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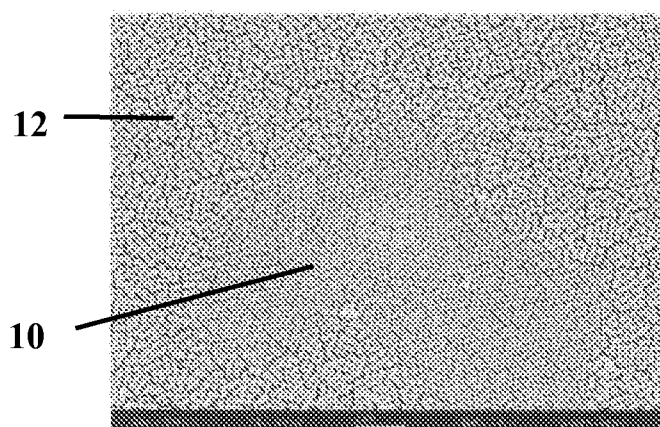


Fig. 1

(57) Abstract: Video display screens for "video off" illumination comprise an imaging display panel, a cover glass sheet for the display panel, and a light source for injecting light into the cover glass sheet, wherein at least a portion of the cover glass sheet is provided with at least one light-scattering bulk or surface element effective to scatter a portion of the light at an angle normal to plane of the cover glass sheet, for front surface illumination, or to scatter a portion of the light into the plane of the sheet, for sheet border or edge illumination.



VIDEO SCREEN COVER GLASS ILLUMINATION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority under 35 U.S.C. § 119 of U.S. Provisional Application Serial No. 61/407,698 filed on October 28, 2010, the content of which is hereby incorporated by reference.

BACKGROUND

Field of the Disclosure

[0002] The present disclosure is in the field of information displays and relates principally to video display screens capable of providing illumination when not in active use.

Technical Background

[0003] Very thin sheet glass is currently being adapted for use in an expanding variety of advanced applications, due to its optical clarity, light weight, and high physical strength potential. One such application is as cover glass sheet for video displays, particularly including large-screen plasma and LCD televisions.

[0004] Large screen televisions can occupy large amounts of wall space, space that is neither attractive nor useful when the televisions are turned off. Recently, some television manufacturers have begun to offer televisions providing accent lighting or minimal room illumination during time periods when the televisions are inactive, that is, when in a so-called "video-off" state. In some cases edge-mounted light-emitting rods or bars are provided on bottom or other edge portions of the television screens.

[0005] These approaches can provide some illumination, but are not aesthetically pleasing and do not conform to the so-called "monolithic" design concept presently favored by purchasers. More attractive or efficient "video-off" lighting solutions for television and other information displays would be of interest to manufacturers and consumers. Similar auxiliary display lighting could provide commercial advantages, for example, for the information

displays utilized in the appliance industry. In either case, display screen lighting systems employing inexpensive yet efficient light sources, and effective designs for maximizing light input from the sources and light output for the users in an aesthetically pleasing design will be required.

SUMMARY

[0006] In accordance with the present disclosure, video display screens are provided with improved display lighting systems for use in the video-off state that offer higher levels of illumination at lower cost and with improved efficiency. The systems provided are light-scattering systems that scatter light propagating within the body of a cover glass sheet outwardly in directions providing wide angle illumination from the front surface of the cover glass and/or diffuse edge lighting from the edges of the cover glass.

[0007] In particular embodiments, anti-glare coatings are applied to at least the edge and/or border regions of the cover glass sheet that can scatter light propagating within the sheet outwardly toward the viewer over a wide range of viewing angles. Current anti-glare systems for these displays, comprising coatings or textured surfaces on the cover glass sheets, produce only a limited scattering of light from presently used light sources. In addition, significant scattering occurs only at high viewing angles, that is, with little light being scattered in directions normal to the plane of the display screens. Embodiments of the presently disclosed displays utilize anti-glare coatings or surfaces comprising scattering sites of dimensions on the order of the wavelengths of the light emitted by the illuminating light sources, so that wide angle scattering over a wide range of light wavelengths is provided.

[0008] Further embodiments of the presently disclosed displays incorporate improved designs for injecting light into the cover glass sheets with high efficiency, to enhance the level of illumination provided by the displays. In some embodiments arrays of large-spot-size light sources of high numerical aperture, such as light-emitting diode (LED) arrays, are disposed to inject light into the rear surfaces of the cover glass sheets. Light-scattering layers or reflective films are then positioned adjacent the arrays on opposing surfaces of the cover glass sheets to scatter and diffuse the injected light over a wide range of angles. Thus the scattered light can be emitted from the edges of the cover glass sheets or guided within the sheets to scattering sites that direct light outwardly from the displays toward the viewer.

[0009] In a first aspect, therefore, the disclosure provides a video display screen comprising an imaging display panel, a cover glass sheet for the display panel, and a light source for injecting light into the cover glass sheet. At least a portion of the cover glass sheet is provided with at least one light-scattering element, typically in the form of a surface layer or coating but alternatively in the form of a light-scattering phase dispersed within the body of the sheet. The light scattering element is positioned to scatter at least some of the source light injected into the sheet in outward directions that may include the edge of the sheet and/or portions of the front surface of the sheet.

[0010] In another aspect the disclosure provides a video display screen comprising an imaging display panel, a cover glass sheet for the display panel, and a light source for injecting light into the cover glass sheet, wherein the imaging display panel has a viewing area and the cover glass sheet has a viewing portion covering the viewing area. In particular embodiments of this display at least the viewing portion of the cover glass sheet is provided with a light-scattering element, such as an anti-glare layer, e.g., a coating or a roughened surface area of the sheet. Included are embodiments wherein the roughened surface area has a roughness effective to scatter light over a range of angles that includes angles normal to outer surface of cover glass sheet.

[0011] In yet another aspect the disclosure provides a video display screen comprising an imaging display panel, a cover glass sheet for the display panel, and a light source for injecting light into the cover glass sheet, wherein at least a portion of the cover glass sheet proximate to the light source is provided with opposing light-scattering bulk or surface elements on opposite surfaces thereof. In particular embodiments of the display the opposing light-scattering surface elements comprise light-scattering ink layers disposed on at least a portion of the border of the cover glass sheet proximate to the light source

[0012] In further aspect the present disclosure provides a video display screen comprising an imaging display panel, a cover glass sheet for the display panel, a light source for injecting light into the cover glass sheet, and at least one light-scattering element on at least a portion of the cover glass sheet, wherein the light-scattering element is a multilayer surface element positioned to scatter light from the light source into the cover glass sheet. In particular

embodiments the light source is an array of high-numerical-aperture LED devices and the multilayer surface element comprises multiple ink layers disposed on a supporting film for scattering light from the devices into the cover glass sheet.

[0013] Cover glass sheets comprising optical cavities capable of efficiently propagating guided light into the planes of the sheets for controlled emittance from sheet edges or major planar surfaces are also disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The presently disclosed video displays are further described below with reference to the appended drawings, wherein:

[0015] Fig. 1 is a micrograph of a glass sheet section coated with light-scattering particles;

[0016] Fig. 2 is a photograph of a section of a cover glass sheet comprising a border region supporting a coating of light-scattering particles;

[0017] Fig. 3a is a photograph presenting a high-angle view of light scattering from a cover glass sheet incorporating a conventional antiglare surface layer;

[0018] Fig. 3b is a low-angle view of light scattering from the glass sheet of Fig. 3a;

[0019] Fig. 3c is a low-angle view of light scattering from a modified cover glass sheet provided in accordance with the present disclosure;

[0020] Fig. 4a and 4b are a schematic illustration of a first illuminating video display screen;

[0021] Fig. 5a, 5b and 5c are a schematic illustration of a second illuminating video display screen;

[0022] Fig. 6 is a photograph of an anti-reflection film with printed ink layers for use in video display screen; and.

[0023] Fig. 7 is a photograph of one view of a cover glass sheet incorporating an optical cavity generating light for edge emittance to provide video screen border illumination.

DETAILED DESCRIPTION

[0024] Current approaches to display lighting in the video-off state include those wherein a light guide or diode light source is attached to edge locations on the display panel or cover

glass, providing edge lighting only. Opaque border strips are typically positioned to block the light source(s) from direct view, with illumination then being limited to light scattered at high viewing angles from the sources and emitted only from edge or border regions of the displays.

[0025] Video displays provided in accordance with the present disclosure include cover glass sheets providing enhanced light-scattering characteristics, substantially increasing illumination levels without requiring light sources of increased power. Light-scattering layers or coatings, such as modified anti-glare or anti-reflection coatings, are selectively applied at least to edge or border portions of the cover glass sheet to increase the scattering of light from the light sources propagating within the cover glass sheet.

[0026] In particular embodiments, a light-scattering coating comprising a mono-layer or several layers of light-scattering particles is applied to surface portions of the cover glass sheet. Application may be by dip-coating or spraying a liquid dispersion of the light-scattering particles onto the sheet surface. If desired the thus-coated sheet may be heat-treated to bond the particles to the sheet surface, as by fusing or sinking the particle layers into the glass surfaces. The sheet may thereafter be further processed as necessary for fabricating the completed video display without damage to the light-scattering coating, including subjecting the sheet to thermal or chemical tempering for improved sheet strength.

[0027] Cover glass sheet provided with light-scattering coatings as above described offers a number of important advantages for video-off illumination. The use of scattering particles with particles sizes in or near the range of visible light wavelengths, e.g., in the 400-1000 nm range, provides light scattering that angularly independent. Thus scattering is no longer limited to high viewing angles but can occur over a wide range of angles, including scattering directions normal and near-normal to the plane of the video display, greatly increasing the amount of light available for practical illumination.

[0028] In addition, for particle sizes of at least 100 nm light scattering can be substantially wavelength-independent. Thus the spectral characteristics of the scattered light are subject to better control, with broad-band or narrow-band scattering being available depending on the spectral characteristics of the light source and the scattering characteristics of the selected

particles. Finally the anti-glare or light-scattering characteristics of the sheet may be varied over different regions of the sheet to permit patterning of the illumination source.

[0029] Fig. 1 of the drawings is an electron photomicrograph of a section of a glass sheet provided with a coating of light-scattering particles disposed on a surface thereof. A coated region 10 comprising multiple layers of particles of 300 nm mean particle size is shown within a wider area 12 covered by a monolayer of the particles.

[0030] Fig. 2 of the drawings is a photograph of a cover glass sheet 20 for a video display wherein a border region of the sheet 22 is covered with a coating of light-scattering particles. The coating is applied by dipping the borders of the sheet into an alcohol suspension of 300 nm particles following by heat treatment to submerge the particles into the sheet surface to a depth of about 100 nm. The coated borders are illuminated by an array of LEDs. A substantial level of light scattering in directions normal to the plane of the sheet is evident from the photograph.

[0031] The light-scattering sheets of Figs. 1 and 2 are illustrative of embodiments of the disclosed video displays wherein the light-scattering surface element is an antiglare coating, wherein the antiglare coating comprises a layer of light-scattering particles, and wherein the light-scattering particles are distributed in a mono-layer deposited, for example, from a liquid dispersion of particles. Embodiments of the latter wherein the layer of light-scattering particles is bonded to the surface of the cover glass, for example by a step of heating the glass to fuse the particle layer thereto are also exemplified.

[0032] Also included are displays incorporating coated cover glass sheets wherein the light scattering particles have a mean particle diameter in the range of 100-1000 nm. As shown above, such particle diameters enable light scattering over a wide range of wavelengths, as well as a wide range of scattering angles that includes angles normal to the front surface or plane of the video display screen. Video-off illumination of such displays may be by any compact light source, including displays wherein the light source is a light-guiding rod or fiber optic element, of an array of LEDs.

[0033] Commercial video displays offering anti-glare features can provide satisfactory glare suppression utilizing cover glass sheets having a slight roughening of the outer (viewer-facing)

surfaces of the sheets. However, anti-glare surfaces of conventional type provide very limited light scattering even though the light wave-guiding efficiency of the opposing major surfaces of the sheets traps a substantial fraction of light injected into sheet edges within the plane of the sheet. Thus the scattering provided by such surfaces is generally observable only at high angles from viewing axes normal to the plane of the sheet.

[0034] Figs. 3a and 3b of the drawings are photographs comparing scattered light intensity from a cover glass sheet edge-illuminated by an LED array. The cover glass sheet illuminated in those figures incorporates a conventional anti-glare surfacing layer, the sheet being viewed at a high angle from the normal to the plane of the sheet in Fig. 3a, and being viewed at an angle approximately normal to the plane of the sheet in Fig. 3b. The limited high-angle nature of light scattering from these conventional anti-glare surfaces is apparent from these photographs, the high-angle scattering of Fig. 3a being substantial and the normal axis scattering from Fig. 3b being extremely weak.

[0035] Embodiments of video displays incorporating cover glass sheets provided in accordance with the present description provide highly efficient guided-light extraction and thus substantially better full-screen illumination than is provided by conventional cover glasses. Fig. 3c of the drawings is a photograph of a similarly edge-illuminated cover glass sheet taken along an axis normal to the plane of the sheet surface. The high level of light scattering from the sheet along that axis is readily apparent from the photograph. Advantageously, the high scattering efficiency achieved in the cover glass sheet of Fig. 3c does not significantly compromise the quality of video images displayed on an imaging display panel positioned behind the cover glass, when the edge illumination of the cover sheet is turned off.

[0036] The clear difference in scattering behavior and thus illumination efficiency as between Figs. 3a-b and Fig. 3c of the drawings results from a change in the nature of the surface roughness present in the anti-glare surfaces of the two cover sheets. The conventional anti-glare cover glass sheet characterized in Figs. 3a and 3b incorporates a roughened anti-glare surface layer with a surface roughness correlation length on the order of 40 microns. In contrast, the modified anti-glare surface layer of the cover glass sheet shown in Fig. 3c has a roughness providing a correlation length of about 500 nm. The advantageous effects of

shorter roughness correlation lengths, i.e., correlation lengths in the light wavelength range of about 100-1000nm, are several. In addition to providing angularly independent light scattering, the scattering efficiency of the surface is improved and thus the potential brightness of video-off illumination is increased. Also improving potential brightness is the fact that the modified anti-glare layers can easily be extended to cover the entire surface area of the video display.

[0037] A video display screen design taking advantage of high efficiency cover glass light scattering is schematically illustrated in Fig. 4 of the drawings. Fig. 4 includes a front view (a) and a side view (b) of a video display screen 30 comprising an imaging display panel 32, a cover glass sheet 34 for the display panel, and a light source 36 for injecting light into the cover glass sheet. Cover glass sheet 34 incorporates a modified anti-glare surface layer (not shown) on the front or viewing surface of the sheet (the outwardly facing surface opposite the display panel). For efficient low-angle and normal axis scattering the modified anti-glare layer has a surface roughness correlation length in the range of visible light wavelengths.

[0038] The anti-glare layer on cover glass sheet 34 covers the entire viewing area 38 of the video display, i.e., that area falling within a surrounding opaque black border 39 disposed on the cover sheet. Border 39 operates to shield light source 36, consisting for example of an LED array, from direct view, with the combination of the rear-mounted LED array and the shielding border imparting a "monolithic" appearance to the assembled video display screen.

[0039] In the embodiment shown in Fig. 4, an adhesive layer 33 is provided to bond cover glass sheet 34 to imaging display panel 32. That layer may be composed of an adhesive having a refractive index below that of display panel 32 to avoid a loss of light propagating within the cover sheet to the adhesive layer or the display panel. Also shown is an optional anti-reflection layer 38 spaced from the outer surface of cover glass sheet 34 to improve the imaging quality of the display. In an alternative construction the adhesive can be replaced by an air gap, e.g., of at least 2 μm width, also to minimize the loss of guided LED light propagating within the cover sheet.

[0040] Embodiments of video display screens such as illustrated by the above examples thus include screens wherein the imaging display panel has a viewing area, the cover glass sheet has

a viewing portion covering the viewing area, and the viewing portion of the cover glass sheet is provided with a light-scattering element in the form of a surface layer. Particularly included are embodiments wherein the light-scattering element comprises a roughened surface area on the cover glass sheet, and wherein the roughened surface area has a roughness effective to scatter light over a range of angles that includes angles normal to cover glass sheet. For that purpose the roughened surface area has a surface roughness correlation length below 1000 nm.

[0041] Also included are display screens wherein a layer of bonding material is provided between the imaging display panel and the cover glass sheet, and wherein the bonding material has a refractive index less than the refractive index of the cover glass sheet. Alternative displays are those wherein an air gap is provided between the cover glass sheet and the imaging display panel.

[0042] In accordance with the foregoing descriptions and examples, a variety of light sources and various methods of mounting the light sources can be used to inject video-off illuminating light into cover glass sheets for video display screens. The use of off-the-shelf LEDs or other low cost light sources having large numerical apertures and/or large spot sizes is advantageous for cost reasons as well for reasons of energy efficiency. And the approach of mounting the sources on the rear surfaces of the border regions of the cover glass sheets, rather than on the edges of the sheets, supports presently preferred "monolithic" display design options.

[0043] The use of rear-mounted light sources for video-off illumination, whether of high numerical aperture or otherwise, requires that improved light input efficiencies be provided. In accordance with the present description improved scattering methods are used to provide the necessary improved efficiencies. As hereinafter more fully disclosed such methods can provide nearly 100% light input efficiency, can enable wavelength or color control for the output or illuminating light via selective absorption and/or wavelength conversion, and can largely avoid light source alignment difficulties.

[0044] An illustrative design for a video display screen comprising a cover glass sheet useful in combination with an imaging display panel to provide a display offering strong video-off illumination is schematically illustrated in Fig. 5 of the drawings. Included in Fig. 5 are a front

view (a), side view (b), and back view (c) of a display 40 comprising an illuminating cover glass sheet 41 attached to an imaging display panel 42. The cover glass sheet of Fig. 5 is adapted to emit illuminating light from sheet bottom edge 41a when a light source consisting of LED array 43 is activated.

[0045] Disposed across the front surface of cover glass sheet 41 is an anti-reflection film 44 in contact with a printed opaque black ink bordering frame 45 outlining an image viewing area 46 through the cover glass. The width of the bottom segment of black ink border 45 is made sufficient to mask LED array 43 attached to the bottom rear surface of cover glass sheet 41 from direct view when the video display screen is viewed as in front view (a).

[0046] To provide a level of light input efficiency sufficient to secure adequate illuminating light output from bottom edge 41a of cover glass sheet 41, light from LED array 43 is caused to scatter multiple times between two opposing white or "broad-band" diffusely reflective surface layers positioned proximate to the mounting location for LED array 43 on the lower rear surface of cover glass sheet 41. These opposing diffusely reflective surface layers form an optical cavity at the base of sheet 41. The desired reflective surface regions may be formed, for example, by white opaque ink border strips 48a and 48(b) disposed on opposing bottom surface sections of glass sheet 41 as shown in Fig. 5. Alternatively, the desired scattering can be effected by similarly positioned opposing roughened surface sections on sheet 41, or by volumetric scattering from a particulate scattering phase distributed within the same bottom portions of sheet 41, neither being shown.

[0047] Light scattered by repeated reflection from white border strips 48a and 48b will diffuse angularly and in position until a point where the light is no longer confined between the strips is reached. Statistical field modeling can derive a statistical distribution of the angular modes of escaping light that will depend in part upon the balance between volumetric and surface scattering from the ink border strips and in part on the number of light reflections before the light exits the confines of the strips.

[0048] Light that is guided within the plane of the cover glass sheet in the video display screen of Fig. 5 will be emitted from the bottom edge 41a of the sheet. If it is desired that only a portion of the guided or unguided light escaping the confines of the reflective strips be

emitted, then the reflective ink strips or other light scattering element(s) can be tapered toward the emission area, such tapering being effective either to limit the amount of escaping light or to cause it to be emitted preferentially at selected angles.

[0049] Control over the color of the emitted light can be exercised, for example, by using colored inks to replace the white reflective inks 48a and 48b in the drawing. Selected wavelengths of light that undergo multiple reflections from such inks can be selectively absorbed, altering the color of the remaining light. Alternative color control methods involve the use of nonlinear optical materials, e.g., crystalline or quantum dot additions to the glass or to reflective strips applied to the glass. Quantum dot methods enable patterning of the emitted light since dots of different sizes can effect the scattering of light of different wavelengths.

[0050] Particular embodiments of the disclosed video display screens incorporating elements of the above-described examples include those wherein at least a portion of the cover glass sheet is provided at locations proximate to the light source for the display screen with opposing light-scattering bulk or surface elements attached to the sheet on opposite surfaces thereof. Included are embodiments wherein the opposing surface elements comprise light-scattering ink layers disposed on at least a portion of a border of the cover glass sheet, wherein the opposing light-scattering ink layers comprise a suspended particulate phase providing volumetric light scattering, or comprise roughened surfaces providing surface light scattering, and wherein the light-scattering ink layers provide broad-band (white) reflectivity. The light source for such displays will advantageously comprise an array of LED devices positioned to inject light into the rear surface of the cover glass sheet.

[0051] For color-controlled video-off illumination the opposing light-scattering ink layers will exhibit wavelength-selective light absorption or reflectivity, or the cover glass will incorporate non-linear optical scattering centers within the surfaces of the glass or the ink layers. The non-linear optical scattering centers are advantageously selected from the group consisting of light-scattering crystallites and quantum dots, with included embodiments comprising displays wherein the non-linear optical scattering centers are disposed in a pattern.

[0052] The video display screen embodiments exemplified in Fig. 5 of the drawings provide bottom edge video-off illumination that is commercially attractive and that can be particularly

efficient where light sources comprising arrays of high-numerical-aperture LED devices can be utilized. However such display screen designs can be expensive to fabricate since the light-scattering systems for efficiently injecting light into the cover glass sheets comprise multilayer surface elements that must be appropriately positioned to effect repeated reflections of the input light between opposing surfaces of the sheets. Multiple and separate ink applications have been employed to arrange the necessary layers.

[0053] In further accordance with the present disclosure, embodiments of the disclosed display screens wherein the multilayer surface elements are present in the form of multiple ink layers disposed on a supporting film are provided. The supporting film suitably comprises an anti-reflection film layer such as film layer 44 in Fig. 5 of the drawings. Prior to combining with the cover glass sheet, the supporting film is provided with multiple ink layers, for example by screen printing, to control light scattering and source masking in the video display screen.

[0054] In a particular example the rear surface of the film is provided with a black or other light-absorbing ink layer, such as bordering black ink layer 45 in Fig. 5 of the drawings, that layer being configured both to block light from the LED array from direct view from an angle normal to the display and to serve as a surrounding frame for the viewing area of the display. Thereafter a white opaque ink layer exhibiting diffuse scattering of white light in the manner of ink layer 48a of Fig. 5 may be applied to the supporting film over the black ink layer.

Subsequent attachment of the thus-coated supporting film to the front surface of a cover glass sheet for a video display screen properly positions both the light absorbing and light scattering ink layers to insure the efficient scattering of light from the LED array into the plane of the cover glass sheet. Fig. 6 of the drawings comprises a photograph presenting an edge-wise view of a supporting anti-reflective film 54 provided with an absorbing black ink layer 55 and a covering white reflective light-scattering strip 58a in accordance with this particular embodiment. The view shown includes a portion of the uncoated side of the film.

[0055] While the use of directly applied ink layers or printed films provides an effective and economical approach toward efficient light injection into a cover glass sheet comprising an optical cavity, an all-glass approach for constructing an optical cavity of similar efficiency would offer advantages in terms of mechanical and thermal durability. Therefore, in

accordance with further embodiments of the disclosed video display screens, diffusely scattering layers of a glass frit are applied and bonded to opposing surfaces of the cover glass sheet.

[0056] In a specific embodiment of a cover glass sheet for such a screen, the glass frit layers are applied to opposing sheet surfaces in place of the opposing light-scattering ink layers or inked films used for scattered light guidance as shown, for example, in Fig. 5 of the drawings. For the frit embodiment, opposing bonded white glass frit layers are disposed at locations 48a and 48b on a cover glass sheet such as sheet 41 of Fig. 5. Like the ink layers, the white frit layers provide diffuse broad-band scattering, forming an optical cavity into which light from a source such as the LED array can be injected and multiply reflected. Light that is angled for guidance between opposing major surfaces of the cover glass sheet is thus produced and propagated within the plane of the sheet to locations such as sheet edges where it can be emitted for illumination. In some embodiments, an opaque black or other light-absorbing ink or frit layer, positioned as for bordering black ink layer 45 in Fig. 5, is superimposed on the frit layer arrangement, both to hide the LED array from direct view and to provide a border for a video display incorporating the cover glass sheet.

[0057] Examples of glass frit compositions suitable for use with commercial cover glass sheets such as, for example, Corning Code 2318 alkali aluminosilicate glass sheet are reported in Table 1 below. The glass frit compositions are reported in mole percent on the oxide basis as calculated from the batches for the source glasses. Also reported in Table 1 where determined on individual samples are glass transition temperatures (T_g), glass softening temperatures (T_s), average thermal expansion coefficients and fusion temperature (T_f) for bonding frit layers of the glasses to glass cover sheets.

[0058]

Table 1 – Glass Frit Compositions

Oxides (mole%)	1	2	3	4	5	6
SiO ₂	62.1	48.4	48.4	43.38	43.4	43.4
B ₂ O ₃	12.1	33.3	33.3	38.29	35.3	38.3
Na ₂ O	8.2	0.0	12.0	9.0	9.0	8.0
K ₂ O	1.1	10.3	1.3	4.33	4.3	2.3
ZnO	0.0	5.0	5.0	5.0	5.0	5.0
Li ₂ O	2.7	3.0	0.0	0.0	3.0	3.0
Al ₂ O ₃	5.8	0.0	0.0	0.0	0.0	0.0
CaO	4.6	0.0	0.0	0.0	0.0	0.0
ZrO ₂	0.7	0.0	0.0	0.0	0.0	0.0
MgO	2.8	0.0	0.0	0.0	0.0	0.0
Physical properties						
CTE	73.8	75.5				
T _g	538°	486°	500°	486°		
T _s	684°	602°				
T _f	700°	600°	700°			

[0059] The compositions reported in Table 1 are only illustrative of a wide range of frit compositions that can be usefully employed to control light scattering from cover glass sheets. In addition, many of these compositions can be modified to alter their light scattering behavior. For example, conventional opacifying additives such as titania, zirconia and/or tin oxide can be incorporated into the glass or a frit preparation to increase the opalescence of the frit layers. Alternatively or in addition, light-absorbing agents or phosphors can be incorporated into the glass or frit to alter the color of the source light as it propagates through the optical cavity formed by the frits.

[0060] Fig. 7 of the drawings includes a photograph of a cover glass sheet incorporating an optical cavity formed by applied frit layers as above described, as viewed from the sheet surface that would face a viewer in a video display screen incorporating the cover glass sheet. As shown in Fig. 7, cover glass sheet 61 is provided along a bottom border portion with a white light-scattering bonded front frit layer 68a that is positioned opposite a white light-scattering rear bonded frit layer (not shown) to form an optical cavity along the cover sheet bottom border. Also attached to the rear surface of the sheet (not shown) is a light source

consisting of an illuminated LED array, that array being hidden from direct view from the front of the cover glass sheet by an opaque black strip 65 applied over light-scattering frit layer 68a.

[0061] A majority of the guided light propagating from the optical cavity formed by the bonded frit layers is emitted from bottom edge 61a of cover glass sheet 61. In addition, however, some of the guided light can be emitted from side and top edges of sheet 61, for example as shown at location 61b.

[0062] The cover glass sheet of Fig. 7 is illustrative of cover glass sheet embodiments of the present disclosure that comprise an optical cavity along at least one border section of the sheet, including embodiments wherein the border section of the sheet is provided with opposed light-scattering surface elements on opposite sheet surfaces of the border section. The light-scattering surface elements in these embodiments can include, for example, a diffusely scattering ink layer disposed on a sheet surface, or a diffusely scattering frit layer bonded to a sheet surface. Also, as indicated in Fig. 7, an opaque masking layer can be disposed on at least one of the light-scattering surface elements when it is desired to mask the source from direct view by users of a video display screen incorporating a cover glass sheet as described.

[0063] While the video display screens and components provided according to the present disclosure have been described above with reference to particular examples of materials, arrangements, designs and procedures, it will be recognized that those examples have been provided for purposes of illustration only, and that various modifications thereof may be employed to meet the demands of similar or related applications within the scope of the appended claims.

What is claimed is:

1. A video display screen comprising an imaging display panel, a cover glass sheet for the display panel, and a light source for injecting light into the cover glass sheet, wherein at least a portion of the cover glass sheet is provided with at least one light-scattering bulk or surface element effective to scatter a portion of the light at an angle normal to plane of the cover glass sheet.
2. A video display screen in accordance with claim 1 wherein the light-scattering surface element is an anti-glare coating.
3. A video display screen in accordance with claim 1 wherein the antiglare coating comprises a layer of light-scattering particles.
4. A video display screen in accordance with claim 1 wherein the light-scattering particles are distributed in a mono-layer, and are deposited on the cover glass sheet from a liquid dispersion of particles.
5. A video display screen in accordance with claim 1 wherein the layer of light-scattering particles is fused to the surface of the cover glass sheet.
6. A video display screen in accordance with claim 1 wherein the cover glass sheet is thermally or chemically tempered
7. A video display screen in accordance with claim 1 wherein the light source is a light-guiding rod or fiber optic element.
8. A video display screen in accordance with claim 1 wherein the light source is an array of LEDs.

9. A video display screen in accordance with claim 1 wherein the light-scattering particles have a mean particle size in the range of 100-1000 nm.
10. A video display screen in accordance with claim 1 wherein the light-scattering particles scatter light over a range of angles that includes angles normal to the front surface of the video display screen.
11. A video display screen in accordance with claim 1 wherein a portion of the cover glass sheet comprises an opaque layer positioned to mask the light source from direct view from an angle normal to the surface of the video display screen.
12. A video display screen comprising an imaging display panel, a cover glass sheet for the display panel, and a light source for injecting light into the cover glass sheet, at least a portion of the cover glass sheet being provided with at least one light-scattering bulk or surface element, wherein the imaging display panel has a viewing area, the cover glass sheet has a viewing portion covering the viewing area, and wherein at least the viewing portion of the cover glass sheet is provided with the light-scattering element.
13. A video display screen in accordance with claim 12 wherein the light-scattering element comprises a roughened surface area on the cover glass sheet, the roughened surface area has a roughness effective to scatter light over a range of angles that includes angles normal to cover glass sheet.
14. A video display screen in accordance with claim 13 wherein the roughened surface area has a surface roughness correlation length below 1000 nm.
15. A video display screen in accordance with claim 12 wherein a layer of bonding material is provided between the imaging display panel and the cover glass sheet, and wherein the bonding material has a refractive index less than the refractive index of the cover glass sheet.

16. A video display screen in accordance with claim 12 wherein an air gap is provided between the cover glass sheet and the imaging display panel.
17. A video display screen comprising an imaging display panel, a cover glass sheet for the display panel, and a light source for injecting light into the cover glass sheet, wherein at least a portion of the cover glass sheet is provided with opposing light-scattering bulk or surface elements on opposite surfaces thereof
18. A video display screen in accordance with claim 17 wherein the opposing surface elements comprise light-scattering ink layers disposed on at least a portion of the border of the cover glass sheet
19. A video display screen in accordance with claim 18 wherein the light-scattering ink layers provide broad-band reflectivity.
20. A video display screen in accordance with claim 17 wherein the light source comprises an array of LED devices positioned to inject light into the rear surface of the cover glass sheet
21. A video display screen in accordance with claim 17 wherein a portion of the cover glass sheet comprises an opaque layer positioned to mask the light source from direct view from an angle normal to the surface of the video display screen.
22. A video display screen in accordance with claim 18 wherein the opposing light-scattering ink layers comprise a suspended particulate phase providing volumetric light scattering.
23. A video display screen in accordance with claim 18 wherein the opposing light-scattering ink layers comprise roughened surfaces providing surface light scattering

24. A video display screen in accordance with claim 18 wherein the opposing light-scattering ink layers exhibit wavelength-selective light absorption or reflectivity
25. A video display screen in accordance with claim 17 wherein the cover glass sheet incorporates non-linear optical scattering centers within the surfaces of the glass or light-scattering ink layers disposed thereon.
26. A video display screen in accordance with claim 25 wherein the non-linear optical scattering centers are selected from the group consisting of light-scattering crystallites and quantum dots.
27. A video display screen in accordance with claim 25 wherein the non-linear optical scattering centers are disposed in a pattern.
28. A video display screen comprising an imaging display panel, a cover glass sheet for the display panel, and a light source for injecting light into the cover glass sheet, at least a portion of the cover glass sheet being provided with at least one light-scattering bulk or surface element, wherein the light-scattering element is a multilayer surface element positioned to scatter light from the light source into the cover glass sheet.
29. A video display screen in accordance with claim 28 wherein the light source is an array of high-numerical-aperture LED devices
30. A video display screen in accordance with claim 28 wherein the multilayer surface element comprises multiple ink layers disposed on a supporting film.
31. A video display screen in accordance with claim 28 wherein the supporting film is an anti-reflection film.

32. A video display screen in accordance with claim 28 wherein the supporting film with multiple ink layers is attached to the cover glass sheet
33. A video display screen in accordance with claim 28 wherein the multiple ink layers comprise a white ink layer exhibiting diffuse light scattering.
34. A video display screen in accordance with claim 28 wherein the multiple ink layers comprise a light absorbing ink layer.
35. A video display screen in accordance with claim 28 wherein the multiple ink layers are positioned to scatter at least a portion of the light from an edge of the cover glass sheet
36. A cover glass sheet for a video display screen comprising an optical cavity along at least one border section of the sheet.
37. A cover glass sheet in accordance with claim 36 wherein the border section of the sheet is provided with opposed light-scattering surface elements on opposite sheet surfaces of the border section.
38. A cover glass sheet in accordance with claim 37 wherein the light-scattering surface elements are white light-scattering layers providing diffuse broad-band light scattering.
39. A cover glass sheet in accordance with claim 37 wherein the light-scattering surface elements include a diffusely scattering ink layer disposed on the sheet surface.
40. A cover glass sheet in accordance with claim 37 wherein the light-scattering surface elements include a diffusely scattering frit layer bonded to a sheet surface.

41. A cover glass sheet in accordance with claim 37 wherein an opaque masking layer is disposed on at least one light-scattering surface element.

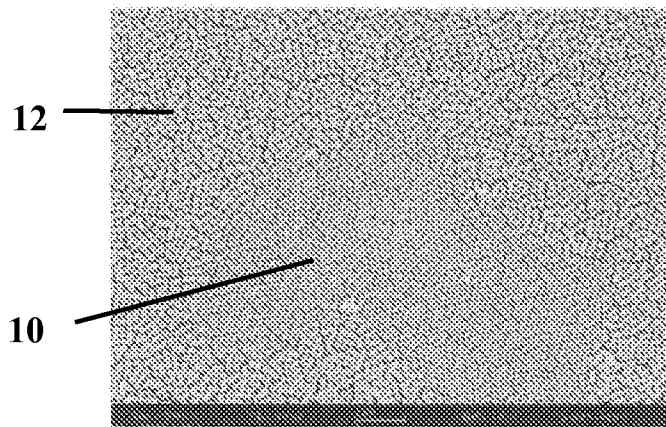


Fig. 1

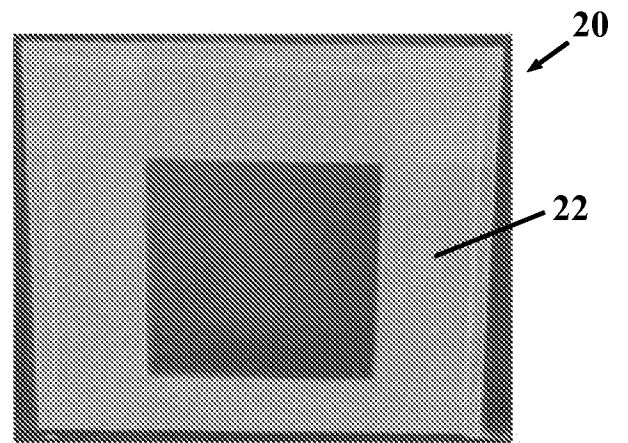


Fig. 2

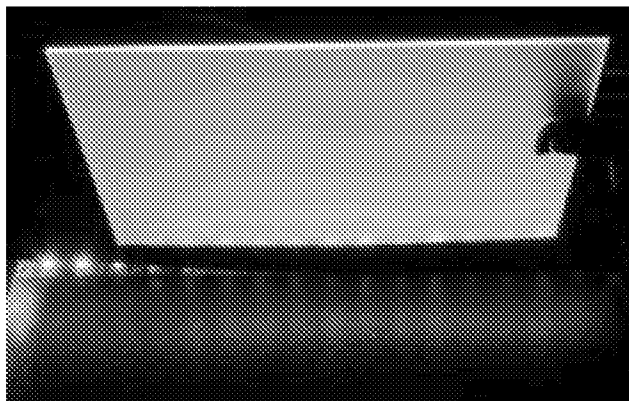


Fig. 3a

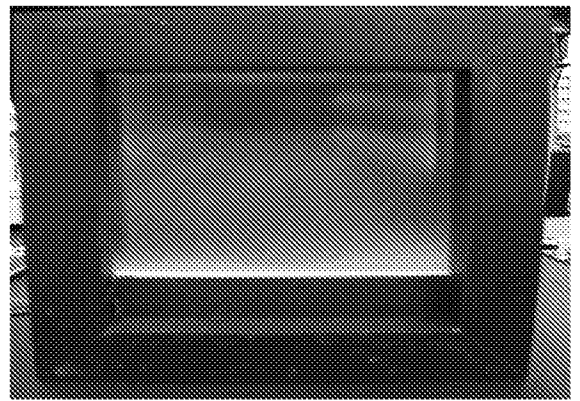


Fig. 3b

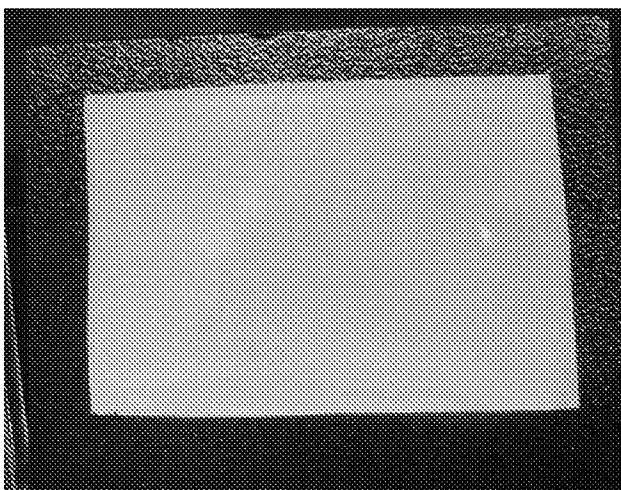


Fig. 3c

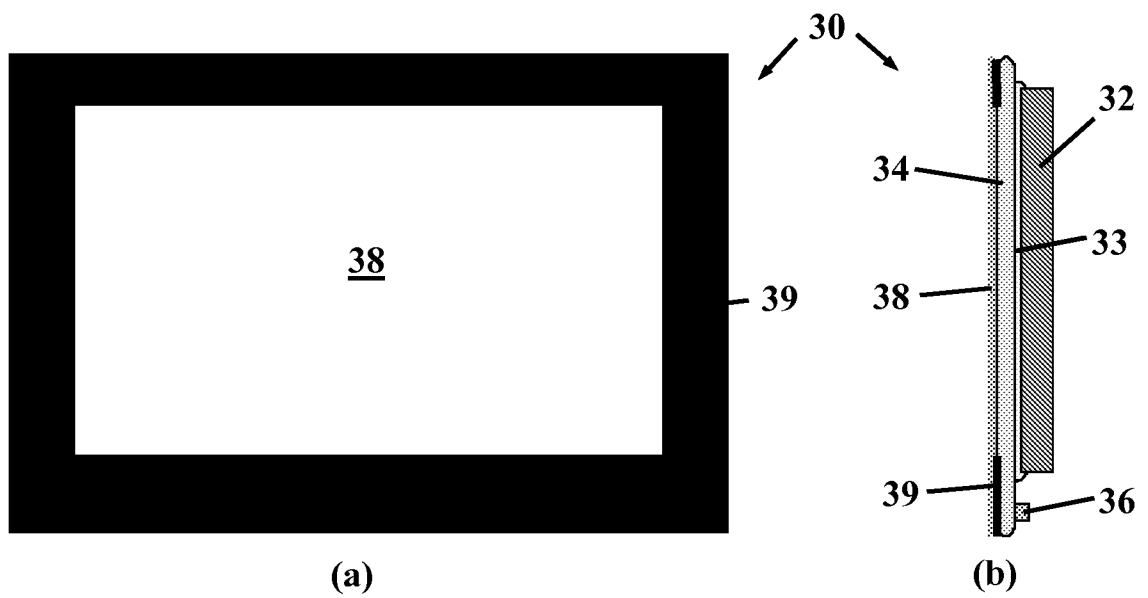


Fig. 4

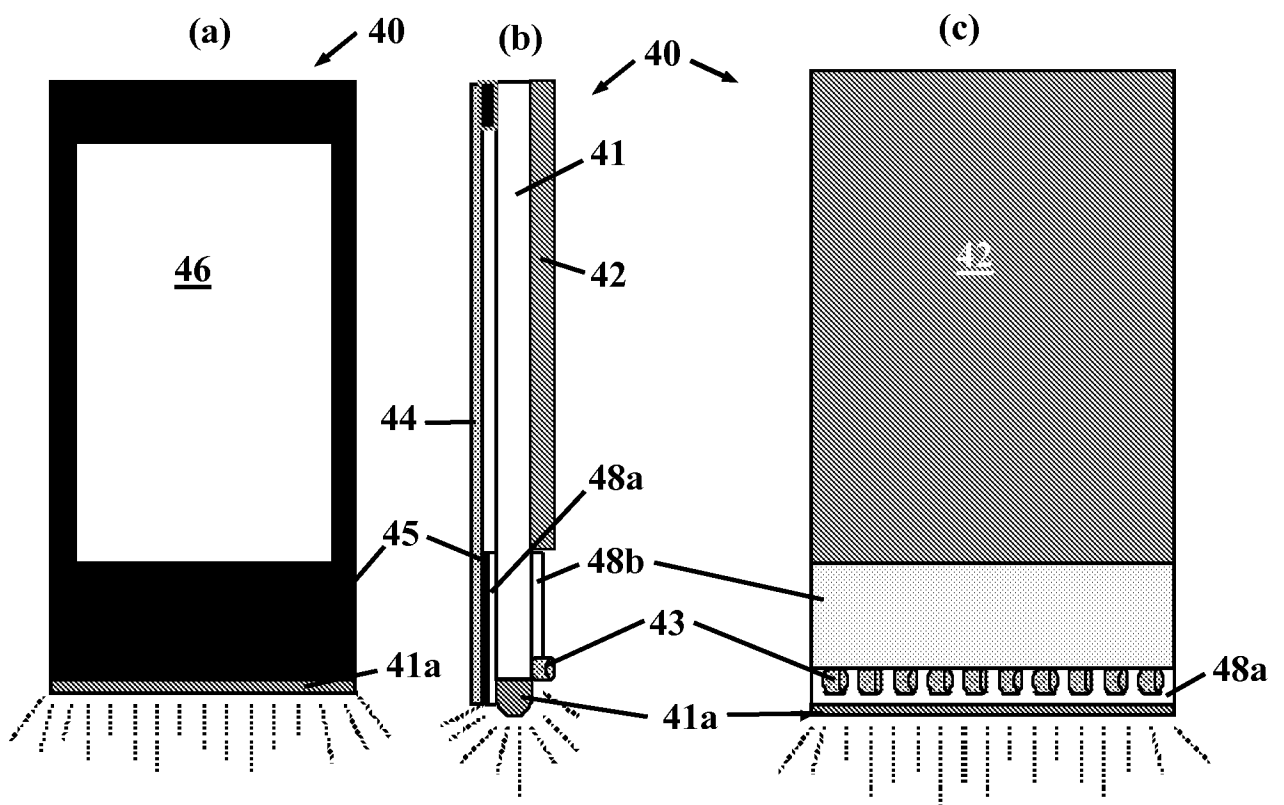


Fig. 5

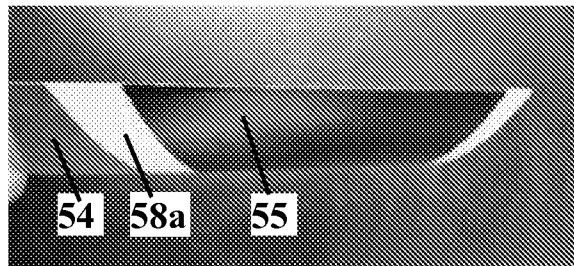


Fig. 6

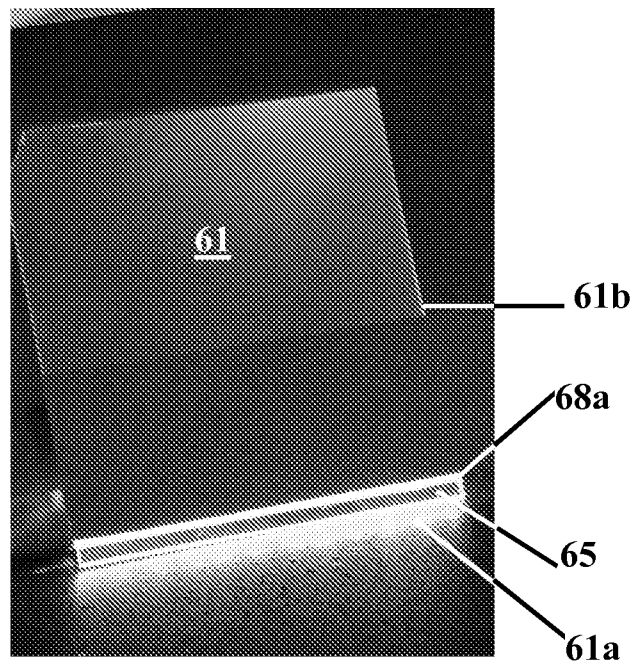


Fig. 7