to 580. In multiple embodiments of the present disclosure, the fragmentation

retention mirror 300 illustrated in **FIG. 3** may be obtained by performing all or selected steps of the method 500 in the same or an altered order depicted in **FIG. 5**. In step 510, the glass substrate is physically activated. In this step the glass substrate is cleaned with DI water and polished with ceria powder in order to
5 remove any surface contamination that may be present on the surface of the glass substrate.

In steps 520 and 530, the glass substrate is chemically activated and sensitized. In this step the glass substrate is coated with stannous chloride and palladium chloride solutions. The chemical activation and sensitization steps
10 ensure good adhesion between the silver layer and glass surface. Then the coated glass surface is cleaned with DI water to remove any residual solutions that may be present on its surface. Step 540 involves providing a metallic coating to the glass substrate, where the glass substrate is treated with silver nitrate solution and the reducer solution viz., ammonia is sprayed on the coated glass substrate.
15 During this elemental silver gets deposited on the surface of the glass substrate.

In step 550, stannous chloride is sprayed on the silvered glass substrate to passivate the glass substrate and further silane solution is sprayed on the surface of the substrate in order to obtain a good adhesion between the silver layer and the paint layer that is to be coated on the glass substrate in the next step.
20 In alternate embodiments, the step of spraying silane on the silvered glass substrate may be optional. In step 560, the silvered glass substrate is pre-heated to a temperature or 80 °C and provided with a protective paint layer by curtain coating or spray coating. The paint layer protects the mirror surface from atmospheric corrosion. In an alternate embodiment, the silvered glass substrate
25 may be treated with adhesion promoters mentioned earlier before applying the paint layer.

In step 570, the mirror is cured at a temperature between 40 °C and 100 °C. In few embodiments of the present disclosure, the curing step may be optional. In step 580, the splinter-proof coating composition of the present
30 disclosure is applied on the mirror using curtain coating. The thickness of the coating ranges between 50 μ and 100 μ. In alternate embodiments, other coating

techniques such as spray coating, dip coating, wet coating techniques, bar coating and spin coating may also be used. In multiple embodiments of the present disclosure, the splinter-proof coating composition of the present disclosure may be applied on the surface of a fully cured mirror or a partially cured mirror or an
5 uncured mirror.

In step 580, the mirror provided with the splinter-proof coating composition of the present disclosure is cured at a temperature below 250 °C to obtain a fragmentation retention mirror that instantly prevents scattering of broken mirror pieces at the time of breakage of the mirror. In embodiments,
10 where the splinter-proof coating composition is applied on a partially cured mirror then the curing process is performed intermittently both after the application of the protective paint layer and application of the coating layer of the present disclosure.

Note that not all of the activities described above in the general
15 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
20 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
25 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
30 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
5 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
10 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,"
15 "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
20 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
25 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.
30 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
5 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
10 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.

15

List of Elements

100	Fragmentation Retention Glass
101	Glass Surface
102	Glass Surface
110	Glass Substrate
120	Splinter-proof Coating Composition
200	Fragmentation Retention Lacquered Glass
201	Glass Surface
202	Glass Surface
210	Glass Substrate
220	Lacquer
250	Lacquered Glass
300	Fragmentation Retention Mirror
310	Glass Substrate
320	Metallic Coating
330	Protective Paint Layer
350	Mirror
400	Method
410	Step
420	Step
430	Step
440	Step
500	Method
510	Step
520	Step
530	Step
540	Step
550	Step
560	Step
570	Step
580	step

Claims

We Claim:

1. A splinter-proof coating composition for glass comprising:
 - 30 to 60 wt % of one or more elastomers based on block copolymers containing polymer blocks formed from vinyl aromatics (A blocks), preferably styrene, and those formed by polymerization of 1,3-dienes (B blocks), preferably butadiene or isoprene or their hydrogenation products or grafted products,
 - 20 to 50 wt % of aliphatic hydrocarbons, preferably C5 aliphatic hydrocarbons, and
 - 10 to 30 wt % of aromatic hydrocarbons, preferably C9 aromatic hydrocarbons dissolved in a solvent, wherein the splinter-proof coating composition withstands heat treatments as high as 310 °C.
2. The splinter-proof coating composition as claimed in claim 1, wherein the block copolymer is styrene butadiene styrene (SBS) or styrene isoprene styrene (SIS).
3. The splinter-proof coating composition as claimed in claim 1, wherein the block copolymer is styrene ethylene butadiene styrene (SEBS) or styrene isoprene butadiene styrene (SIBS).
4. The splinter-proof coating composition as claimed in claim 1, wherein C5 aliphatic hydrocarbons are selected from the group consisting of trans-1,3-pentadiene, cis-1,3-pentadiene, 2-methyl-2-butene, dicyclopentadiene, cyclopentadiene, cyclopentene or their combinations thereof.
5. The splinter-proof coating composition as claimed in claim 1, wherein C9 aromatic hydrocarbons are selected from the group consisting of vinyl toluenes or their isomers, dicyclopentadiene, indene, methyl styrene, styrene, methylindenes or their combinations thereof.

6. The splinter-proof coating composition as claimed in claim 1, wherein the solvent is selected from the group consisting of xylene, hexane, heptane, cyclohexane, ethyl benzene, toluene, ketones (unbranched), acetone, esters, glycol esters, ethyl alcohol, butyl alcohol or ethyl hexanol.
7. The splinter-proof coating composition as claimed in claim 1 has a viscosity ranging between 350 cps and 5000 cps with Brookfield viscometer spindle no. 28 at ambient temperature.
8. The splinter-proof coating composition as claimed in claim 1 when provided on the glass substrate forms a transparent self-adhesive coating.
9. A method of obtaining a fragmentation retention glass substrate comprising the steps of:
 - physical activation of a glass substrate;
 - optionally treating the activated glass substrate with adhesion promoters;
 - providing a layer of the splinter-proof coating composition as claimed in claim 1 over the surface of the glass substrate; and
 - curing the coated glass substrate below 310 °C to obtain a fragmentation retention glass substrate that instantly prevents scattering of broken glass pieces at the time of breakage of the glass substrate.
10. The method as claimed in claim 9 wherein the glass substrate may be selected from a clear glass or a lacquered glass or a functionally coated glass.
11. A method of obtaining a fragmentation retention mirror comprising the steps of:
 - physical activation of a glass substrate;
 - chemical activation of the physically activated glass substrate;
 - sensitization of the chemically activated glass substrate;
 - providing a metallic coating on the surface of the activated glass substrate;
 - passivating the metal coated glass substrate;

optionally treating the metal coated glass substrate with adhesion promoters;
optionally pre-heating the metal coated glass substrate to a temperature below 80 °C;
overlying the passivated metal coated glass substrate with a corrosion protective paint;
optionally curing the painted glass substrate at a temperature ranging between 40 °C and 100 °C;
providing a layer of the splinter-proof coating composition as claimed in claim 1 over the painted glass substrate;
curing the coated glass substrate at a temperature below 310 °C to obtain a fragmentation retention mirror that instantly prevents scattering of broken mirror pieces at the time of breakage of the mirror.

12. The method as claimed in claim 9 or claim 11 wherein the physical activation of glass substrate involves polishing the glass substrate with abrasive powders like ceria powder.
13. The method as claimed in claim 9 or claim 11 wherein the adhesion promoters are selected from the group consisting of silane, organosilane, oligomeric silane, chlorinated and non-chlorinated polyolefin, organotitanates, organozirconates or organoaluminate.
14. The method as claimed in claim 9 or claim 11 wherein the splinter-proof coating composition is provided using coating techniques selected from the group consisting of curtain coating, bar coating, brush coating or spray coating.
15. The method as claimed in claim 9 or claim 11 wherein the splinter-proof coating composition is provided at a thickness ranging between 30 μ and 200 μ .
16. The method as claimed in claim 11 wherein chemical activation of glass substrate involves treating the glass substrate stannous chloride and palladium chloride solutions.

17. The method as claimed in claim 11 wherein the metallic coating comprises one or more metals selected from silver or aluminum.
18. The method as claimed in claim 11, where the splinter-proof coating composition may be applied to a fully cured or a half cured painted glass substrate or to a uncured painted glass substrate.
19. A fragmentation retention glass substrate comprising a splinter-proof coating composition as claimed in claim 1 on at least one surface of the glass substrate.
20. The fragmentation retention glass substrate as claimed in claim 19 comprising a protective top coat having hydrophilic compounds overlying the splinter-proof coating.

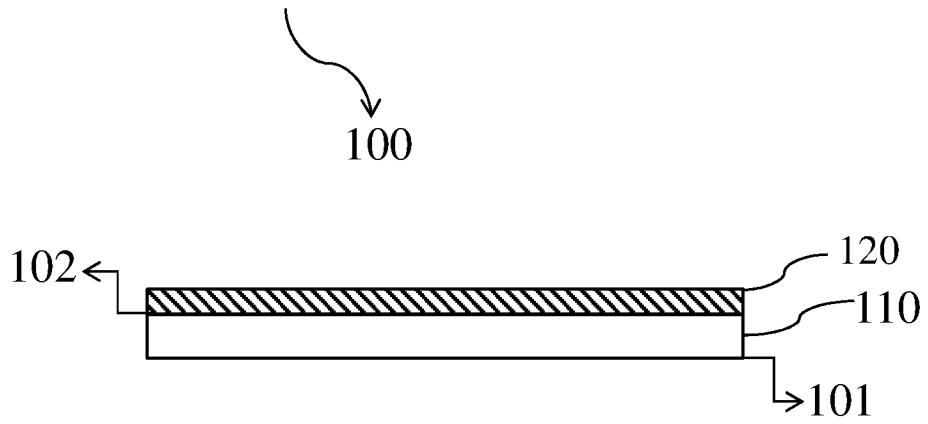


FIG. 1

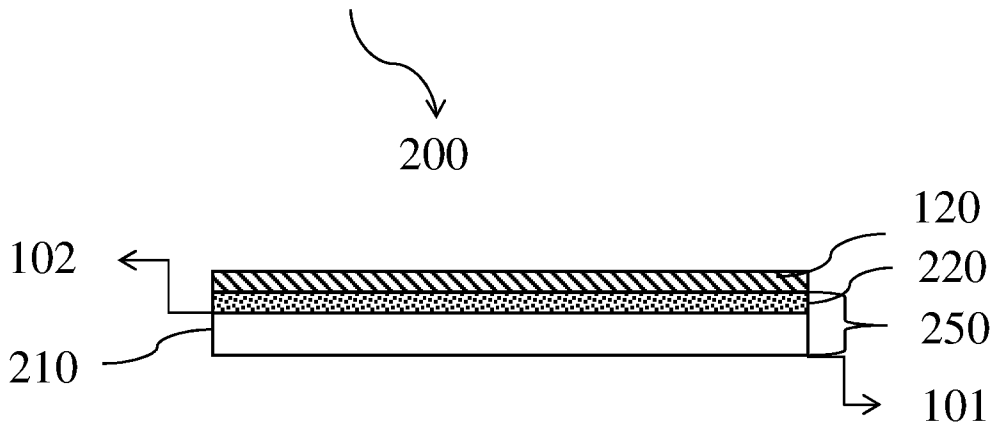


FIG. 2

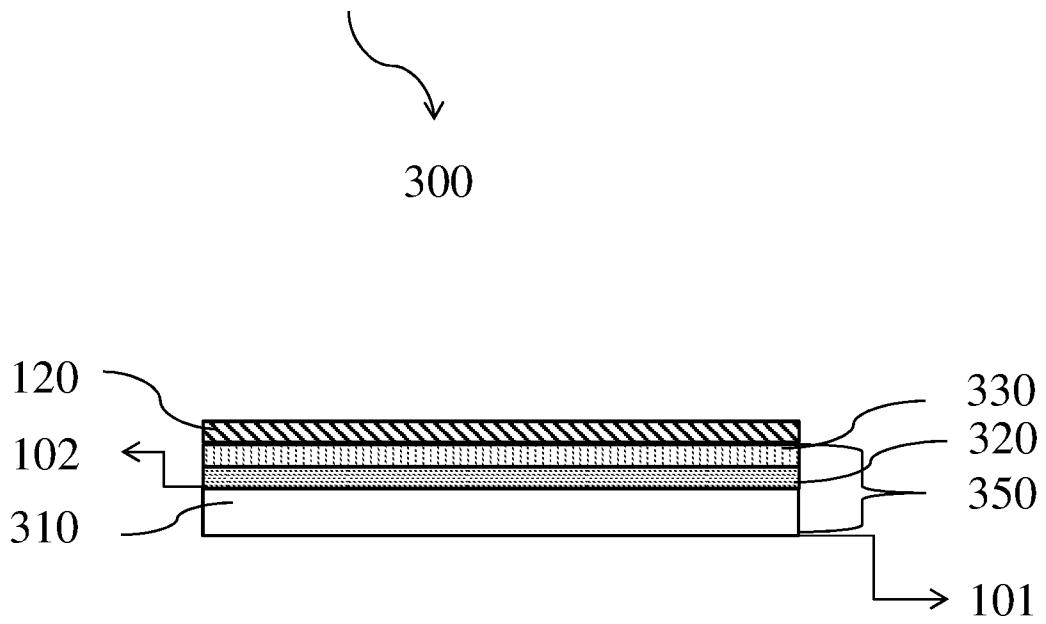


FIG. 3

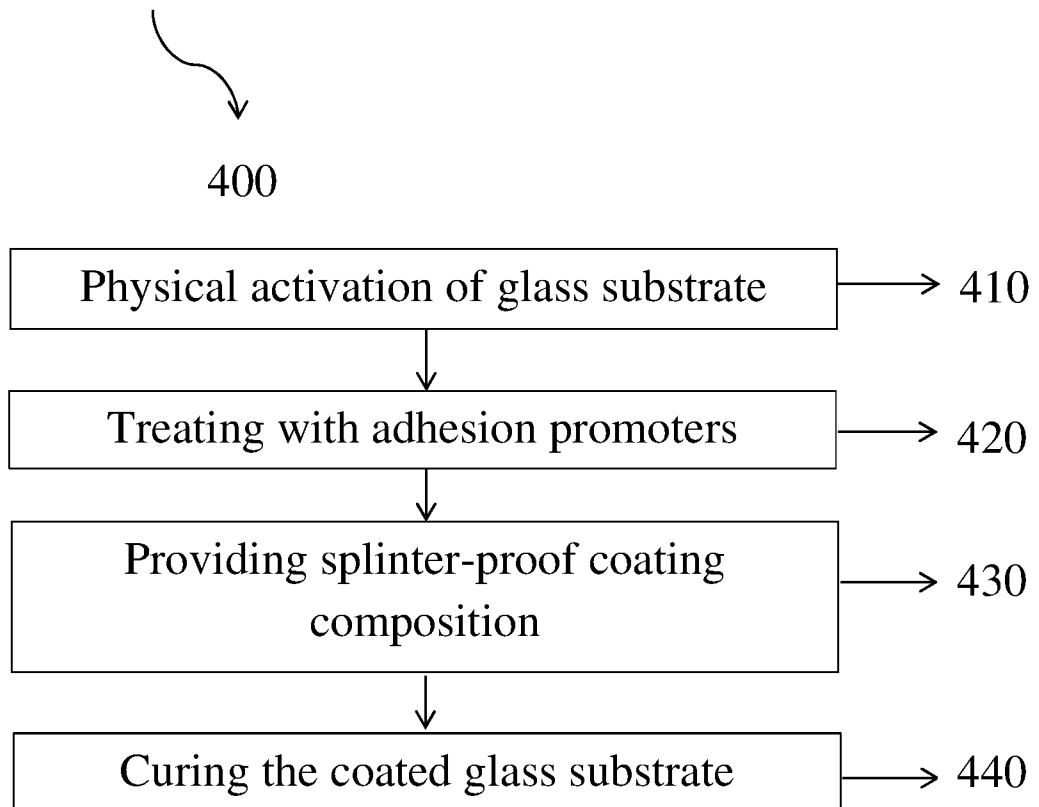


FIG. 4

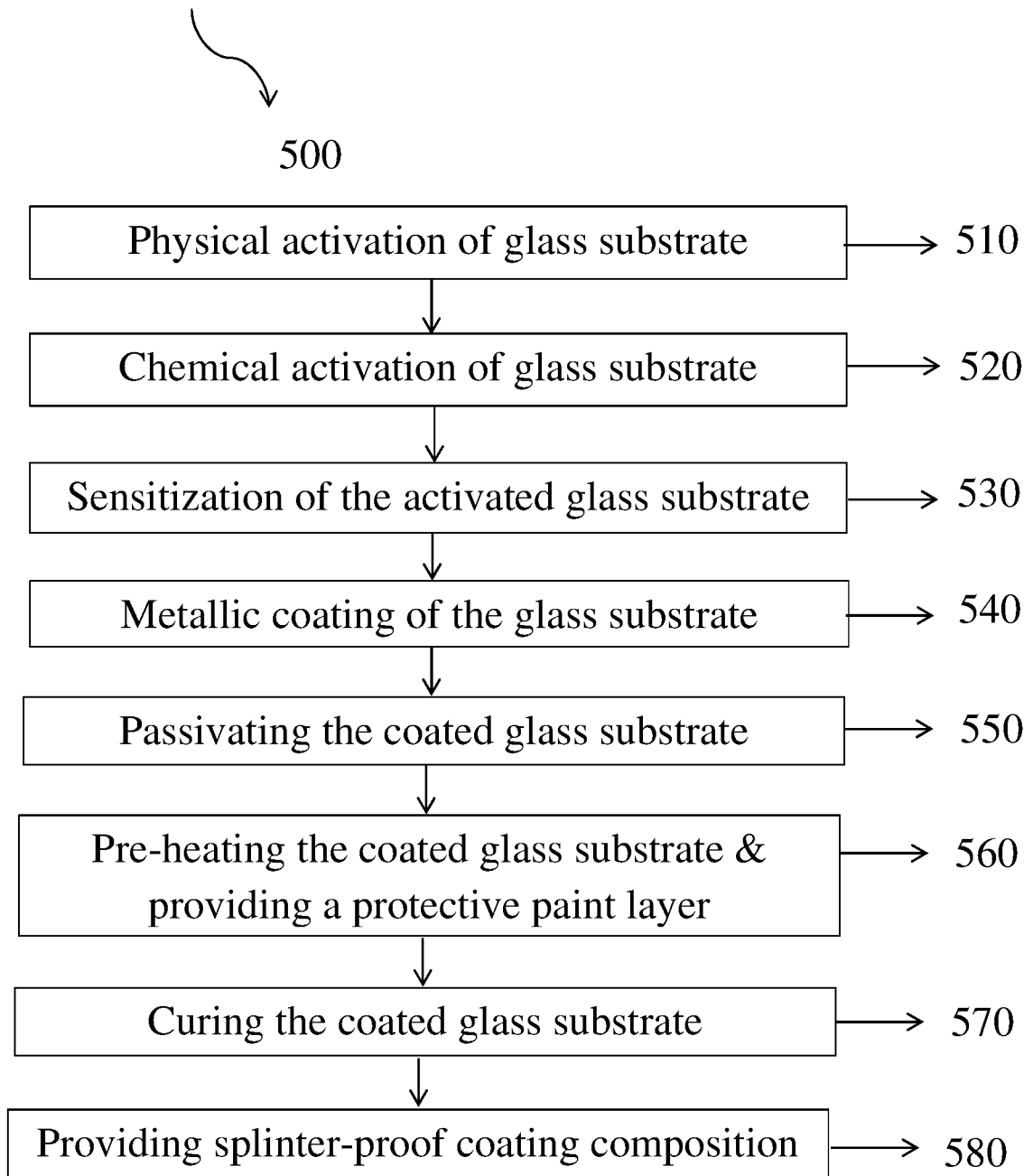


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2019/050652

A. CLASSIFICATION OF SUBJECT MATTER C09J7/00, C09D153/00, C09D153/02, C08L53/02 Version=2019.01		
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) C08L, C09D, C09J		
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.
Y	US20070231571 A1 (EASTMAN CHEMICAL COMPANY) Published on 04 October 2007 (04-10-2007) abstract, figures, paragraphs:[0001], [0048]-[0059] Examples, Claims: 1-102	1-20
Y	US20160243799 A1 (KURARAY CO. LTD.) Published on 25 August 2016 (25-08-2016) abstract, paragraphs: [0001], [0010]-[0036], [0072], [0104], [0114], [0150]-[0153], [0179], Examples, Claims: 1-14	1-20
Y	US9249262 B2 (KANEKA CORPORATION) Published on 02 February 2016 (02-02-2016) abstract, column: 2, 3, 32, 33, 34, Examples, Claims: 1-36	1-20
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> 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 20-11-2019		Date of mailing of the international search report 20-11-2019
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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Citation	Pub.Date	Family	Pub.Date
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