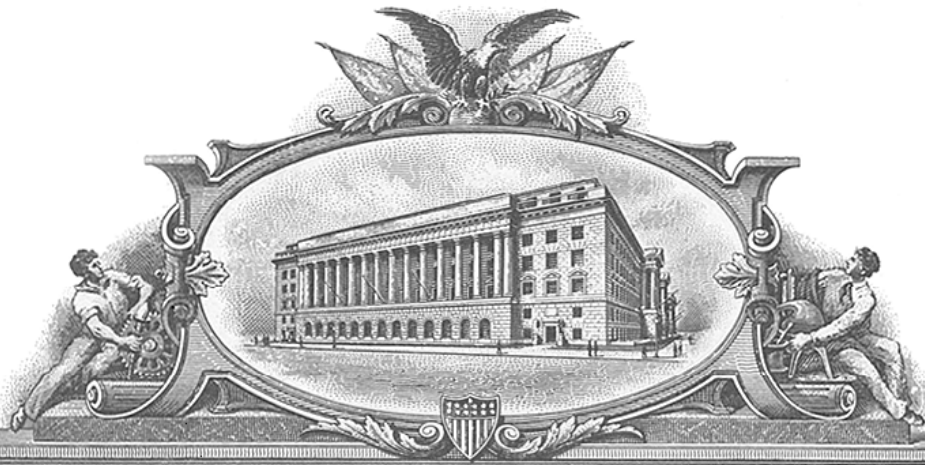


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Provisional Application for Patent Cover Sheet

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c)

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Title of Invention

SWITCHABLE GLAZING WITH IMPROVED LOW TEMPERATURE RESPONSE

Attorney Docket Number (if applicable)

1511.23900

Correspondence Address

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Signature	Joseph L. Morales/			Date (YYYY-MM-DD)	2017-12-07
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SWITCHABLE GLAZING WITH IMPROVED LOW TEMPERATURE RESPONSE

Cross-references to related applications

5 None

Abstract of the disclosure

Switchable (variable light transmittance) glazing, on which the tint can be dynamically controlled, is starting to appear in the automotive market. Promising switchable
10 technologies include: polymer dispersed liquid crystal (PDLC), suspended particle devices (SPD) and electrochromic. While each has its own advantages and disadvantages all share one common limitation: at low temperatures, the time required to change state increases. At a low enough temperature, the switching will stop for all practical purposes. This limitation is overcome by combining the switchable technology with a resistive
15 heating circuit. The heating circuit uses minimal power to maintain the glazing at or above the temperature required for acceptable switching time and operation.

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20 Field of the invention

This invention relates to the field of laminated automotive glazing.

Background of the invention

In response to the government regulatory requirements for increased automotive fuel
25 economy, as well as the growing public awareness and demand for energy efficient

environmentally friendly products, automotive original equipment manufacturers, around the world, have been working to improve the energy efficiency of their vehicles.

One of the key elements of this strategy to improve efficiency has been solar control. By reducing the solar load on the vehicle substantial improvements can be made in energy consumption, especially in warmer climates, by reducing the load on the air conditioning unit and allowing operation of the vehicle with the windows closed which improves aerodynamics. This is especially important for electric vehicles where the improvement directly translates into an increase in the range of the vehicle.

Infrared absorbing and infrared reflecting glazing are the two primary technologies that are being used to improve solar control.

Infrared absorbing glass has a higher iron content than ordinary clear glass giving it a greenish tint. The iron compounds in the glass absorb solar energy. There are also plastics that can be used with laminated glass that contain solar energy absorbing compounds that can achieve the same effect. By absorbing the energy before it enters the passenger compartment, the solar load on the vehicle is reduced. While a heat absorbing window can be very effective in reducing the solar load, the glass will heat up and transfer some of the absorbed energy to the passenger compartment through convective transfer and radiation.

A more efficient method is to reflect the energy back to the atmosphere allowing the glass so stay cooler. This is done through the use of various infrared reflecting films and coatings.

Infrared coatings and films are generally too soft to be exposed to the elements. Instead, they must be fabricated as one of the internal layers of a laminated product to prevent damage and degradation of the film or coating. One of the advantages of a laminated window over a tempered monolithic glazing is that a laminate can make use of these infrared reflecting coatings and films in addition to heat absorbing compositions and interlayers.

It is common practice to use a combination of infrared absorbing and infrared reflecting technologies on the same laminate. An infrared absorbing layer is placed behind an infrared reflecting layer to absorb the remaining infrared that is not reflected.

5

Infrared reflecting coatings include but are not limited to the various metal/dielectric layered coatings applied through Magnetron Sputtered Vacuum Deposition (MSVD) as well as others known in the art that are applied via pyrolytic, spray, controlled vapor deposition (CVD), dip and other methods.

10

Infrared reflecting films include both metallic coated plastic substrates as well as organic based non-metallic optical films which reflect in the infrared. Most of the infrared reflecting films are comprised of a plastic film substrate having an infrared reflecting layered metallic coating applied.

15

One of the drawback of both heat absorbing and heat reflecting glazing is that the solar load reduction is present all the time even when it is not needed or desired. In colder climates and at times when heat is needed, it would be advantageous to have the capability to utilize the energy of the sun to heat the vehicle interior.

20

With internal combustion engines (ICE), heating was never a problem. Internal combustion engines are very inefficient and so abundant waste heat is available. A typical ICE powered vehicle has a heater with a capacity of 4-5kW. In an electric vehicle, there is some waste heat from the battery but most if not all of the cabin heating must be provided by means of a resistive heating system.

25

It would be desirable to have a darker heat absorbing tint to keep the solar energy out to reduce the load on the air conditioning but to be able to let as much solar in as possible when heat is needed.

30

To control the level of light and energy transmission through the laminate, there are a number of technologies available: electrochromic, photochromic, thermochromic and

electric field sensitive films which are designed to be incorporated into laminated glass. Of particular interest are electrochromic, suspended particle device (SPD) films and polymer dispensed liquid crystal (PDLC) films with which we can change the light transmittance of the glazing in response to an electrical signal.

5

SPD is a variable tint technology with which the level of tint can be controlled and varied in response to an applied electrical field. SPD goes from dark in the off state to less dark in the on state. In a SPD film, microscopic droplets of liquid containing needle like particles, light vales, are suspended in a matrix. In the off state the particles are in a random state of alignment and block the transmission of light. The degree of alignment and resulting tint can be varied in response to the applied voltage. The light transmittance in the on and off states can also be shifted through changes to the thickness and composition of the active material. In the off state, it is still possible to see clearly through SPD.

15

PDLC is a light scattering technology which goes from opaque in the off state to clear in the on state. In a PDLC film, microscopic droplets of liquid crystal are suspended in a polymer matrix. In the off state the liquid crystals are in a random state of alignment and scatter the light providing privacy. In the off state, the film is substantially opaque. When an electric filed is applied, the crystals align and allow light to pass. The degree of scattering can be varied by varying the amplitude of the applied voltage. The level of light transmittance in the on and off states can also be shifted by making changes to the thickness and composition of the active material. PDLC is primarily a privacy product though it can also be used for solar control as it reduces the solar energy transmitted.

25

SPD and PDLC glazing are both manufactured by adding a special film layer to the laminate. The film is comprised of the active material sandwiched between two thin plastic layers having a transparent conductive coating on each.

30 To incorporate into a laminate, sheets of plastic interlayer are needed on each side of the film so as to bond the film to the other layers of the laminate. The film is laminated in between two plastic bonding interlayer layers in order to form a laminated glazing.

Electrochromic switchable glazing undergoes a chemical reaction when a current is passed through the active material, in much the same way that a battery functions when it charges and discharges. The active material undergoes an oxidation or reduction reaction as the materials changes from light to dark and back. This is a relatively slow process with the switching time measure is minutes.

SPD and PDLC however operate on a different principle. There is no chemical reaction. The molecules that make up the active material undergo a kinetic change in response to the presence of an electrical field. This is why the switching time of SPD and PDLC is measured in seconds or fractions of a second making it orders of magnitude faster than electro-chromic glazing. This is one of the primary advantage that the two have over electrochromic.

Electrochromic, SPD and PDLC can all be used for solar control as they reduce the level of light transmittance and energy transferred to the cabin.

Laminates that incorporate these variable light transmittance technologies are sometime referred to as “smart” glass or as switchable glazing.

One disadvantage is that smart glass can only operate over a limited range of temperature.

The viscosity of the microscopic droplets that the active material is suspended in (SPD) and of the liquid crystal itself (PDLC), is a function of temperature. As the temperature drops, the switching time increases. At sufficiently low temperatures the material is unable to change states. The actual temperature will depend upon the formulation.

At elevated temperatures, PDLC will reach a point where it will become clear and not switch to the light scattering state. SPD will still switch but the switching speed is much slower.

Electrochromic glazing, which is relatively slow to switch states, relies on a chemical reaction which also takes longer at lower temperatures.

5 As a result, the use of electrochromic, PDLC and SPD has been limited due to these temperature constraints.

It would be advantageous to be able to operate over an extended temperature range.

Brief summary of the invention

10 The ability change light transmittance at lower temperatures is improved by adding a resistive heated circuit to the glazing. A variety of means can be used including but not limited to: printed silver frit, conductive coated glass, conductive coated film and embedded wire. The heated circuit does need to deice or defog and so can be designed to draw minimal power.

15

Advantages:

- Extended lower temperature operation
- Shorter switching time at lower temperatures.
- Lower energy consumption for heating and cooling.
- 20 • Fabricated using standard automotive glass processes and equipment.

Brief description of drawings

Figure 1A	Cross section of a typical automotive laminate.
Figure 1B	Cross section of a typical automotive laminate with coating and
Figure 2	Exploded view of windshield with a variable light transmittance film.
Figure 3	Exploded view of windshield with a variable light transmittance film and a screen print silver resistive heating circuit.
Figure 4	Exploded view of windshield with a variable light transmittance film and a transparent conductive coated glass resistive heating circuit on the number two surface of glass.
Figure 5	Exploded view of windshield with a variable light transmittance film and a transparent conductive coated film resistive heating circuit.
Figure 6	Exploded view of windshield with a variable light transmittance film and an embedded wire resistive heating circuit.

Reference numerals

2	Glass
4	Plastic Interlayer
6	Obscuration
18	Coating
34	Bus bar
42	Coated Film
44	Switchable Film
46	Silver
48	Wire
101	Surface one
102	Surface two
103	Surface three
104	Surface four
201	Outer glass layer
202	Inner glass layer

Detailed description of the invention

The following terminology is used to describe the laminated glazing of the invention.

A typical automotive laminate cross section is illustrated in Figures 1A and 1B. The laminate is comprised of two layers of glass, the exterior or outer, 201 and interior or
5 inner, 202 that are permanently bonded together by a plastic layer 4 (interlayer). The glass surface that is on the exterior of the vehicle is referred to as surface one 101 or the number one surface. The opposite face of the exterior glass layer 201 is surface two 102 or the number two surface. The glass 2 surface that is on the interior of the vehicle is referred to as surface four 104 or the number four surface. The opposite face of the
10 interior layer of glass 202 is surface three 103 or the number three surface. Surfaces two 102 and three 103 are bonded together by the plastic layer 4. An obscuration 6 may be also applied to the glass. Obscuration are commonly comprised of black enamel frit printed on either the number two 102 or number four surface 104 or on both. The laminate may also comprise a coating 18 on one or more of the surfaces. The laminate may also
15 comprise a film 12 laminated between at least two plastic layers 4.

Most of the worlds' flat glass is produced by the float glass process, first commercialized in the 1950s. In the float glass process, the raw ingredients are melted in a large refractory vessel and then the molten glass is extruded from the vessel onto a bath of molten tin
20 where the glass floats. The thickness of the glass is controlled by the speed at which the molten glass is drawn from the vessel. As the glass cools and hardens, the glass ribbon transfers to rollers. Float glass thickness can typically vary by +/-50 um over a short distance due to what is known as draw line distortion. This is caused by the mechanical means used to draw the molten glass extruded from the vessel into a thin ribbon on the
25 flat glass float line.

We distinguish between the "air" side of the float glass and the "tin" side. A thin coating of tin remains on the glass which will fluoresce and thus can be detected with ultra-violet light.

30

The types of glass 2 that may be used include but are not limited to: the common soda-lime variety typical of automotive glazing as well as aluminosilicate, lithium

aluminosilicate, borosilicate, glass ceramics, and the various other inorganic solid amorphous compositions which undergo a glass transition and are classified as glass included those that are not transparent. The glass layers may be comprised of heat absorbing glass compositions as well as infrared reflecting and other types of coatings.

5

The glass layers may be annealed or strengthened. There are two processes that can be used to increase the strength of glass. They are thermal strengthening, in which the hot glass is rapidly cooled (quenched) and chemical tempering which achieves the same effect through an ion exchange chemical treatment. In the chemical tempering process, ions in and near the outside surface of the glass are exchanged with ions that are larger. These places the outer layer of glass in compression. Compressive strengths of up to 1,000 Mpa are possible.

Laminated safety glass is made by bonding two sheets of glass, the outer glass layer 201 and the inner glass layer 202 of annealed glass 2 together using a plastic bonding layer comprised of a thin sheet of transparent plastic or thermos plastic interlayer 4 as shown in Figure 1. Annealed glass is glass that has been slowly cooled from the bending temperature down through the glass transition range. This process relieves any stress left in the glass from the bending process. Annealed glass breaks into large shards with sharp edges. When laminated glass breaks, the shards of broken glass are held together, much like the pieces of a jigsaw puzzle, by the plastic layer helping to maintain the structural integrity of the glass. A vehicle with a broken windshield can still be operated. The plastic interlayer 4 also helps to prevent penetration by objects striking the laminate from the exterior and in the event of a crash occupant retention is improved.

25

Black enamel frit is comprised of pigments, carriers, binders and finely ground glass. Other materials are also sometimes added to enhance certain properties: the firing temperate, anti-stick, chemical resistance, etc. The black frit is applied to the glass using a silk screen or ink jet printing process prior to the heating and bending of the glass. As the flat glass is heated during the bending process, the powdered glass in the frit softens and melts, fusing to the surface of the glass. The black print becomes a permanent part of the glass. The frit is said to be “fired” when this takes place. This is a vitrification

30

process which is very similar to the process used to apply enamel finishes on bathroom fixtures, pottery, china and appliances.

5 This black frit print obscuration on many automotive glazing serves both a functional and an aesthetic role. The substantially opaque black print on the glass serves to protect the poly-urethane adhesive used to bond the glass to the vehicle from ultra-violet light and the degradation that it can cause. It also serves to hide the adhesive from view from the exterior of the vehicle. The black obscuration must be durable, lasting the life of the vehicle under all exposure and weather conditions. Part of the aesthetic requirement is
10 that the black have a dark glossy appearance and a consistent appearance from part to part and over the time. A part produced today must match up with one that was produced and in service 20 years ago. The parts must also match up with the other parts in the vehicle which may not have been fabricated by the same manufacturer or with the same formulation of frit. Standard automotive black enamel inks (frits) have been developed
15 that can meet these requirements.

The glass layers are formed using gravity bending, press bending, cold bending or any other conventional means known in the art. Gravity and press bending methods for forming glass are well known in the art and will not be discussed in the present disclosure.

20 Cold bending is a relatively new technology. As the name suggest, the glass is bent, while cold to its final shape, without the use of heat. On parts with minimal curvature a flat sheet of glass can be bent cold to the contour of the part. This is possible because as the thickness of glass decreases, the sheets becomes increasingly more flexible and can be
25 bent without inducing stress levels high enough to significantly increase the long term probability of breakage. Thin sheets of annealed soda-lime glass, in thicknesses of about 1 mm, can be bent to large radii cylindrical shapes (greater than 6 m). When the glass is chemically or heat strengthened the glass is able to endure much higher levels of stress and can be bent along both major axis. The process is primarily used to bend chemically
30 tempered thin glass sheets (≤ 1 mm) to shape.

Cylindrical shapes can be formed with a radius in one direction of less than 4 meters. Shapes with compound bend, that is curvature in the direction of both principle axis can be formed with a radius of curvature in each direction of as small as approximately 8 meters. Of course, much depends upon the surface area of the parts and the types and thicknesses of the substrates.

The cold bent glass will remain in tension and tend to distort the shape of the bent layer that it is bonded to. Therefore, the bent layer must be compensated to offset the tension. For more complex shapes with a high level of curvature, the flat glass may need to be partially thermally bent prior to cold bending.

The glass to be cold bent is placed with a bent to shape layer and with a bonding layer placed between the glass to be cold bent and the bent glass layer. The assembly is placed in what is known as a vacuum bag. The vacuum bag is an airtight set of plastic sheets, enclosing the assembly and bonded together at the edges, which allows for the air to be evacuated from the assembly and which also applies pressure on the assembly forcing the layers into contact. The assembly, in the evacuated vacuum bag, is then heated to seal the assembly. The assembly is next placed into an autoclave which heats the assembly and applies high pressure. This completes the cold bending process as the flat glass at this point has conformed to the shape of the bent layer and is permanently affixed. The cold bending process is very similar to a standard vacuum bag/autoclave process, well known in the art, with the exception of having an unbent glass layer added to the stack of glass.

Heat strengthened, full temper soda lime float glass, with a compressive strength in the range of at least 70 Mpa, can be used in all vehicle positions other than the windshield. Heat strengthened (tempered) glass has a layer of high compression on the outside surfaces of the glass, balanced by tension on the inside of the glass which is produced by the rapid cooling of the hot softened glass. When tempered glass breaks, the tension and compression are no longer in balance and the glass breaks into small beads with dull edges. Tempered glass is much stronger than annealed laminated glass. The thickness limits of the typical automotive heat strengthening process are in the 3.2mm to 3.6 mm

range. This is due to the rapid heat transfer that is required. It is not possible to achieve the high surface compression needed with thinner glass using the typical blower type low pressure air quenching systems.

- 5 A panoramic windshield is a windshield on which the top edge has been substantially extended such that it comprises a portion of the vehicle roof.

The plastic bonding layer 4 (interlayer) has the primary function of bonding the major faces of adjacent layers to each other. The material selected is typically a clear plastic
10 when bonding one glass layer 2 to another glass layer 2. For automotive use, the most commonly used bonding layer 4 (interlayer) is polyvinyl butyl (PVB). In addition to polyvinyl butyl, ionoplast polymers, ethylene vinyl acetate (EVA), cast in place (CIP) liquid resin and thermoplastic polyurethane (TPU) can also be used. Interlayers are available with enhanced capabilities beyond bonding the glass layers together. The
15 invention may include interlayers designed to dampen sound. Such interlayers are comprised whole or in part of a layer of plastic that is softer and more flexible than that normally used. The interlayer may also be of a type which has solar attenuating properties.

- 20 Automotive interlayers are made by an extrusion process with has a thickness tolerance and process variation. As a smooth surface tends to stick to the glass, making it difficult to position on the glass and to trap air, to facilitate the handling of the plastic sheet and the removal of air (deairing) from the laminate, the surface of the plastic is normally embossed contributing additional variation to the sheet. Standard thicknesses for
25 automotive PVB interlayer at 0.38 mm and 0.76 mm (15 and 30 mil).

Resistive heating circuits are commonly provided on automotive backlites in order to assist vision and enhance safety by melting snow and ice and clearing fog. Heated circuits are also provided on some windshields. On vehicles that have wipers that are hidden
30 below the hood line when not in use, a heated wiper rest area is needed to keep the wipers clear of snow and ice when not in use and to prevent the buildup of snow in ice in the rest area when in use. Windshields that have safety cameras also require a heated circuit that

can quickly clear the portion of the windshield in the camera field of view. Most vehicle are equipped with hot air windshield defrosting systems. Some are also provided with full windshield resistive heating as well. A number of technologies are in use in the production of the various types of heated circuits. In general, for most climates and
5 typical glazing, a power density of at least 4 - 5 watts per square decimeter is required for good de-ice performance. For more demanding applications, such as the wiper rest area, power densities as high as 15 watts per square decimeter are known.

The optimum switching temperature is somewhere around 10 - 20 C although it will vary
10 with the technology and the manufacturer. Likewise, the lower end of the range varies. A power density in the 2.5 – 3 watt range is sufficient to raise and maintain the temperature of the switchable material at a close to optimal temperature. The actual power density of the circuit will depend upon the technology, the position of the glazing and the manufacturer.

15 Several types of resistive heating circuits are used in automotive glazings. All can be used in embodiments of the invention.

Full surface windshield heating is commonly provided through the use of a conductive
20 transparent coating. The coating is vacuum sputtered directly onto the glass and is comprised of multiple layers of metal and dielectrics. With resistances in the range of 2-6 ohms per square, a voltage convertor is needed to reach the power density required. The lower power density required to maintain switching may allow for the use of a standard 12 volt electrical supply.

25 Silver frit is the most common type of heated circuit used for backlites, heated wiper rests and camera defrosters. It is also the most cost effective. Finely silver powder is mixed with carriers, binders and finely ground glass. Other materials are also sometimes added to enhance certain properties: the firing temperature, anti-stick, chemical resistance, etc.
30 The silver frit is applied to the glass using a silk screen or ink jet printing process prior to the heating and bending of the glass. As the flat glass is heated during the bending process, the powdered glass in the frit softens and melts, fusing to the surface of the glass.

The silver frit print becomes a permanent part of the glass. The frit is said to be “fired” when this takes place. This is a vitrification process which is very similar to the process used to apply enamel finishes on bathroom fixtures, pottery, china and appliances. Resistances as low as 2 milliohms per square and line widths as narrow as 0.5 mm are possible. The primary drawback to silver print is the aesthetics of the fired silver which has a dark orange to mustard yellow color depending upon which side of the glass it is printed on, the air side or the tin side.

A transparent conductive coated film can also be used to provide for a resistive heated circuit. This is very similar too and made in the same manner that transparent conductive coated glass is made. A voltage convertor is needed to reach the power density required for windshield full surface heating. The lower power density of the invention may allow for the use of a standard 12 volt electrical supply.

An embedded wire resistive heated circuit is formed by embedding fine wires into the plastic bonding layer of a laminate. The wires are embedded in the plastic through the use of heat or ultra-sound. Tungsten is a preferred material due to its tensile strength, which is 10x that of Copper and its flat black color. Heated windshields typically use tungsten wire that is in the 18 – 22 um range at which point the wires are virtually invisible. The wires are embedded using an oscillating sinusoidal like pattern to reduce glare that can occur under certain lighting conditions. For positions of the glazing other than the windshield, larger wire diameters can be used. Wire are typically embedded utilizing some sort of CNC machine.

A micro-mesh resistive heating circuit is comprised of very fine conductive lines which are deposited onto a non-conductive substrate such as glass or plastic using a vacuum sputtering technique. Patterns are formed by masking of the substrate using a lithographic process similar to that used to produce integrated circuits. Line widths of 10 um are possible, at which point, the mesh is invisible for all practical purposes. The primary advantage of this method is that the pattern can be designed to provide for very precise control of the heating. As the conductors do not need to be transparent, the thickness can

be much great than that which is possible when coating the entire substrate. The process is also simpler as only a single metal layer is required.

5 The heated circuit may be operated in a manual or automatic manner. Both methods have been used for deice and defog applications. The circuit may be operated in response to the user. Generally, a timer is used to limit the power consumption and to prevent overheating. Temperature feedback may be provided for closed loop control. As most modern vehicles have interior and exterior temperature sensors, the vehicle climate control may operate the circuit based upon the temperature. For optimum efficiency, a
10 light sensor may be used to detect the switching speed and operating the heating circuit in response to the measured switching speed and the temperature.

The laminated panoramic glass roof of Figures 2, illustrates the prior art. The laminate is comprised of a standard soda-lime 2.5 mm thick clear exterior glass layer **201** and a 2.1
15 mm soda-lime solar green interior glass layer **202**. Black frit **6** is screen printed on surface two **102** and surface four **104**. The glass **2** layers are thermally bent using a gravity bending process. A layer of SPD film **44**, with busbars **37** on opposite ends, is sandwiched between two layers of clear plastic bonding interlayer **4**. The SPD film **44** has a light transmittance of 20% in the ON state and 2% in the OFF, unpowered state.
20 The assembled laminated is processed, using standard automotive laminating equipment.

It should be understood that while the switchable technology of the embodiments are SPD, the same heated circuits may be incorporated into laminates which utilize other switchable technologies.

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DETAILED DESCRIPTION OF THE EMBODIMENTS

1. The laminated panoramic glass roof of Figures 3, illustrates the first embodiment. The laminate is comprised of a standard soda-lime 2.5 mm thick clear exterior glass layer **201** and a 2.1 mm soda-lime solar green interior glass layer **202**. Black frit **6** is
30 screen printed on surface two **102** and surface four **104**. A silver frit heating circuit, with 0.6mm wide lines and a power density of 3 watts per decimeter squared is screen printed on the number four surface **104**. Screen printed silver frit busbars **37** are used

to connect the printed heater lines. The glass **2** layers are thermally bent using a gravity bending process. A layer of SPD film **44**, with busbars **37** on opposite ends, is sandwiched between two layers of clear plastic bonding interlayer **4**. The SPD film **44** has a light transmittance of 20% in the ON state and 2% in the OFF, unpowered state. The assembled laminated is processed, using standard automotive laminating equipment.

2. The laminated panoramic glass roof of Figures 4, illustrates the second embodiment. The laminate is comprised of a standard soda-lime 2.5 mm thick clear exterior glass layer **201** and a 2.1 mm soda-lime solar green interior glass layer **202**. Black frit **6** is screen printed on surface two **102** and surface four **104**. After printing, the outer glass layer 201 is heated to fire the black print. After firing, the outer layer is coated my means of a MSVD process to apply a transparent silver based coating having a sheet resistance of 2.5 ohms per square. At 12 volts, the heating circuit has a power density of 3 watts per decimeter square. Thin flat tinned copper busbars are used to power the coated heater circuits. The glass **2** layers are thermally bent using a gravity bending process. A layer of SPD film **44**, with busbars **37** on opposite ends, is sandwiched between two layers of clear plastic bonding interlayer **4**. The SPD film **44** has a light transmittance of 20% in the ON state and 2% in the OFF, unpowered state. The assembled laminated is processed, using standard automotive laminating equipment.

3. The laminated panoramic glass roof of Figures 5, illustrates the third embodiment. The laminate is comprised of a standard soda-lime 2.5 mm thick clear exterior glass layer **201** and a 2.1 mm soda-lime solar green interior glass layer **202**. Black frit **6** is screen printed on surface two **102** and surface four **104**. The heated circuit is comprised of a plastic film coated by means of a MSVD process used to apply a transparent silver based coating having a sheet resistance of 2.5 ohms per square. At 12 volts, the heating circuit has a power density of 3 watts per decimeter square. Thin flat tinned copper busbars are used to power the coated heater circuit. The glass **2** layers are thermally bent using a gravity bending process. A layer of SPD film **44**, with busbars **37** on opposite ends, is sandwiched between two layers of clear plastic

bonding interlayer **4**. The SPD film **44** has a light transmittance of 20% in the ON state and 2% in the OFF, unpowered state. A layer of clear plastic bonding interlayer **4** bonds the SPD to the conductive coated film and a third clear plastic bonding interlayer **4** is added to bond the coated film to the outer glass **201**. The assembled laminated is processed, using standard automotive laminating equipment.

4. The laminated panoramic glass roof of Figures 6, illustrates the forth embodiment. The laminate is comprised of a standard soda-lime 2.5 mm thick clear exterior glass layer **201** and a 0.7 mm chemically tempered interior glass layer **202**. Black frit **6** is screen printed on surface two **102**. An embedded tungsten wire heating circuit, with a power density of 3 watts per decimeter squared is embedded into the clear plastic bonding interlayer that is positioned between the SPD **44** layer and the interior glass layer **202**. Thin tinned copper busbars are used to provide 12 volt power to the wire heating elements. The outer glass **201** layer is thermally bent using a gravity bending process. The interior glass layer **202**, is cold bent. A layer of SPD film **44**, with busbars **37** on opposite ends, is sandwiched between two layers of clear plastic bonding interlayer **4**. The SPD film **44** has a light transmittance of 20% in the ON state and 2% in the OFF, unpowered state. The assembled laminated is processed, using standard automotive laminating equipment.

- 20
5. Embodiment 5 is the same as embodiment 1 but with a PDLC film replacing the SPD.
 6. Embodiment 6 is the same as embodiment 2 but with a PDLC film replacing the SPD.
 7. Embodiment 7 is the same as embodiment 3 but with a PDLC film replacing the SPD.
 8. Embodiment 8 is the same as embodiment 4 but with a PDLC film replacing the SPD.

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It must be understood that this invention is not limited to the embodiments described and illustrated above. A person skilled in the art will understand that numerous variations and/or modifications can be carried out that do not depart from the spirit of the invention, which is only defined by the following claims.

30

CLAIMS

What is claimed is:

1. A variable light transmittance laminated glazing comprising:
 - a. an outer glass layer;
 - b. an interior glass layer;
 - c. at least one plastic layer between the outer and inner glass layers;
 - d. at least one switchable layer.
2. The laminate of claim 1 wherein the laminate comprises an infrared reflecting coating.
3. The laminate of claim 1 wherein the laminate comprises an infrared reflecting film.
4. The laminate of claim 1 wherein the switchable technology is SPD.
5. The laminate of claim 1 wherein the switchable technology is PDLC.
6. The laminate of claim 1 wherein the switchable technology is electrochromic.
7. The laminate of claim 1 wherein the heated circuit is comprised of an embedded wire heated circuit.
8. The laminate of claim 1 wherein the heated circuit is comprised of a silver frit heated circuit.
9. The laminate of claim 1 wherein the heated circuit is comprised of a transparent conductive coated film heated circuit.
10. The laminate of claim 1 wherein the heated circuit is comprised of a transparent conductive coated glass heated circuit.
11. The laminate of claim 1 wherein the laminate comprises a cold bent glass layer.
12. The laminate of claim 1 wherein the laminate comprises a chemically tempered glass layer.
13. A vehicle comprising the laminate of claim 1.

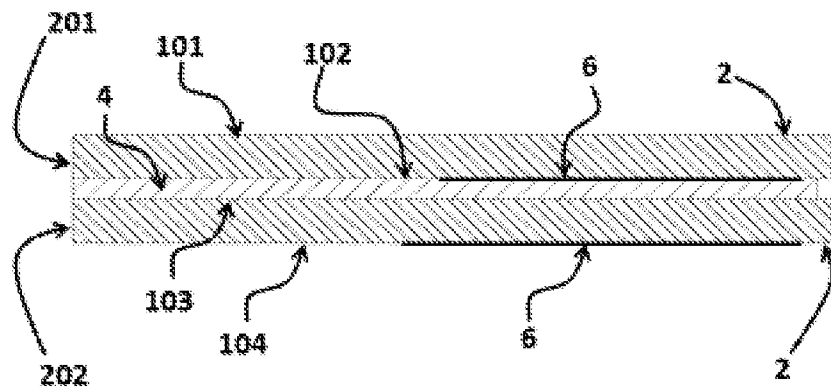


Fig. 1A

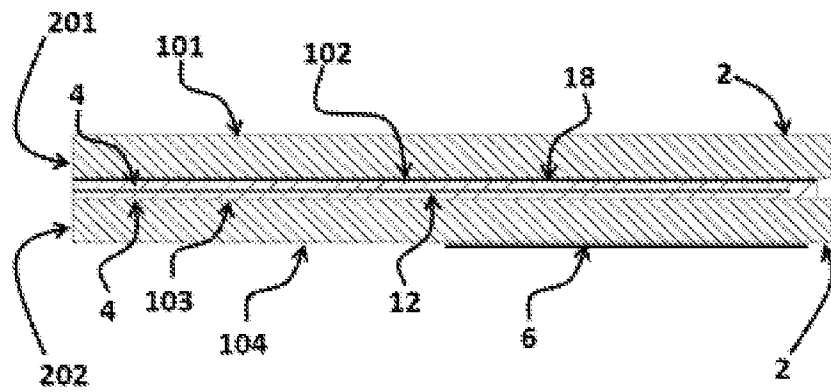


Fig. 1B

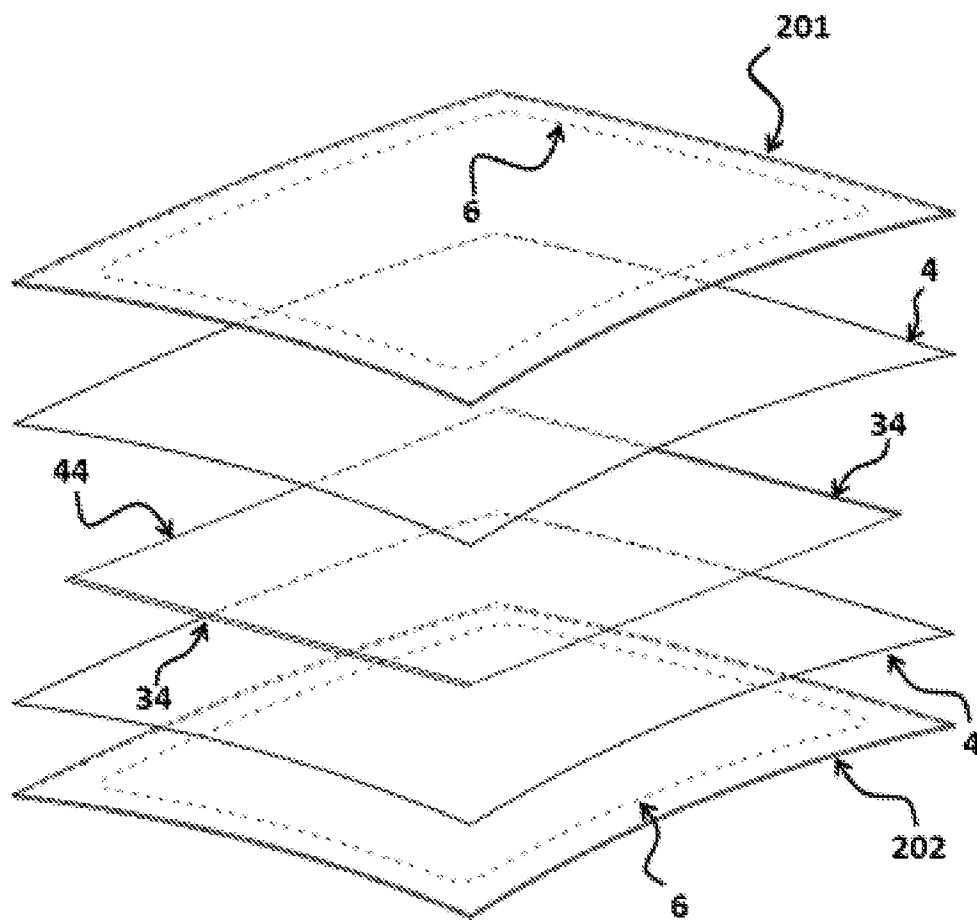


Fig. 2

3/6

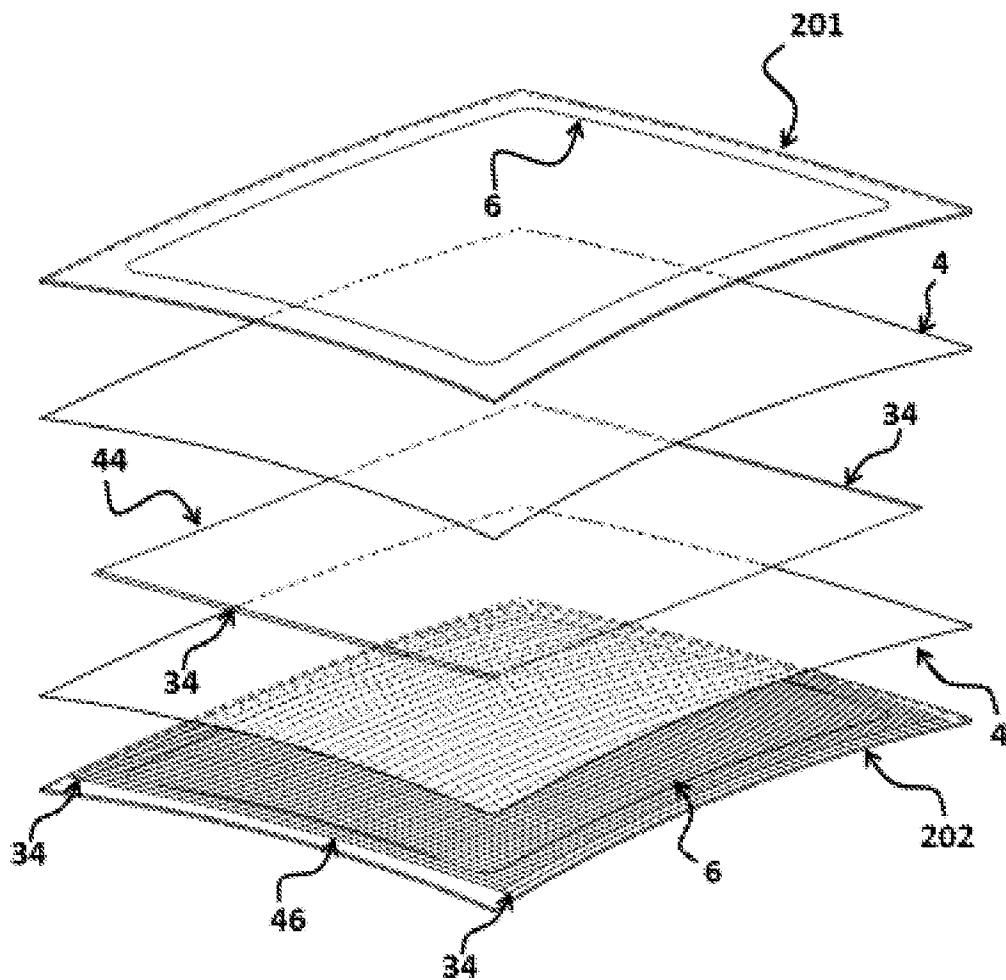


Fig. 3

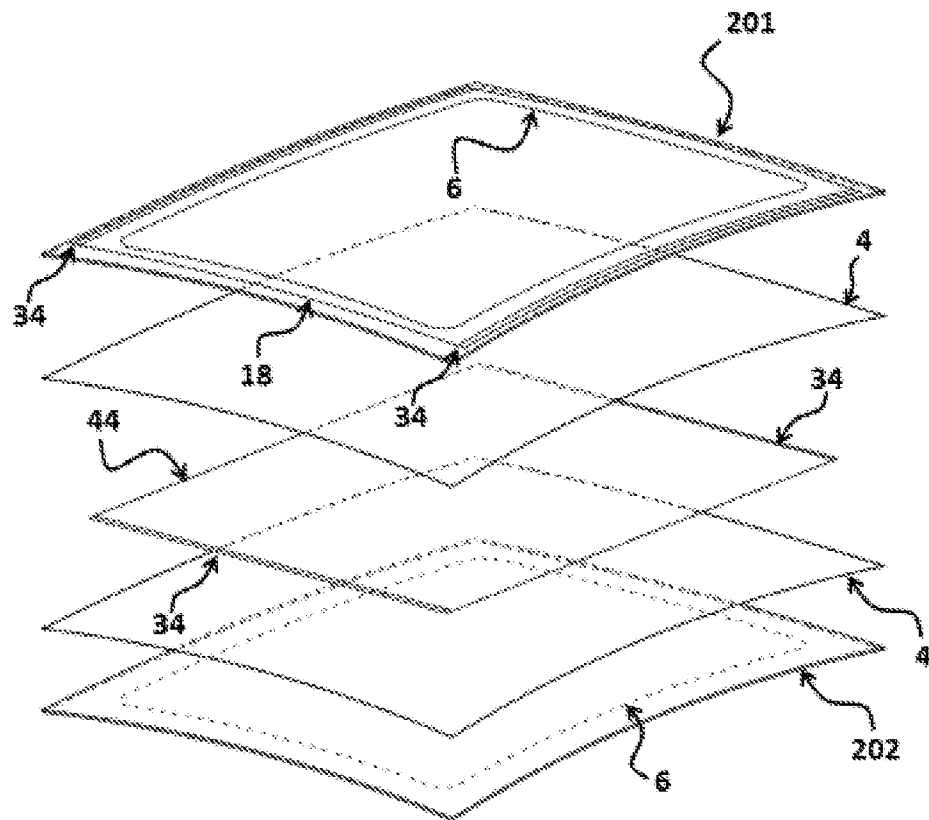


Fig. 4

5/6

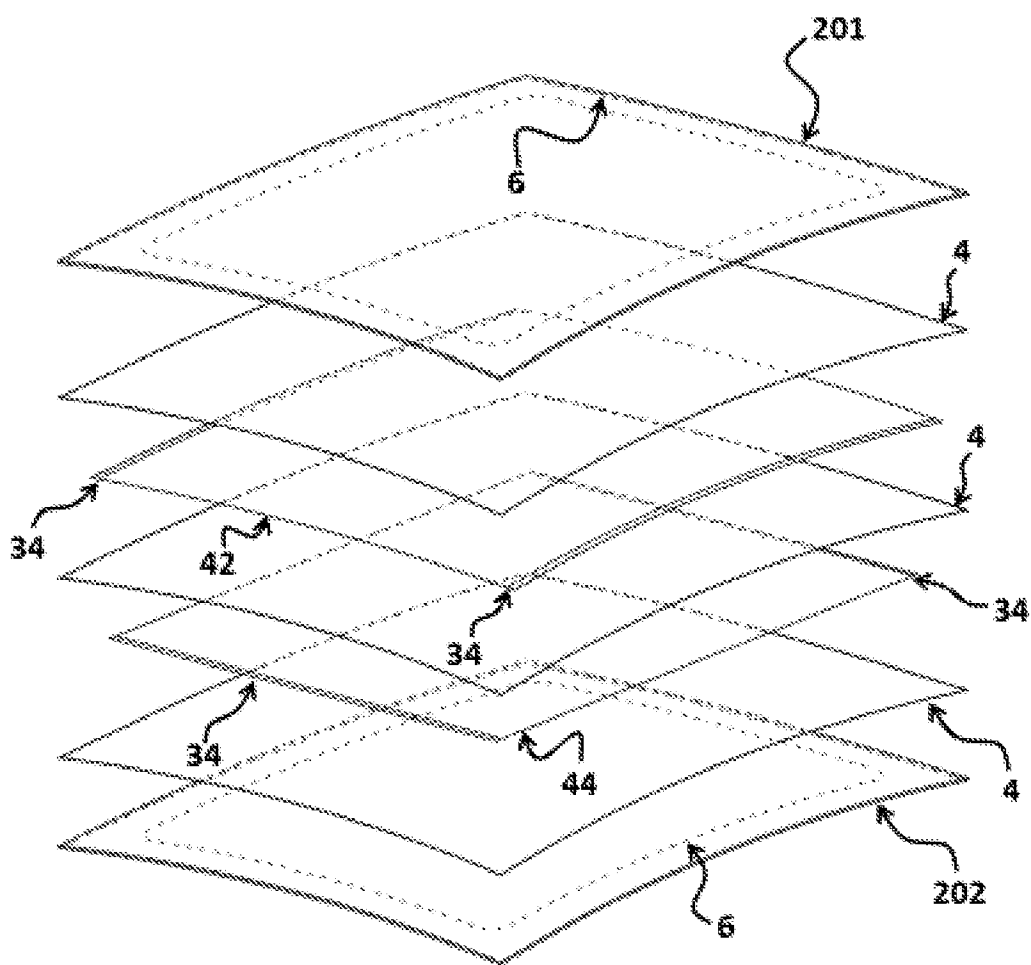


Fig. 5

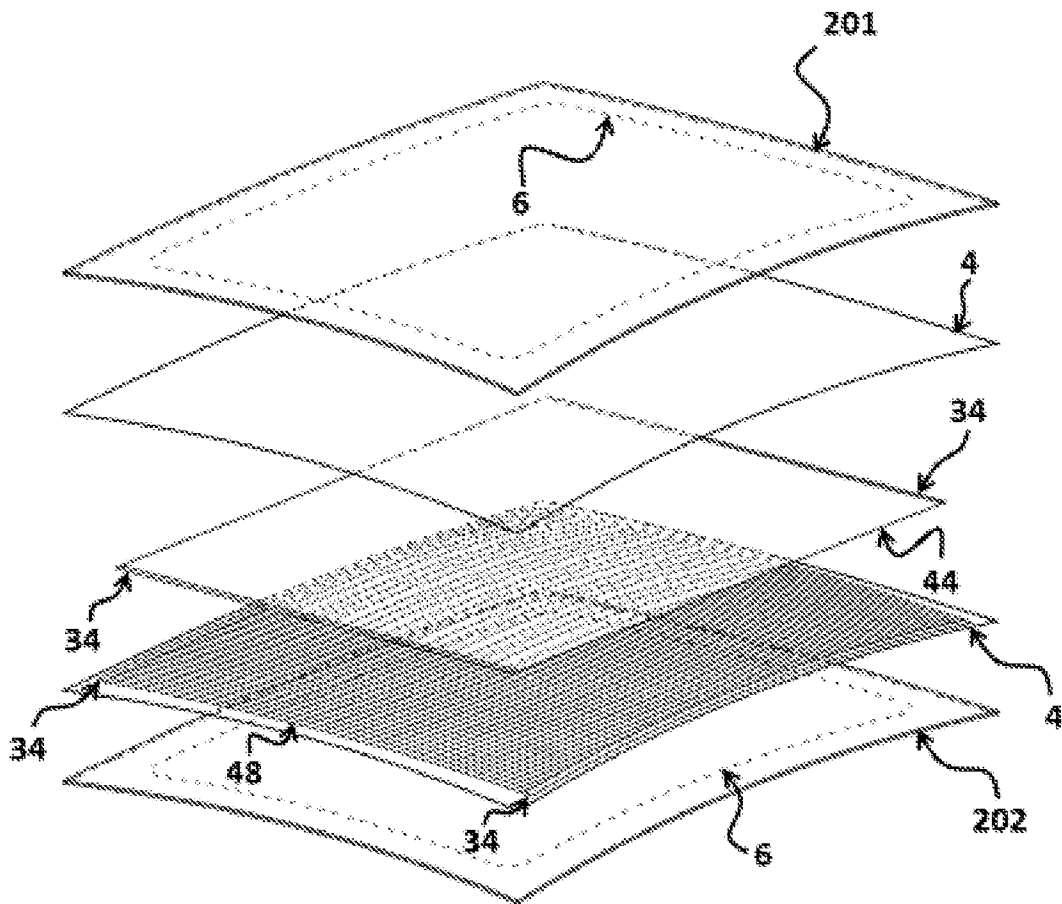


Fig. 6

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	1511.23900
		Application Number	
Title of Invention	SWITCHABLE GLAZING WITH IMPROVED LOW TEMPERATURE RESPONSE		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2:

☐	Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)
--------------------------	---

Inventor Information:

Inventor	1				Remove
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
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Residence Information (Select One) US Residency ☒ Non US Residency Active US Military Service					
City	Lima	Country of Residence ⁱ	PE		
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Address 2					
City	Cercado de Lima	State/Province			
Postal Code		Country ⁱ	PE		
Inventor	2				Remove
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Alfredo	Daniel	Koc Li		
Residence Information (Select One) US Residency ☒ Non US Residency Active US Military Service					
City	Lima	Country of Residence ⁱ	PE		
Mailing Address of Inventor:					
Address 1	Av. Guillermo Dansey 1996				
Address 2					
City	Cercado de Lima	State/Province			
Postal Code		Country ⁱ	PE		
Inventor	3				Remove
Legal Name					

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	1511.23900
		Application Number	
Title of Invention	SWITCHABLE GLAZING WITH IMPROVED LOW TEMPERATURE RESPONSE		

Prefix	Given Name	Middle Name	Family Name	Suffix
	Gonzalo	Rafael	Vizcarra Mendoza	
Residence Information (Select One) US Residency ☒ Non US Residency Active US Military Service				
City	Lima	Country of Residence ⁱ	PE	

Mailing Address of Inventor:				
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Address 2				
City	Cercado de Lima	State/Province		
Postal Code		Country ⁱ	PE	
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button. Add				

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).			
☐ An Address is being provided for the correspondence information of this application.			
Customer Number	130961		
Email Address	morales@moralesq.com	Add Email	Remove Email

Application Information:

Title of the Invention	SWITCHABLE GLAZING WITH IMPROVED LOW TEMPERATURE RESPONSE		
Attorney Docket Number	1511.23900	Small Entity Status Claimed	☐
Application Type	Provisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	6	Suggested Figure for Publication (if any)	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country ⁱ

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	1511.23900
		Application Number	
Title of Invention	SWITCHABLE GLAZING WITH IMPROVED LOW TEMPERATURE RESPONSE		

Publication Information:

☐	Request Early Publication (Fee required at time of Request 37 CFR 1.219)
☐	Request Not to Publish. I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application has not and will not be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.			
Please Select One:	☒ Customer Number	US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number	130961		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78. When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.			Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)ⁱ the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	1511.23900
		Application Number	
Title of Invention	SWITCHABLE GLAZING WITH IMPROVED LOW TEMPERATURE RESPONSE		

			Remove
Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	Access Code ^j (if applicable)
Additional Foreign Priority Data may be generated within this form by selecting the Add button.			Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013. NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	1511.23900
		Application Number	
Title of Invention	SWITCHABLE GLAZING WITH IMPROVED LOW TEMPERATURE RESPONSE		

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	1511.23900
		Application Number	
Title of Invention	SWITCHABLE GLAZING WITH IMPROVED LOW TEMPERATURE RESPONSE		

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant	1	Remove
If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section. Clear		
☒ Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.		Person who shows sufficient proprietary interest
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:		
Name of the Deceased or Legally Incapacitated Inventor:		
If the Applicant is an Organization check here. ☒		
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Mailing Address Information For Applicant:		
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Address 2		
City	Panama City	State/Province
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Phone Number		Fax Number
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	1511.23900
		Application Number	
Title of Invention	SWITCHABLE GLAZING WITH IMPROVED LOW TEMPERATURE RESPONSE		

Assignee 1				
Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.				
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This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Joseph L. Morales/		Date (YYYY-MM-DD)	2017-12-07
First Name	Joseph	Last Name	Morales	Registration Number
				58835
Additional Signature may be generated within this form by selecting the Add button. Add				

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	1511.23900
		Application Number	
Title of Invention	SWITCHABLE GLAZING WITH IMPROVED LOW TEMPERATURE RESPONSE		

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	31166553
Application Number:	62596104
International Application Number:	
Confirmation Number:	9082
Title of Invention:	SWITCHABLE GLAZING WITH IMPROVED LOW TEMPERATURE RESPONSE
First Named Inventor/Applicant Name:	Mario Arturo Mannheim Astete
Customer Number:	130961
Filer:	Joseph L. Morales
Filer Authorized By:	
Attorney Docket Number:	1511.23900
Receipt Date:	07-DEC-2017
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File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Provisional Cover Sheet (SB16)	14038.PDF	1477192	no	3
			454a7c040b1019b45025fae636d3353c2d199b39		
Warnings:					
Information:					
2	Specification	14040.PDF	279308	no	24
			eaabb5b053afe5c0611797fae194c8119540f02d		
Warnings:					
Information:					
3	Application Data Sheet	14036.PDF	1822972	no	9
			d96614cfe4ecfffaebd766375e4525a6dd5bc767		
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	30103	no	2
			9e4f271304f25c70a03453b8fb5b5a22d04a283e		
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Total Files Size (in bytes):			3609575		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.