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### Molding of plastic glazing of tailgates

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#### Abstract

A method of manufacturing a plastic glazing of a tailgate of a vehicle, the method comprising: injecting a first material into a molding apparatus to form a first component of the plastic glazing, wherein the first component comprises a panel of the plastic glazing; injecting a second material into the molding apparatus to form a second component of the plastic glazing, wherein the second component combines with at least the first component, wherein at least a portion of the first component and the second component comprises a transparent cover of a molded light assembly; and injecting a third material into the molding apparatus to form a third component, wherein the third component combines with at least the first component.

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## **Background/Summary**

RELATED APPLICATION (1) The present application claims priority to and the benefit of U.S. application 62/215,084, "Molding of Plastic Glazing of Tailgates" (filed Sep. 7, 2015), the entirety of which is incorporated herein by reference for any and all purposes.

### **BACKGROUND**

#### **Technical Field**

(1) The present disclosure relates to tailgates and, specifically, to methods of molding plastic glazing of tailgates.

#### **Technical Background**

(2) Vehicles such as sports utility vehicles ("SUVs"), vans, hatchbacks, and the like include a structural component known as a tailgate. The tailgate is provided to open or close an opening formed at a rear portion of a vehicle. The tailgate is typically hinged to the main vehicle body, for example, along its upper end, such that it can swing open and close. Examples of tailgates include a rear door tailgate or a truck lid tailgate.

(3) The tailgate may support one or more other vehicle components, such as a rear glass window and one or more light assemblies (e.g., a supplemental brake light, a puddle light). The tailgate may also be adjacent to body cavities into which rear lamp units are inserted. These parts and other parts may add to the cost and complexity of assembling a vehicle.

(4) Light assemblies in vehicles, in particular, comprise a large number of separate components. For example, a typical vehicle may have several different types of lights, including, for example, parking lights, turn indicator lights, brake lights, and the like. Each of these lights may be made from many parts. These parts add to the cost and complexity of assembling a vehicle. Accordingly, as recognized in U.S. Pat. No. 7,048,423 ("the '423 patent"), it is desirable to have a lighting assembly with fewer parts. The '423 patent discloses an integrated light assembly including a plurality of lamps **210, 216** enclosed in a housing **202**, which may serve as a lens for the lamps, and mounted on a substrate **204**. Because the lamps **210, 216** share a common substrate and lens, the additional cost of having a separate lamp unit is eliminated. This structure disclosed in the '423 patent, however, has many drawbacks. For one, because multiple lamps are mounted together in a single housing without sidewalls or reflectors for directing the angle of their light, the structure does not account for haziness issues. Moreover, if two lights of varying color are mounted in the housing, the structure disclosed in the '423 patent does not have a way of preventing color overlap. These drawbacks may limit the use of such a light assembly in a vehicle under state and federal regulations governing vehicle lighting requirements. Thus, while the '423 patent discloses an integrated part for a vehicle, its application may be limited.

(5) Inhomogeneities such as seams and openings between separate vehicle components may also

add to the cost of assembling, sealing and/or insulating an interior of the vehicle and/or its components. Moreover such seams and openings may cause aerodynamic inefficiencies and disturb the vehicle's overall aesthetical appearance. Additional components may also be required to connect separate vehicle components to one another, which may add to the overall weight of a vehicle.

(6) Moreover, the assembly of a vehicle may be very labor intensive. A dedicated labor force investing a large number of hours may be required to ensure the proper placement of separate vehicle components with respect to others. Having many separate components may also lead to quality assurance concerns and other performance issues. Accordingly, it may be desirable to have a faster and less labor-intensive method of assembling a vehicle.

(7) The present disclosure aims to solve these problems and other problems in the prior art.

## SUMMARY

(8) In accordance with the purpose(s) of the invention, as embodied and broadly described herein, this disclosure, in one aspect, relates to vehicle components, including tailgates, and to methods of molding plastic glazing of tailgates.

(9) As will be apparent from the present disclosure, problems and/or objectives for improvement with respect to a tailgate including plastic glazing, as described herein, may include providing a tailgate that integrates one or more other components of a vehicle, thereby reducing a total number of components of a vehicle and reducing the complexity and cost of assembling a vehicle. Such problems and/or objectives for improvement also may include providing a tailgate that reduces a number of inhomogeneities, seams, and other disruptions, interruptions, and gaps along a surface of a vehicle, thereby increasing an aesthetic appearance of the vehicle and increasing aerodynamic performance. Such problems and/or objectives for improvement further may include providing a tailgate that conceals one or more other features of a vehicle, such as, for example, a light assembly or unit, thereby increasing an aesthetic appearance of the vehicle.

(10) Problems and/or objectives for improvement with respect to a tailgate, as described herein, may also include an efficient method of manufacturing a tailgate including the above improvements. As noted above, the assembly of a vehicle may be very labor intensive, which not only adds to the costs of assembly but may also create quality and performance concerns.

(11) Accordingly, aspects of the present disclosure provide a method of manufacturing a plastic glazing of a tailgate of a vehicle, the method comprising: injecting a first material into a molding apparatus to form a first component of the plastic glazing, wherein the first component comprises a panel of the plastic glazing; injecting a second material into the molding apparatus to form a second component of the plastic glazing, wherein the second component combines with at least the first component, wherein at least a portion of the first component and the second component comprises a translucent cover of a molded light assembly; and injecting a third material into the molding apparatus to form a third component, wherein the third component combines with at least the first component. Such a method of manufacture may reduce labor costs due to its automatic operation and lead to faster production.

(12) Additional aspects of the invention will be set forth in part in the description which follows, and in part will be obvious from the description, or can be learned by practice of the invention. The advantages of the invention will be realized and attained by means of the elements and combinations particularly pointed out in the appended claims. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention, as claimed.

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## Description

## BRIEF DESCRIPTION OF THE DRAWINGS

(1) The foregoing summary, as well as the following detailed description, is better understood when read in conjunction with the appended drawings. There is shown in the drawings example embodiments, and the present invention is not intended to be limited to the specific embodiments and methods disclosed.

(2) FIG. 1 is a schematic view of a front of a first exemplary plastic glazing of a tailgate in accordance with an embodiment of the present disclosure.

(3) FIG. 2 is a deconstructed view of a tailgate assembly including the first exemplary plastic glazing depicted in FIG. 1 and a housing unit in accordance with an embodiment of the present disclosure.

(4) FIG. 3 is a schematic view of a front of a second exemplary plastic glazing of a tailgate in accordance with an embodiment of the present disclosure.

(5) FIG. 4 is a cross-sectional view of the second exemplary plastic glazing depicted in FIG. 3.

(6) FIG. 5 is a schematic view of a front of a third exemplary plastic glazing of a tailgate in accordance with an embodiment of the present disclosure.

(7) FIG. 6 is a cross-sectional view of the third exemplary plastic glazing depicted in FIG. 5.

(8) FIG. 7 is a schematic view of a front of a fourth exemplary plastic glazing of a tailgate in accordance with an embodiment of the present disclosure.

(9) FIG. 8 is a cross-sectional view of a vehicle having the fourth exemplary plastic glazing depicted in FIG. 7.

(10) FIG. 9 is an enlarged view of an upper region of the cross-sectional view of the vehicle having the fourth exemplary plastic glazing depicted in FIG. 7.

## DESCRIPTION

(11) Aspects of the disclosure will now be described in detail with reference to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, unless specified otherwise.

(12) Systems and methods disclosed herein provide a tailgate or lift gate and, in particular, a tailgate having a plastic glazing having a one-piece monolithic construction. The one-piece monolithic structure can be fabricated in one piece using an injection molding process. Vehicles of a hatchback or van configuration typically include an access opening at their rear and a tailgate that selectively opens and closes the access opening. The tailgate may be mounted on the main body of the vehicle using a hinged connection. As such, the tailgate may operate like a hinged flap, which swings open and close along the hinged connection. The tailgate is typically operated manually but may also be operated electronically using a power actuator.

(13) The tailgate may support one or more other vehicle components such as a rear window, a logo or marking, a light assembly or unit, a license plate holder, etc. These components are usually attached to the tailgate using screws or other connectors or an adhesive. In its closed position, the tailgate may also be adjacent to one or more cavities in the body of the vehicle for receiving a rear lamp unit or other light unit.

(14) In order to reduce the number of separate components of a vehicle, systems and methods disclosed herein may provide an integrated tailgate assembly including and/or integrating one or more other vehicle components. For example, systems and methods disclosed herein may provide a tailgate having a plastic glazing including a rear window. The plastic glazing of the tailgate may be constructed of a thermoplastic polymer including a portion that is clear as the rear window. In other systems and methods disclosed herein, additional vehicle components may also be included in the plastic glazing. Such components may include, for example, a colored translucent portion for a rear light unit; an additional translucent portion for a courtesy light, a license plate light, or other light unit; a cavity and fixation unit (e.g., a threaded hole, a hook or clip) for supporting a light unit; a cavity and fixation unit for supporting a license plate; a textured and/or raised region for a logo or

other marking; a spoiler or other aerodynamic feature; an opening that serves as a ventilation opening; and the like.

(15) Systems and methods disclosed herein may also provide a tailgate that reduces a number of inhomogeneities, seams, and other disruptions, interruptions, and gaps along a surface of a vehicle, thereby increasing an aesthetic appearance of the vehicle and increasing aerodynamic performance. Systems and methods disclosed herein further may provide a tailgate that conceals one or more other features of a vehicle, such as, for example, a light unit, thereby increasing an aesthetic appearance of the vehicle.

(16) Systems and methods disclosed herein may also provide a method of manufacturing a tailgate or, specifically, a plastic glazing of a tailgate. Such systems and methods may provide a method of producing a plastic glazing using multi-shot injection molding techniques. For example, in certain aspects of the disclosure, a plastic glazing of a tailgate may be formed via a three-shot injection molding process. In a first shot, a clear thermoplastic polymer may be injected to form a shell or outline of the plastic glazing. In a second shot, a colored thermoplastic polymer may be injected to form one or more colored regions in the plastic glazing. For example, a red thermoplastic polymer may be injected to form a red translucent region to serve as the lens for a rear light of a vehicle.

(17) The multi-shot molding techniques may use a mold cavity that can be altered between different volumes in order to accommodate different shots of the molding process. The mold cavity initially may be positioned to have a first volume for receiving a first material. Once the first material is injected and curing, the mold cavity may be adjusted to have a second volume for receiving a second material. This process may be repeated for receiving additional shots of material. The mold cavity can be adjusted between its first volume and its second volume and later volumes using a number of different techniques. Such techniques include, for example, the use of a moveable slide, transfer molding, the use of a rotating platen, and the like.

(18) A single nozzle or multiple nozzles may be used for injecting material into the mold cavity. For example, a single nozzle may be used for injecting a first material and a second material into the mold cavity. Alternatively, a first nozzle may be used for injecting a first material into the cavity, and a second nozzle may be used for injecting a second material into the cavity.

(19) Referring now to FIG. 1, an exemplary plastic glazing **100** of a tailgate of a vehicle is depicted. The plastic glazing **100** may be a one-piece monolithic structure formed of one or more thermoplastic polymers. Examples of suitable thermoplastic polymers include: polycarbonate, polyester carbonate, poly methyl methacrylate, and the like. According to a preferred aspect of the disclosure, the plastic glazing **100** may be formed of a polycarbonate. The plastic glazing **100** can have an outer surface that is seamless, i.e., lacking any visual openings, junctions, disruptions, interruptions, gaps, or the like.

(20) The plastic glazing **100** has a first colored portion **102** that functions as a portion of a right tail lamp of the vehicle, and a second colored portion **104** that functions as a portion of a left tail lamp of the vehicle. In particular, the colored portions **102**, **104** can function as lenses of the tail lamps of the vehicle. The plastic glazing **100** also has a third portion **106** for an additional light unit such as, for example, an axillary brake light or a courtesy light. The plastic glazing **100** also includes a clear transparent portion **108** that functions as a rear window of the vehicle, and a colored non-transparent portion **110**. The colored non-transparent portion may be strategically placed to hide one or more structures positioned behind the plastic glazing **100**.

(21) Referring now to FIG. 2, a housing unit **200** of a tailgate is depicted. The housing unit **200** may be formed of a fiber-reinforced polymer. According to a preferred aspect of the disclosure, the housing unit **200** may be formed of a long-glass fiber-reinforced polypropylene such as, for example, SABIC® STAMAX™ plastic. As depicted in FIG. 2, the housing unit **200** comprises one or more cavities for receiving a light unit. In particular, the housing unit **200** comprises a first cavity **212** for receiving a first light unit **202**, a second cavity **214** for receiving a second light unit **204**, and a third cavity **216** for receiving a third light unit **206**. The light units **202**, **204**, **206** can be

fixed directly onto the housing unit **200** via access doors and/or using mechanical fasteners (e.g., screw, bolt, and the like). The cavities **212, 214, 216** can prevent light from the light units from bleeding outside of a confined space. As such, additional cavities (not depicted) may be formed next to the cavities **212, 214, 216** for holding additional light units, and the cavities would prevent the light generated by one light unit from bleeding into a space reserved for another light unit.

(22) The light units **202, 204, 206** may be a single type of light unit. For example, the light units **202, 204, 206** can be brake light units. Alternatively, the light units **202, 204, 206** may comprise more than one kind of light unit. For example, the light units **202, 204** can be brake light units, and the light unit **206** can be a courtesy light unit.

(23) The plastic glazing **100** may be secured to the housing unit **200** such that the light units **202, 204, 206** are disposed between the plastic glazing **100** and the housing unit **200**. In particular, the plastic glazing **100** may be secured to the housing unit **200** such that the light units **202, 204, 206** are disposed behind the portions **102, 104, 106** (depicted in FIG. 1). The light unit **202** may be disposed behind the first colored portion **102**, the light unit **204** may be disposed behind the second colored portion **104**, and the light unit **206** may be disposed behind the third portion **106**.

(24) Light emitted from the light units **202, 204, 206** through the portions **102, 104, 106** of the plastic glazing **100** may be emitted as a colored light in accordance with certain international standards governing vehicle lighting such as, for example, ECE Regulation No. 48 and SAE Standard J578. As noted above, the portions **102, 104** can function as the lens for the vehicle's tail lamps. Accordingly, light emitted from the light units **202, 204** through the portions **102, 104** may be red. ECE Regulation No. 48 defines the color "red" as emitted light with chromaticity coordinates (x,y) that lie within the chromaticity areas defined by the following boundaries in the CIE xyY color space:

(25) TABLE-US-00001 R.sub.12 yellow boundary:  $y = 0.335$  R.sub.23 the spectral locus R.sub.34 the purple line R.sub.41 purple boundary:  $y = 0.980 - x$

With the following (x,y) intersection points: R.sub.1: (0.645, 0.335) R.sub.2: (0.665, 0.335) R.sub.3: (0.735, 0.265) R.sub.4: (0.721, 0.259)

Thus, to fulfill this regulation, the light emitted through the portions **102, 104** may have chromaticity coordinates (x,y) that fall within the chromaticity area defined for the color red in ECE Regulation No. 48, as set forth above.

(26) While the portions **102, 104** and the light units **202, 204** are described herein as producing a red light, one of ordinary skill in the art would appreciate that the portions **102, 104** and the light units **202, 204** may also be designed to produce lights having other colors, such as, for example, yellow or amber. These colors are also defined in ECE Regulation No. 48 as well as in other international standards.

(27) The housing unit **200** also includes an opening **208**. When the plastic glazing **100** is secured to the housing unit **200** such that the light units **202, 204, 206** line up with the portions **102, 104, 106**, the opening **208** may line up with the clear transparent portion **108** of the plastic glazing **100**. By lining up with the clear transparent portion **108**, the opening **208** allows an individual's view through the transparent portion **108** (which, as described above, may function as the rear window of the vehicle) to remain unobstructed.

(28) Each of the light units **202, 204, 206** may include one or more light components such as, for example, an incandescent lamp, an electroluminescent lamp, a gas discharge lamp, and the like. Because the light units **202, 204, 206** are secured directly onto the housing unit **200**, a separate housing for each light unit **202, 204, 206** may not be needed. Thus, the housing unit **200**, which serves as the structural carrier for the plastic glazing **100** of the tailgate, integrates a housing function of a light unit. Moreover, because the portions **102, 104, 106** may function as the lens of a light unit—i.e., the portion **102** may function as the lens for the light unit **202**, the portion **104** may function as the lens for the light unit **204**, and the portion **106** may function as the lens for the light unit **206**—a separate lens for each light units **202, 204, 206** also may not be needed.

(29) The plastic glazing **100** may be secured to the housing unit **200** using an adhesive and/or a mechanical fastening system (e.g., a screw bolt or clip fastening system). The adhesive used may be a commercially available adhesive that is typically used in the automotive industry for the adhesive bonding of plastic components. Such adhesives may include, for example, wet adhesives, contact adhesives, hot-melt adhesives, or reaction adhesives. The thickness of the adhesive required may vary depending on the specific geometries of the plastic glazing **100** and the housing unit **200**. When the adhesive is a hot-melt adhesive that can be processed under thermoplastic conditions, it may be possible to bond the plastic glazing **100**, the housing unit **200**, and the hot-melt adhesive together during a multi-shot injection molding process.

(30) While the tailgate including the plastic glazing **100** and the housing unit **200** is depicted as having three light units **202**, **204**, **206**, one of ordinary skill in the art would appreciate that the tailgate can comprise less or more light units. Such light units may include, for example, license plate lamps, turn signal lamps, backup lamps, and the like.

(31) Referring now to FIG. **3**, an exemplary plastic glazing **300** of a tailgate is depicted. Similar to the plastic glazing **100** depicted in FIG. **1**, the plastic glazing **300** may be a one-piece monolithic structure formed of one or more thermoplastic polymers. The plastic glazing **300** has two colored portions **302**, **304** that function as portions of tail lamps of the vehicle or, specifically, the lens of the tail lamps. The plastic glazing **300** also includes a clear transparent portion **306** that functions as a rear window of the vehicle, and a non-transparent portion **308**. The non-transparent portion **308** may be black or be another color and/or effect. The non-transparent portion **308** can form an outline around the clear transparent portion **306**, thereby outlining the rear window of the vehicle.

(32) FIG. **4** depicts a cross-sectional view of the plastic glazing **300** along the line A-A. As depicted in FIG. **4**, the plastic glazing **300** may comprise multiple thermoplastic polymers. The plastic glazing **300** may comprise a clear transparent component **310**, a dark component **312** for forming dark edges or blackout (e.g., opaque or substantially opaque regions), and a colored component **314**. Each component can be formed by a different thermoplastic polymer such as, for example, different colored polycarbonate resins. The transparent component **310** may be formed of a clear thermoplastic polymer to provide a clear unobstructed view there through. In certain aspects, the transparent component **310** may comprise a certain degree of color but nonetheless retain sufficient transparency to allow a high degree of light transmittance. For example, the transparent component **310** may comprise a tint, such as a grey, green, or brown tint. The dark component **312** may be a black or other colored non-transparent thermoplastic polymer that is configured to control light transmission through the transparent component **310**. In particular, the dark component **312** may be optimally positioned on the plastic glazing **300** to conceal one or more vehicle components disposed behind the plastic glazing **300** such as, for example, a housing unit.

(33) The transparent component **310** can be in a first layer, and the dark component **312** and the colored component **314** can be in a second layer separate from the first. The transparent component **310**, the dark component **312**, and the colored component **314** can have the same thickness or different thicknesses. In an aspect of the disclosure, the transparent component **310** can have a thickness that is greater than that of the dark component **312** and the colored component **314**. The transparent component **310** can have a greater thickness in order to provide structural strength to the plastic glazing **300**. In another aspect of the disclosure, the thickness of the dark component **312** can be increased in order to provide structural support to an outer panel of the plastic glazing **300** along which the dark component **312** is disposed.

(34) The transparent component **310** may define a panel or overall shell of the plastic glazing **300**. The dark component **312** and the colored component **314** may be disposed behind the transparent component **310** towards an interior of a vehicle. By being disposed behind the transparent component **310**, the dark component **312** and the colored component **314** may be protected from weathering effects. Moreover, the dark component **312** and the colored component **314** would not create any inhomogeneities or raised portions on a surface of the vehicle.



(35) A first portion of the clear transparent component **310** that does not overlap the dark component **312** and the colored component **314** in the longitudinal direction (i.e., a direction along the line A-A) may form the transparent portion **306** that functions as the rear window of the vehicle. The colored component **314** and a second portion of the clear transparent component **310** that overlaps the colored component **314** in the longitudinal direction may form the colored portion **304** that functions as a lens of a tail lamp unit. And the dark component **312** and additional portions of the clear transparent component **310** that overlap the dark component **312** in the longitudinal direction may form the non-transparent portion **308**.

(36) The plastic glazing **300** may be manufactured or produced using an injection molding technique. In particular, the plastic glazing **300** may be produced using a three-shot injection molding technique. The three-shot injection molding technique may use a mold cavity that can be altered between different volumes. The mold cavity can be an example of a molding apparatus. The mold cavity can be set to a first volume for receiving a first shot of material. The first shot of material may form the transparent component **310**. Accordingly, the mold cavity can be set to a volume corresponding to that of the transparent component **310**. A first material may be injected into the mold cavity to form the transparent component **310**. The first material may be a clear, transparent thermoplastic polymer such as, for example, a clear polycarbonate. After the first shot has been injected, the mold cavity may be changed from its first volume into a second volume.

(37) The next shot of material may form the colored component **314**. Accordingly, the mold cavity can be set to a volume corresponding to that of the colored component **314**. A second material may be injected into the mold cavity to form the colored component **314**. The second material may be a similar type of material as the first material so that heat released by the second material along the edge of the first material may melt and fuse (i.e., combine) the colored component **314** to the clear transparent component **310**. As such, if the first material is a clear polycarbonate, the second material may be a colored polycarbonate, such as, for example, a red polycarbonate. Such a fusing process may comprise a polymerization where a molecules of the first material and molecules of the second material react together to form polymer chains. After the second shot has been injected, the mold cavity can be changed from its second volume to a third volume. The third and final shot of material may form the dark component **312**. Accordingly, the mold cavity can be set to a volume corresponding to that of the dark component **312**. Such may involve taking into account the portion of the cavity already filled by the first and second shots. A third material may be injected into the mold cavity to form the dark component **312**. The third material also may be a similar type of material as the first and second materials such that heat released by the third material along the end of the first and second materials may melt and fuse the other components to the dark component **312**. After the third shot, the entire molded assembly may be left to cool.

(38) According to certain aspects of the disclosure, the order of the second shot and the third shot may be changed. Thus, instead of injecting the second material to form the colored component **314** in the second shot, the third material for forming the dark component **312** may be injected during the second shot. In such aspects, the mold cavity may be adjusted first to a volume corresponding to the dark component **312** and then to a volume corresponding to the colored component **314**.

(39) The mold cavity may be altered from a first volume to a second volume, and so on and so forth, using a number of different techniques. According to a preferred aspect of the disclosure, the mold cavity may also be altered using a rotating platen. The rotating platen may be attached to a core plate which has one or more cores mirrored across a centerline of the platen coinciding with the axis of rotation. The core plate may cooperate with a cavity plate to form one or more mold cavities. The cavity plate may have a plurality of cavities with differing geometries. During a multi-shot molding process, the rotating platen may be rotated to move the cores such that they are positioned across from the different cavities. The rotating platen may be rotated by a hydraulic motor or cylinder, or a mechanical means, or the like. To prepare for a first shot, the rotating platen may position a core across from a first cavity, and the mold may close to seal the cavity. A first shot

of material may be injected into the first cavity. The mold can then open, and the rotating platen may rotate to position the core across from a second cavity. The mold can close to seal the second cavity, and a second shot of material may be injected into the second cavity. The mold can open again, and the rotating platen may rotate an additional time to position the core across from a third cavity. The mold can close again, and a third shot of material may be injected into the third cavity. This injection mold technique is preferred because it permits parallel injections, where a first core disposed across from a first cavity may receive a first shot of material while a second core disposed across from a second cavity may receive a second shot of material (having already received its first shot of material during an earlier rotation).

(40) While the rotating platen technique is preferred, one of ordinary skill in the art would appreciate that other injection molding techniques may also be used to manufacture the plastic glazing **300**. For example, according to another aspect of the disclosure, the mold cavity may be defined by a series of mold dies. Two mold dies may be selected from a group of mold dies to define a mold cavity having a first volume. Each mold die may form a side of the mold cavity. A first shot of material may be injected into the space between the two mold dies and allowed to briefly cool. One of the mold dies may then be removed and a different mold die may be applied to the side from which that mold die was removed. The different mold die with the remaining mold die may define a second volume. A second shot of material may then be injected and allowed to briefly cool. One of the mold dies may again be removed and a different mold die may be applied to the side from which that mold die was removed. This final mold die with the remaining mold die may define a third and final volume. A third shot of material may then be injected into the space between the two mold dies.

(41) Moreover, while these techniques are described assuming a three-shot process, one of ordinary skill in the art would recognize that more than three shots of material may be used to form a plastic glazing, and that such a technique may be implemented with a mold cavity that can be altered into any desirable number of volumes that are needed to form the component.

(42) Referring now to FIG. 5, an exemplary plastic glazing **400** of a tailgate is depicted. The plastic glazing **400** may be a one-piece monolithic structure formed of one or more thermoplastic polymers. The plastic glazing **400** has two colored portions **402**, **404** that function as portions of tail lamps of the vehicle or, specifically, the lens of the tail lamps. The plastic glazing **400** also includes a clear transparent portion **406** that functions as a rear window of the vehicle, and a non-transparent portion **408**. The non-transparent portion **408** may match an exterior color of the vehicle.

(43) FIG. 6 depicts a cross-sectional view of the plastic glazing **400** along the line B-B. As depicted in FIG. 6, the plastic glazing **400** may comprise a translucent component **410**, a dark component **412** for forming dark edges or blackout, and a colored component **414**. Each component may be formed for a different thermoplastic polymer such as, for example, different colored polycarbonate resins.

(44) The translucent component **410** can comprise a certain degree of color. In certain aspects, the translucent component **410** can comprise a tint, such as a grey, green, or brown tint.

(45) The translucent component **410** and the colored component **414** can be in a first layer, and the dark component **412** can be in a second layer separate from the first. The translucent component **410**, the dark component **412**, and the colored component **414** may have the same thickness or different thicknesses. According to an aspect of the disclosure, the translucent component **410** and the colored component **414** can have the same thickness, while the dark component **412** can have a thickness that is smaller or greater than that of the translucent component **410** and the colored component **414**. The dark component **412** can be disposed behind the translucent component **410** and the colored component **414** towards an interior of a vehicle. Such would minimize any inhomogeneities along an exterior surface of the vehicle.

(46) A first portion of the translucent component **410** that does not overlap the dark component **412**

in the longitudinal direction (i.e., a direction along the line A-A) may form the transparent portion **406** that functions as the rear window of the vehicle. A portion of the colored component **414** that does not overlap the dark component **412** in the longitudinal direction may form the colored portion **404** that functions as a lens of a tail lamp unit. And the dark component **412** and additional portions of the translucent component **410** and the colored component **414** that overlap the dark component **412** in the longitudinal direction may form the non-transparent portion **408**.

(47) Similar to the plastic glazing **300** of FIG. **3**, the plastic glazing **400** depicted in FIG. **5** may be manufactured or produced using an injection molding technique. In particular, the plastic glazing **300** may be produced using a three-shot injection molding method, such as those described above with respect to the plastic glazing **300**. In order to combine or bond the dark component **412** to the translucent component **410** and the colored component **414**, the dark component **412** may be injected after the translucent component **410** and the colored component **414**. Additionally, it is preferred that each of the translucent component **410**, the dark component **412**, and the colored component **414** comprise a similar thermoplastic polymer in order to facilitate bonding of the various components during the injection molding process. In a preferred aspect of the disclosure, all three components may be polycarbonate resins.

(48) Moreover, it is preferred that the translucent component **410** be injected first into the molding apparatus and allowed to cure before injecting the colored component **414** (and the dark component **412**) to prevent color in the later injected components from seeping into the translucent component **410**.

(49) Referring now to FIG. **7**, an exemplary plastic glazing **500** of a tailgate of a vehicle is depicted. The plastic glazing **500** comprises a main body **506**. The main body **506** has a first translucent portion **508** that is transparent that functions as a rear window of the vehicle. The main body **506** also has a second translucent portion **502** and a plurality of fixation mechanisms **504**. The second translucent portion **502** can function as a lens for a light unit—in particular, a license plate light unit. The second translucent portion **502** can be positioned above an area on the plastic glazing **500** for receiving a license plate. Because the plastic glazing **500** does not include any seams or breaks along its different components, the light unit behind the second translucent portion **502** may be concealed from the outside until the light unit is turned on.

(50) The fixation mechanisms **504** can be disposed below the second translucent portion **502**. The fixation mechanisms **504** may be configured to secure a license plate. In an aspect, the fixation mechanisms **504** may be screw holes for receiving screws. This aspect is described in further detail below with respect to FIGS. **8** and **9**. In an alternative aspect, the license plate **602** may be fixed to the plastic glazing **500** using plastic clips. The plastic clips may be designed to snap into a counterpart feature of the plastic glazing **500**. These counterpart features may be injection molded into the tailgate. The plastic clips may be broken off and replaced by new clips in order to attach new license plates.

(51) FIG. **8** depicts a cross-section of the plastic glazing **500** along the line C-C. As depicted in FIG. **8**, a license plate **602** may be attached to the plastic glazing **500** using a plurality of screws **604**. The plurality of screws **604** may attach the license plate **602** to the plastic glazing **500** by being threaded into the plurality of fixation mechanisms **504**.

(52) The main body **506** of the plastic glazing **500** may be formed of a first thermoplastic polymer. The plastic glazing **500** may also have a dark component **606** that is disposed behind the main body **506** towards the interior of the vehicle. The dark component **606** may form a blackout portion of the plastic glazing **500**. The dark component **606** may form an outline of a rear window of the vehicle. The dark component **606** may also provide structural support for a panel of the plastic glazing **500**.

(53) Similar to the plastic glazing **300** of FIG. **3**, the plastic glazing **500** depicted in FIG. **7** may be manufactured or produced using an injection molding technique. In particular, the plastic glazing **500** may be produced using a multi-shot injection molding method, such as those described above

with respect to the plastic glazing **500**. In a first shot, a clear transparent thermoplastic polymer (e.g., a clear polycarbonate resin) may be injected into a first mold to form the main body **506**. As noted above, the main body **506** may have a plurality of fixation mechanisms **504**. Accordingly, the mold for the first shot may be shaped to form the plurality of fixation mechanisms **504**.

(54) In a second shot, an opaque thermoplastic polymer (e.g., a black polycarbonate resin) may be injected to form the dark component **606**. Shots of additional material may also be injected molded to main body **506** and the dark component **606** to achieve various other color schemes or functional purposes.

(55) Referring now to FIG. **9**, an enlarged view of an upper region labeled D of the cross-sectional view of the plastic glazing **500** is depicted. As shown in the enlarged view, the main body **506** of the plastic glazing **500** may further comprise fixation mechanisms as represented by numerals **704**, **706** for fixing a light unit **702** to the vehicle. The light unit **702** may be an interior light unit that projects light through the main body **506**, which may be formed of a clear transparent thermoplastic polymer. The light unit **702** can be secured to the vehicle using any number of known fixation methods. For example, the light unit may be secured to the vehicle by being snapped into place between the two fixation mechanisms **704**, **706**. The light unit may also be secured to the vehicle using screws, bolts, or other fastening members. Thus, while the fixation mechanisms **704**, **706** are depicted in FIG. **9**, one of ordinary skill in the art would appreciate that other fixation mechanisms, including industry-standard snap-fits, hooks, etc., may be used.

(56) Additionally, as depicted in FIG. **9**, the tailgate including the plastic glazing **500** may further include a spoiler portion **708** and a supporting member **710**. The supporting member **710** may be a part of a housing unit (e.g., a STAMAX™ unit) that is disposed behind the plastic glazing **500** for supporting additional light units and the like. The spoiler portion **708** may be formed of an additional thermoplastic polymer and may be attached to the main body **506** using an adhesive or mechanical fastening system.

(57) According to certain aspects of the disclosure, the tailgate assemblies disclosed herein may also include additional layers on top of the thermoplastic polymer layers. For example, a layer for increasing scratch resistance may be added to an exterior surface of the plastic glazing. As another example, an additional layer for adding more support to the thermoplastic polymer layers may also be added to an interior surface of the plastic glazing. This additional layer may be formed of a plastic, a metal, or other material for increasing the structural strength of the tailgate.

(58) It will be appreciated that the present disclosure may include any one and up to all of the following examples.

(59) Example 1: A method of manufacturing a plastic glazing of a tailgate of a vehicle, the method comprising: injecting a first material into a molding apparatus to form a first component of the plastic glazing, wherein the first component comprises a panel of the plastic glazing; injecting a second material into the molding apparatus to form a second component of the plastic glazing, wherein the second component combines with at least the first component, wherein at least a portion of the first component and the second component comprises a translucent cover of a light unit; and injecting a third material into the molding apparatus to form a third component, wherein the third component combines with at least the first component.

(60) Example 2: The method of Example 1, wherein the first material is a thermoplastic polymer.

(61) Example 3: The method of Example 1, wherein the second material is a thermoplastic polymer.

(62) Example 4: The method of Example 1, wherein the third material is a thermoplastic polymer.

(63) Example 5: The method of Example 1, wherein each of the first material, the second material, and the third material is a thermoplastic polymer.

(64) Example 6: The method of any of Examples 2-5, wherein the thermoplastic polymer comprises one or more of: acrylate; acrylonitrile butadiene styrene; acrylonitrile styrene; polybutylene terephthalate; polycarbonate; polyethylene; polyethylene terephthalate;

polyoxymethylene; polypropylene; polyurethane; and poly-vinyl-chloride.

(65) Example 7: The method of any of Examples 1-6, wherein the light unit is a tail lamp.

(66) Example 8: The method of any of Examples 1-6, wherein the light unit is an interior light.

(67) Example 9: The method of any of Examples 1-6, wherein the light unit is a license plate light.

(68) Example 10: The method of any of Examples 1-6, wherein the light unit is a puddle light.

(69) Example 11: The method of any of Examples 1-6, wherein the light unit is a turn signal light.

(70) Example 12: The method of any of Examples 1-11, wherein the translucent cover of the light unit is configured to emit a colored light.

(71) Example 13: The method of Example 12, wherein the colored light emitted by the translucent cover has a CIE chromaticity coordinate lying within a color space defined by the boundaries in the CIE xyY color space:

(72) TABLE-US-00002 R.sub.12 yellow boundary:  $y = 0.335$  R.sub.23 the spectral locus R.sub.34 the purple line R.sub.41 purple boundary:  $y = 0.980 - x$

With the (x,y) intersection points: R.sub.1: (0.645,0.335) R.sub.2: (0.665,0.335) R.sub.3: (0.735,0.265) R.sub.4: (0.721,0.259)

(73) Example 14: The method of Example 12, wherein the colored light emitted by the translucent cover has a CIE chromaticity coordinate lying within a color space defined by the boundaries in the CIE xyY color space:

(74) TABLE-US-00003 A.sub.12 green boundary:  $y = x - 0.120$  A.sub.23 the spectral locus

A.sub.34 red boundary:  $y = 0.390$  A.sub.41 white boundary:  $y = 0.790 - 0.670$

With the (x,y) intersection points: A.sub.1: (0.545,0.425) A.sub.2: (0.560,0.440) A.sub.3: (0.609,0.390) A.sub.4: (0.597,0.390)

(75) Example 15: The method of any of Examples 1-12, wherein the second component comprises a translucent cover of an additional light unit, and wherein the light unit and the additional light unit are different ones of: a tail lamp, a license plate light, an interior light, a turn signal light, and a puddle light.

(76) Example 16: The method of any of Examples 1-12, wherein at least one of the first component, the second component, and the third component comprises a fixation mechanism.

(77) Example 17: The method of any of Examples 1-12, wherein the first component comprises a fixation mechanism.

(78) Example 18: The method of Example 17, wherein the fixation mechanism is configured to secure a light source of the light unit.

(79) Example 19: The method of Example 17, wherein the fixation mechanism is configured to secure a license plate.

(80) Example 20: The method of any of Examples 1-12, wherein the second material is injected into the molding apparatus after the first material is injected into the molding apparatus and before the third material is injected into the molding apparatus.

(81) Example 21: The method of any of Examples 1-12, wherein the third component comprises a blackout, and wherein the blackout is configured to control a transmission of light through the first component.

(82) Example 22: The method of Example 21, wherein the third material injected to form the third component is injected into the molding apparatus after the first material is injected into the molding apparatus and before the second material is injected into the molding apparatus.

(83) Example 23: The method of any of Examples 1-12, wherein the first component further comprises a rear window.

(84) Example 24: The method of Example 23, wherein the blackout forms an outline of the rear window formed by the first component.

(85) Example 25: The method of any of Examples 1-12, wherein the third component is configured to provide structural support to the panel of the plastic glazing.

(86) Example 26: An apparatus for forming a plastic glazing of a tailgate of a vehicle, wherein the

plastic glazing is of one-piece monolithic molded plastic construction, the apparatus comprising: a first cavity for receiving a first material, wherein the first cavity is configured to mold the first material into a first component, wherein the first component comprises a panel of the plastic glazing; a second cavity for receiving a second material, wherein the second cavity is configured to mold the second material into a second component that combines with at least the first component, wherein at least a portion of the first component and the second component comprises a translucent cover of a light unit; and a third cavity for receiving a third material, wherein the third cavity is configured to mold the third material into a third component that combines with at least the first component.

(87) Example 27: The apparatus of Example 26, wherein the first material is a thermoplastic polymer.

(88) Example 28: The apparatus of Example 26, wherein the second material is a thermoplastic polymer.

(89) Example 29: The apparatus of Example 26, wherein the third material is a thermoplastic polymer.

(90) Example 30: The apparatus of Example 26, wherein each of the first material, the second material, and the third material is a thermoplastic polymer.

(91) Example 31: The apparatus of any of Examples 27-30, wherein the thermoplastic polymer comprises one or more of: acrylate; acrylonitrile butadiene styrene; acrylonitrile styrene; polybutylene terephthalate; polycarbonate; polyethylene; polyethylene terephthalate; polyoxymethylene; polypropylene; polyurethane; and poly-vinyl-chloride.

(92) Example 32: The apparatus of any of Examples 26-31, wherein the light unit is a tail lamp.

(93) Example 33: The apparatus of any of Examples 26-31, wherein the light unit is an interior light.

(94) Example 34: The apparatus of any of Examples 26-31, wherein the light unit is a license plate light.

(95) Example 35: The apparatus of any of Examples 26-31, wherein the light unit is a puddle light.

(96) Example 36: The apparatus of any of Examples 26-31, wherein the light unit is a turn signal light.

(97) Example 37: The apparatus of any of Examples 26-36, wherein the translucent cover of the light unit is configured to emit a colored light.

(98) Example 38: The apparatus of Example 37, wherein the colored light emitted by the translucent cover has a CIE chromaticity coordinate lying within a color space defined by the boundaries in the CIE xyY color space:

(99) TABLE-US-00004 R.sub.12 yellow boundary:  $y = 0.335 R_{.23}$  the spectral locus R.sub.34 the purple line R.sub.41 purple boundary:  $y = 0.980 - x$

With the (x,y) intersection points: R.sub.1: (0.645,0.335) R.sub.2: (0.665,0.335) R.sub.3: (0.735,0.265) R.sub.4: (0.721,0.259)

(100) Example 39: The apparatus of Example 37, wherein the colored light emitted by the translucent cover has a CIE chromaticity coordinate lying within a color space defined by the boundaries in the CIE xyY color space:

(101) TABLE-US-00005 A.sub.12 green boundary:  $y = x - 0.120 A_{.23}$  the spectral locus A.sub.34 red boundary:  $y = 0.390 A_{.41}$  white boundary:  $y = 0.790 - 0.670$

With the (x,y) intersection points: A.sub.1: (0.545,0.425) A.sub.2: (0.560,0.440) A.sub.3: (0.609,0.390) A.sub.4: (0.597,0.390)

(102) Example 40: The apparatus of any of Examples 26-37, wherein the second component comprises a translucent cover of an additional light unit, and wherein the light unit and the additional light unit are different ones of: a tail lamp, a license plate light, an interior light, a turn signal light, and a puddle light.

(103) Example 41: The apparatus of any of Examples 26-37, wherein at least one of the first

component, the second component, and the third component comprises a fixation mechanism.

(104) Example 42: The apparatus of any of Examples 26-37, wherein the first component comprises a fixation mechanism.

(105) Example 43: The apparatus of Example 41, wherein the fixation mechanism is configured to secure a light source of the light unit.

(106) Example 44: The apparatus of Example 41, wherein the fixation mechanism is configured to secure a license plate.

(107) Example 45: The apparatus of any of Examples 26-37, wherein the third component comprises a blackout, and wherein the blackout is configured to control a transmission of light through the first component.

(108) Example 46: The apparatus of any of Examples 26-37, wherein the first component further comprises a rear window.

(109) Example 47: The apparatus of Example 46, wherein the blackout forms an outline of the rear window formed by the first component.

(110) Example 48: The apparatus of any of Examples 26-37, wherein the third component is configured to provide structural support to the panel of the plastic glazing.

(111) Example 49: The apparatus of Example 26, wherein a portion of the first cavity is formed on a stationary plate.

(112) Example 50: The apparatus of Example 26, wherein a portion of the second cavity is formed on a stationary plate.

(113) Example 51: The apparatus of Example 26, wherein a portion of the third cavity is formed on a stationary plate.

(114) Example 52: The apparatus of Example 26, wherein portions of the first cavity, the second cavity, and the third cavity are formed together on a single stationary plate.

(115) Example 53: The apparatus of Example 52, wherein a corresponding portion of the first cavity, the second cavity, and the third cavity is formed on a rotating plate.

(116) In general, systems and methods disclosed herein may alternately comprise, consist of, or consist essentially of, any appropriate components herein disclosed. The invention may additionally, or alternatively, be designed so as to be devoid, or substantially free, of any components used in the prior art compositions or that are otherwise not necessary to the achievement of the function and/or objectives of the present invention.

(117) Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context.

(118) Aspects of the present disclosure described in connection with illustrated embodiments have been presented by way of illustration, and the present disclosure is therefore not intended to be limited to the disclosed embodiments. Furthermore, the structure and features of each embodiment described herein can be applied to the other embodiments described herein. Accordingly, those skilled in the art will realize that the present disclosure is intended to encompass all modifications and alternative arrangements included within the spirit and scope of the present disclosure, as set forth by the appended claims.

## Claims

1. A plastic glazing of a tailgate of a vehicle, the plastic glazing comprising: a translucent component molded from a first polycarbonate injected in a first shot, wherein a portion of the translucent component forms a rear window of the vehicle; a colored component molded from a second polycarbonate injected onto the translucent component in a second shot, wherein the

colored component comprises a lens of a light unit; and a non-transparent component molded from a third polycarbonate injected directly onto the translucent component, and the colored component, in a third shot, wherein an overlapping portion of the translucent component and the non-transparent component forms a blackout region proximate to the rear window, wherein the plastic glazing is of one-piece molded plastic construction, and wherein the plastic glazing includes an opening for ventilation.

2. The plastic glazing of claim 1, comprising a spoiler.

3. The plastic tailgate of claim 2, wherein the spoiler is fastened to a component of the plastic glazing.

4. The plastic tailgate of claim 3, wherein the spoiler is mechanically fastened to the component.

5. The plastic tailgate of claim 3, wherein the spoiler is adhered to the component.

6. The plastic glazing of claim 1, wherein the blackout region is configured to conceal an adhesive.

7. The plastic glazing of claim 1, wherein the plastic glazing is configured to attach to a housing unit of the tailgate, wherein the blackout region is configured to conceal an adhesive attaching the housing unit to the plastic glazing.

8. The plastic glazing of claim 1, comprising a protective layer disposed on a surface of the plastic glazing.

9. The plastic glazing of claim 1, wherein each of the translucent component, the colored component, and the non-translucent component are fused together.

10. A plastic glazing of a tailgate of a vehicle, the plastic glazing comprising: a translucent component molded from a first polycarbonate injected in a first shot, wherein a portion of the translucent component forms a rear window of the vehicle; a colored component molded from a second polycarbonate injected onto the translucent component in a second shot, wherein the colored component comprises a lens of a light unit; and a non-transparent component molded from a third polycarbonate injected onto the translucent component, and the colored component, in a third shot, wherein an overlapping portion of the translucent component and the non-transparent component forms a blackout region proximate to the rear window, wherein the plastic glazing is of one-piece molded plastic construction, wherein the plastic glazing includes an opening for ventilation; and wherein each of the non-translucent component and the colored component is disposed behind the translucent component towards an interior of the vehicle.

11. A tailgate system for a vehicle, comprising: plastic glazing, comprising: a translucent component molded from a first polycarbonate injected in a first shot, wherein a portion of the translucent component forms a rear window of the vehicle; a colored component molded from a second polycarbonate injected onto the translucent component in a second shot, wherein the colored component comprises a lens of a light unit; and a non-transparent component molded from a third polycarbonate injected directly onto the translucent component, and the colored component, in a third shot, wherein an overlapping portion of the translucent component and the non-transparent component forms a blackout region proximate to the rear window, wherein the plastic glazing is of one-piece molded plastic construction, and wherein the plastic glazing includes an opening for ventilation, and a housing unit coupled to the plastic glazing.

12. The system of claim 11, wherein the housing unit is formed of a fiber-reinforced polymer.

13. The system of claim 11, comprising a light unit disposed in the housing unit.

14. A plastic glazing of a tailgate of a vehicle, the plastic glazing comprising: a translucent component molded from a first polycarbonate injected in a first shot, wherein a portion of the translucent component forms a rear window of the vehicle; a colored component molded from a second polycarbonate injected onto the translucent component in a second shot, wherein the colored component comprises a lens of a light unit; and a non-transparent component molded from a third polycarbonate injected directly onto the translucent component, and the colored component, in a third shot, wherein an overlapping portion of the translucent component and the non-transparent component forms a blackout region proximate to the rear window, wherein the plastic



glazing is of one-piece molded plastic construction, and wherein the plastic glazing includes a spoiler.

15. The plastic tailgate of claim 14, wherein the spoiler is fastened to another component of the tailgate.

16. The plastic tailgate of claim 15, wherein the spoiler is mechanically fastened to another component of the tailgate.

17. The plastic tailgate of claim 15, wherein the spoiler is adhered to the tailgate.

18. The plastic tailgate of claim 14, wherein the plastic glazing includes an opening for ventilation.

19. The plastic tailgate of claim 14, wherein the plastic glazing is seamless without visual openings.

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