



(51) International Patent Classification:

G02C 7/10 (2006.01) G02B 5/23 (2006.01)

G02B 5/22 (2006.01) G02B 5/28 (2006.01)

(21) International Application Number:

PCT/US2022/082166

(22) International Filing Date:

21 December 2022 (21.12.2022)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

63/292,876 22 December 2021 (22.12.2021) US

(71) Applicant: OAKLEY, INC. [US/US]; One Icon, Foothill Ranch, California 92610 (US).

(72) Inventor: BOYLES, Colin; c/o Oakley, Inc., One Icon, Foothill Ranch, California 92610 (US).

(74) Agent: HOLOUBEK, Michelle K. et al.; Sterne, Kessler, Goldstein & Fox P.L.L.C., 1100 New York Avenue, NW, Washington, District of Columbia 20005 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,

(54) Title: EYEWEAR WITH CHROMA ENHANCEMENT

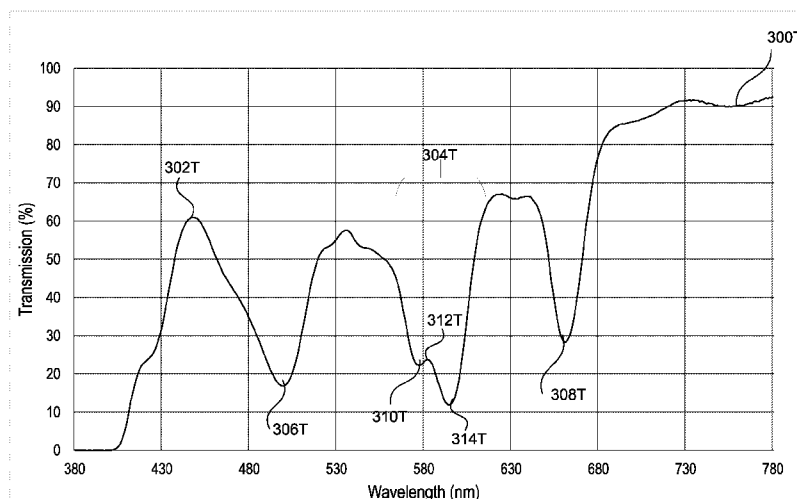


FIG. 3A

(57) Abstract: Embodiments comprise a lens for an eyewear. The lens includes an optical filter. A transmittance spectral profile of the optical filter includes a saddleback transmission valley having a local maximum transmittance, a first minimum transmittance, and a second minimum transmittance. The local maximum transmittance of the transmittance valley is positioned at a first wavelength from about 570 nm to about 600 nm. A difference in transmittance between the first minimum transmittance and the local maximum transmittance is less than 5%.

LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI,
SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN,
GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

EYEWEAR WITH CHROMA ENHANCEMENT

BACKGROUND

[0001] Eyewear can include optical elements that attenuate light in one or more wavelength bands. For example, sunglasses typically include a lens that absorbs a significant portion of light in the visible spectrum. A sunglass lens can have a dark coating that strongly absorbs visible light, thereby significantly decreasing the luminous transmittance of the lens. Sunglass lenses, however, are not suitable for all purposes, such as, for example, for indoor use, driving, or select sporting activities.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] Aspects of this disclosure are best understood from the following detailed description when read with the accompanying figures. It is noted that, in accordance with the common practice in the industry, various features are not drawn to scale. In fact, the dimensions of the various features may be arbitrarily increased or reduced for clarity of discussion.

[0003] Fig. 1 illustrates a perspective view of an eyewear configured to provide chroma enhancement, according to some embodiments.

[0004] Figs. 2A-2C illustrate cross-sectional views of an optical filter configured to provide chroma enhancement for an eyewear, according to some embodiments.

[0005] Figs. 3A -17B show optical characteristics of various optical filters of a lens, each optical filter configured to provide chroma enhancement, according to some embodiments.

[0006] Illustrative embodiments will now be described with reference to the accompanying drawings. In the drawings, like reference numerals generally indicate identical, functionally similar, and/or structurally similar elements.

DETAILED DESCRIPTION

[0007] The following disclosure provides many different embodiments, or examples, for implementing different features of the provided subject matter. Specific examples of

components and arrangements are described below to simplify the present disclosure. These are, of course, merely examples and are not intended to be limiting. For example, the formation of a first feature over a second feature in the description that follows may include embodiments in which the first and second features are formed in direct contact, and may also include embodiments in which additional features may be formed between the first and second features, such that the first and second features may not be in direct contact. As used herein, the formation of a first feature on a second feature means the first feature is formed in direct contact with the second feature. In addition, the present disclosure may repeat reference numerals and/or letters in the various examples. This repetition does not in itself dictate a relationship between the various embodiments and/or configurations discussed.

[0008] Spatially relative terms, such as “beneath,” “underlying,” “underneath,” “below,” “lower,” “above,” “over,” “upper,” “lower,” and the like may be used herein for ease of description to describe one element or feature’s relationship to another element(s) or feature(s) as illustrated in the figures. The spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein may likewise be interpreted accordingly.

[0009] It is noted that references in the specification to “one embodiment,” “an embodiment,” “an example embodiment,” “exemplary,” etc., indicate that the embodiment described may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases do not necessarily refer to the same embodiment. Further, when a particular feature, structure or characteristic is described in connection with an embodiment, it would be within the knowledge of one skilled in the art to effect such feature, structure or characteristic in connection with other embodiments whether or not explicitly described.

[0010] It is to be understood that the phraseology or terminology herein is for the purpose of description and not of limitation, such that the terminology or phraseology of the present specification is to be interpreted by those skilled in relevant art(s) in light of the teachings herein.

- [0011] In some embodiments, the terms “about” and “substantially” can indicate a value of a given quantity that varies within 5 % of the value (e.g., $\pm 1\%$, $\pm 2\%$, $\pm 3\%$, $\pm 4\%$, or $\pm 5\%$ of the value).
- [0012] As used herein, the term “between a first value and a second value,” as used for example in “a wavelength range is between 440 nm and 520 nm,” means that the wavelength range is from 440 nm to 520 nm, where end points of 440 nm and 520 nm are both included in the wavelength range.
- [0013] As used herein, the term “visible spectral range” refers to a wavelength range from about 380 nm to about 780 nm.
- [0014] As used herein, the term “across a spectral range” refers to all wavelengths (e.g., with an increment of 1 nm) within the spectral range, including the endpoints of the spectral range.
- [0015] As used herein, the terms “over a spectral range” and “in a spectral range” refer to at least one wavelength within the spectral range.
- [0016] As used herein, the term “optical transmittance” refers to the fraction of incident electromagnetic power transmitted through an object.
- [0017] As used herein, the term “visible light transmittance (VLT)” refers to a luminous transmittance profile, such as using Commission Internationale de l’Eclairage (CIE) standard illuminant D65, ISO 12331, or ANSI Z80.3.
- [0018] As used herein, the term “chroma enhancement filter” refers to a chroma enhancement material, a chroma enhancement dye, a chroma enhancement doping, a chroma enhancement coating, a chroma enhancement film, a chroma enhancement layer, a chroma enhancement wafer, or a chroma enhancement lens body that can provide chroma enhancement to increase the vividness of the perceived colors.
- [0019] As used herein, the term “horizontal” refers to a direction along (i.e., in the plane) or substantially parallel to a surface of an eyewear’s lens.
- [0020] As used herein, the term “vertical” refers to a direction substantially perpendicular to the horizontal direction (i.e., perpendicular to the plane defined by an eyewear’s lens’s surface).
- [0021] As used herein, the term “disposed,” as used for example in “a first layer is disposed over a second layer,” means that the first layer is either directly placed against

the second layer's surface, or that the first layer is indirectly placed over the second layer's surface with at least a third layer in between.

[0022] As used herein, the term “coupled,” as used for example in “a first layer is coupled to a second layer” means that the first layer is disposed over the second layer (as “disposed” is defined above), or that the first layer is integrated into the second layer.

[0023] Objects that humans can visually observe in the environment typically emit, reflect, or transmit visible light from one or more surfaces. The surfaces can be considered an array of points that the human eye is unable to resolve any more finely. Each point on a surface typically does not emit, reflect, or transmit a single wavelength of light; rather, it emits, reflects, or transmits a broad spectrum of wavelengths that are interpreted as a single color in human vision. Generally speaking, if one were to observe the corresponding “single wavelength” of light for that interpreted color (for example, a visual stimulus having a very narrow spectral bandwidth, such as 1 nm), it would appear extremely vivid when compared to a color interpreted from a broad spectrum of observed wavelengths.

[0024] A lens for an eyewear can incorporate an optical filter to remove outer bands of a broad visual stimulus to make colors appear more vivid as perceived in human vision. Such eyewear can be configured to substantially increase the colorfulness, clarity, and/or vividness of a scene. Nevertheless, it may be challenging to balance a chroma enhancement (CE) ratio with passing driving standards due to the low optical transmission of the lens at certain wavelengths.

[0025] In some embodiments, the eyewear can include a lens that has a saddleback absorption profile in one or more spectral ranges. The lens may absorb light in a broader range in the one or more spectral ranges while having a minimum desired transmission at each wavelength in the spectral range. The saddleback absorption profile can be achieved using a combination of one or more dyes (e.g., one or more organic dyes). If only a single absorption dye at a given wavelength in the spectral range were to be used, the lens may absorb too much light at that singular wavelength and fail driving tests. Alternatively, if the lens includes a broadband dye for the spectral range, then the chroma enhancement benefits are minimized. Embodiments of the present disclosure effectively provide an eyewear having chroma enhancement while maintaining a desired transmission, thus suitable for use when driving. For example, embodiments of the present disclosure allow

eyewear to provide chroma enhancement while also meeting ANSI Z80.3-2018, ISO 12312:2013, and AS/NZS 1067:2003-A2009 standards.

[0026] In some embodiments, the eyewear can include a lens that blocks one or more wavelengths in the blue spectrum while transmitting other wavelengths in the blue spectrum. For example, the lens may transmit blue wavelengths (e.g., about 445 nm to about 495 nm) that are beneficial during daylight hours (e.g., control daytime circadian cycle) while blocking undesired blue wavelengths (i.e., toxic blue, about 410 nm to 430 nm).

[0027] In some embodiments, the eyewear can include a lens that has chroma enhancement in one or more spectral windows. For example, the lens may have a saddleback absorption profile in one or more spectral ranges and a single absorption profile in one or more spectral ranges. In some embodiments, the lens can have an overall color appearance of grey/neutral.

[0028] The lens includes an optical filter having chroma enhancement. In some embodiments, the lens includes a lens body and a chroma enhancement filter. In some embodiments, the chroma enhancement filter can be bodily incorporated into the lens body. The chroma enhancement filter may be incorporated with other filters. In some embodiments, the lens can include an anti-reflection layer disposed over the lens body's rear surface. In some embodiments, the anti-reflection layer can be a coating or a film configured to reduce an optical reflectivity from the lens body's rear surface.

[0029] Embodiments of the present disclosure are directed to a lens for an eyewear that provides chroma enhancement in one or more wavelength bands, and a method of forming the same.

[0030] Fig. 1 illustrates a perspective view of an eyewear **100** configured to provide chroma enhancement, according to some embodiments. Eyewear **100** can include a lens **102A**, a lens **102B**, a mounting frame **112** configured to support the lenses **102A** and **102B**, and ear stems **106A** and **106B** attached to mounting frame **112**. Eyewear **100** can be of any type, including general-purpose eyewear, special-purpose eyewear, sunglasses, driving glasses, sporting glasses, goggles, indoor eyewear, outdoor eyewear, eyewear incorporated into headgear (such as visors for helmets), vision-correcting eyewear, contrast-enhancing eyewear, chroma-enhancing eyewear, color-enhancing eyewear, color-altering eyewear, gaming eyewear, eyewear designed for another purpose, or

eyewear designed for a combination of purposes. In some embodiments, lenses and frames of many other shapes and configurations may be used for eyewear **100**. For example, eyewear **100** can have a single lens, such as in a goggle or visor. It should be noted that eyewear **100** shown in Fig. 1 is not drawn to scale but is drawn to more easily illustrate certain aspects of eyewear **100**.

[0031] Lenses **102A** and **102B** have an optical filter that provides chroma enhancement while transmitting a desired amount of light to pass driving tests. In some embodiments, the optical filter provides chroma enhancement in a range from about 570 nm to about 600 nm. Lenses **102A** and **102B** can be non-corrective or corrective for vision. In some embodiments, lenses **102A** and **102B** can be configured to provide vision correction for a wearer of eyewear **100**, and can have optical power. Such lenses can be configured to correct for near-sighted or far-sighted vision or astigmatism. In other embodiments, lenses **102A** and **102B** are non-corrective or plano lenses that lack such optical power for vision correction.

[0032] Lenses **102A** and **102B** can include an optical filter **104**. Each lens **102A** and **102B** has a front surface **108** and a rear surface **110**. In some embodiments, front surface **108** and/or rear surface **110** can be a hydrophobic surface. Optical filter **104** can be configured to provide any desired lens chromaticity, a chroma-enhancing effect, a photochromic effect, an electrochromic effect, an optical polarizing effect, or any combination thereof. In some embodiments, lenses **102A** and **102B** can be configured to provide a substantially neutral visible light spectral profile as seen through lenses **102A** and **102B**. For example, an overall color appearance of lenses **102A** and **102B** can be substantially color neutral and substantially transparent. In some embodiments, an overall color appearance of lenses **102A** and **102B** can be substantially gray. In some embodiments, the overall color appearance of lenses **102A** and **102B** has a yellowness index YI E313 less than about 20, less than about 15, less than about 10, less than about 5, less than about 1, or from about 40 to about 45.

[0033] Lenses **102A** and **102B** can be made of any of a variety of optical materials including glasses or plastics such as acrylics or polycarbonates. The lenses can have various shapes. For example, each of lenses **102A** and **102B** can be flat, have one axis of curvature, two axes of curvature, or more than two axes of curvature. Each of lenses **102A** and **102B** can be cylindrical, parabolic, spherical, toroidal, flat, or elliptical, or any

other shape such as a meniscus or catenoid. In some embodiments, each of lenses **102A** and **102B** can have a blank diameter ranging from about 75 mm to about 90 mm. When worn, lenses **102A** and **102B** can extend across the wearer's normal straight ahead line of sight, and can extend substantially across the wearer's peripheral zones of vision. As used herein, the wearer's normal line of sight shall refer to a line projecting straight ahead of the wearer's eye, with substantially no angular deviation in either the vertical or horizontal planes. In some embodiments, lenses **102A** and **102B** can extend across a portion of the wearer's normal straight ahead line of sight. Providing curvature in the lenses **102A** and **102B** can result in various advantageous optical qualities for the wearer, including reducing the prismatic shift of light rays passing through the lenses **102A** and **102B**, and providing an optical correction, such as correcting an optical distortion or modifying an optical focal power. Regardless of the particular vertical or horizontal curvature of front surface **108** and rear surface **110** of each of lens **102A** and **102B**, however, other types of front surface **108** and rear surface **110** of each of lens **102A** and **102B** may be chosen such as to minimize one or more of power, prism, and astigmatism of lens **102A** and **102B** in the mounted and as-worn orientation. In some embodiments, each of lenses **102A** and **102B** can be a plano lens configured to provide the optical correction. In some embodiments, lenses **102A** and **102B** can be a lens blank or semi-finished so that lenses **102A** and **102B** can be capable of being machined, at some time following manufacture, to provide the optical correction for the wearer. In some embodiments, lenses **102A** and **102B** can have optical power and can be prescription lenses configured to correct for near-sighted or far-sighted vision. In some embodiments, lenses **102A** and **102B** can have cylindrical characteristics to correct for astigmatism. In some embodiments, lenses **102A** and **102B** can be canted and mounted in a position rotated laterally relative to centrally oriented dual lens mountings.

[0034] Each of lenses **102A** and **102B** can have a thickness t_1 between front surface **108** and rear surface **110**. In some embodiments, thickness t_1 can be varied along front surface **108** and/or rear surface **110**. For example, thickness t_1 can be varied along a horizontal direction between ear stems **106A** and **106B**. Thickness t_1 can also be varied along a vertical direction perpendicular to the horizontal direction and along front surface **108**/rear surface **110**. In some embodiments, thickness t_1 can be a tapering thickness along

a horizontal axis and can be decentered for the optical correction. In some embodiments, thickness t_1 can be configured to provide the optical correction for lenses **102A** and **102B**.

[0035] Mounting frame **112** can include orbitals that partially or completely surround the lenses **102A** and **102B**. Mounting frame **112** can be made of a variety of suitable materials including, for example and without limitation, metal, acetate, nylon, etc. Mounting frame **112** can be of varying configurations and designs, and the illustrated embodiment shown in Fig. 1 is provided for exemplary purposes only. As illustrated, mounting frame **112** can include a top frame portion and a pair of ear stems **106A** and **106B** connected to opposing ends of the top frame portion. Ear stems **106A** and **106B** can be configured to support the eyewear **100** when worn by a user. In some embodiments, eyewear **100** can include a flexible band (not shown in Fig. 1) used to secure eyewear **100** in front of the wearer's eyes in place of ear stems **106A** and **106B**. Further, lenses **102A** and **102B** may be mounted to the frame **112** with an upper edge of lens **102A** and/or **102B** extending along or within a lens groove and being secured to mounting frame **104**. For example, the upper edge of lens **102A** and/or or **102B** can be formed in a pattern, such as a jagged or non-linear edge, and apertures or other shapes around which mounting frame **104** can be injection molded or fastened to secure lens **102A** and/or **102B**. Further, lenses **102A** and **102B** can be attachable to mounting frame **104** by means of a slot with inter-fitting projections or other attachment structure formed in lenses **102A** and **102B** and/or mounting frame **104**. It is also contemplated that lenses **102A** and **102B** can be secured along a lower edge of mounting frame **112**. Various other configurations can also be utilized. Such configurations can include direct attachments of ear stems **106A** and **106B** or a strap to lenses **102A** and **102B** without any frame, or other configurations that can reduce the overall weight, size, or profile of the eyeglasses. In some embodiments, mounting frame **112** can be configured to retain a unitary lens placed in front of both of the wearer's eyes. In some embodiments, the lens may be a standalone unitary lens that directly attach to ear stems **106A** and **106B** or to a strap.

[0036] Fig. 2A shows a cross-sectional view of a lens **200**, according to some embodiments. Lens **200** can be an embodiment of lenses **102A** and **102B** shown in Fig. 1. The discussion of lenses **102A** and **102B** applies to lens **200**, unless mentioned otherwise. Further, the discussion of elements with the same annotations in Figs. 1 and 2A applies to each other, unless mentioned otherwise. Section line A-A' is shown in both Fig. 1 and

Fig. 2A to illustrate the relative orientation of lens **200** between the two figures. As shown in Fig. 2A, lens **200** can have front surface **108** and rear surface **110**, can include a lens body **208** having a front surface **212** and a rear surface **210**. In some embodiments, front surface **212** and rear surface **210** can respectively represent lens **200**'s front surface and rear surface.

[0037] Lens body **208** can include optical filter **104**. For example, optical filter **104** can be integrated with lens body **208**. Optical filter **104** can be configured to filter undesired wavelengths. In some embodiments, optical filter **104** can minimize optical transmittance in a range from about 410 nm to about 430 nm. In some embodiments, optical filter **104** can provide CE in a range from about 550 nm to about 630 nm.

[0038] Lens body **208** can be formed of polycarbonate (PC), allyl diglycol carbonate monomer (being sold under the brand name CR-39®), a resin layer (e.g., MR-8®), glass, nylon, polyurethane, polyethylene, polyamide (PA), polyethylene terephthalate (PET), biaxially-oriented polyethylene terephthalate polyester film (BoPET, with one such polyester film sold under the brand name MYLAR®), acrylic (polymethyl methacrylate or PMMA), triacetate cellulose (TAC), a polymeric material, a co-polymer, a doped material, any other suitable material, or any combination of materials. In some embodiments, lens body **208** can be an injection molded, polymeric lens body.

[0039] Lens body **208** can have a concave surface and a convex surface. Lens body **208** can have a desired base curve and thickness (e.g., thickness t_1 shown in Fig. 1) to provide the optical correction. For example, each of lens body **208**'s front surface **212** and rear surface **210** can have a spheric, toric, cylindrical, or freeform geometry with proper thickness distribution (e.g., tapering thickness along front surface **212** and/or rear surface **210**). Front surface **212** and/or rear surface **210** can have spheric, toric, or cylindrical geometries with a non-zero base curve in a horizontal and/or vertical direction. In some embodiments, front surface **212** and/or rear surface **210** can have spheric, toric, or cylindrical geometries with a base curve of about base 4 and greater, about base 6 and greater, or about base 8 and greater.

[0040] In some embodiments, lens body **208** can further integrate with one or more chroma enhancement filters configured to increase a scene's vividness viewed through eyewear **100** while maintaining a minimal desired transmittance to pass driving tests. For example, the chroma enhancement filters can be dispersed throughout lens body **208**. In

some embodiments, the chroma enhancement filter can be at least partially incorporated into lens body **208**. In some embodiments, lens body **208** can be impregnated with, loaded with, or otherwise include the chroma enhancement filters. The vividness of interpreted colors can be correlated with an attribute known as a chroma value of a color. The chroma value can be one of the attributes or coordinates of the CIE L*C*h* color space. Together with attributes known as hue and lightness, the chroma value can be used to define colors perceivable in human vision. It has been determined that visual acuity can be positively correlated with the chroma values of colors in an image. In other words, the visual acuity of an observer can be greater when viewing a scene with high chroma value colors than when viewing the same scene with lower chroma value colors. Therefore, lens body **208** can be configured to enhance the chroma profile of a scene viewed through lens **200**. In some embodiments, lens body **208** having chroma enhancement properties can be a molded body. In some embodiments, the chroma enhancement filter can be provided as a layer enclosed by or intermixed with lens body **208**. In some embodiments, lens body **208** having chroma enhancement properties can be configured to increase or decrease the chroma value in one or more chroma enhancement windows in the visible spectral range. The chroma enhancement filter(s) integrated with lens body **208** can be further configured to preferentially transmit or attenuate light in the one or more chroma enhancement windows to provide enhanced chroma values. For example, an environment can predominantly reflect or emit a color, where the chroma enhancement filter integrated with lens body **208** can be adapted to provide the chroma enhancement by attenuating or enhancing an optical transmittance for one or more wavelengths associated with the predominantly reflected or emitted color.

[0041] In some embodiments, the chroma enhancement filter is integrated with lens body **208**, and can include one or more dyes. In some embodiments, the dyes are organic dyes. In some embodiments, the dyes include one or more of an Exciton ABS 473, ABS 574, or ABS 594 dye.

[0042] In some embodiments, lens **200** can further include one or more functional layers (not shown in Fig. 2A), such as an optical filter configured to provide optical filtering, a polarizer configured to provide polarization, an electro-chromic layer configured to provide electrochromism, a reflection layer configured to provide a partial reflection of incoming visible light, an absorption layer configured to provide a partial or complete

absorption of infrared light, a color enhancement layer, a color alteration layer, an anti-static functional layer, an anti-fog functional layer, a scratch resistance layer, a mechanical durability layer, a hydrophobic functional layer, a reflective functional layer, a darkening functional layer, an aesthetic functional layer including tinting, a glue layer, a mechanical protection layer configured to provide mechanical protection to lenses **102A** and **102B**, to reduce stresses within lens **200**, or to improve bonding or adhesion among the layers in lens **200**, a physical vapor deposition (PVD) layer, or any combination of these. In some embodiments, the chroma enhancement filter can be at least partially incorporated into the one or more functional layers in lens **200**. In some embodiments, the one or more functional layers in lens **200** can be impregnated with, loaded with, or otherwise include the chroma enhancement filters.

[0043] In some embodiments, the lens can include an ultraviolet (UV) absorption layer in the optical filter or a layer that includes UV absorption outside of the optical filter layer. Such a layer can decrease bleaching of the optical filter. In addition, UV absorbing agents can be disposed in any lens component or combination of lens components (e.g., optical filter **104**). In some embodiments, the lens may have an UV transmission cutoff at a wavelength from about 380 nm to about 400 nm. In some embodiments, the transmission below about 400 nm, below about 390 nm, or below about 380 nm is less than about 10%, less than about 5%, or less than about 1%. In some embodiments, the lens has a sharp spectral cutoff at about 390 nm or at about 400 nm.

[0044] In some embodiments, a transmittance spectral profile of the lens **200** comprises a saddleback transmission valley. The saddleback transmission valley has a first minimum transmittance, a local maximum transmittance, and a second minimum transmittance. The local maximum transmittance of the transmittance valley is positioned at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 584 nm, at about 585 nm, or at about 586 nm. A difference in transmittance between the first minimum transmittance and the local maximum transmittance is less than about 15%, less than about 10%, less than about 5%, less than about 4%, or less than about 3%. In some embodiments, a difference in transmittance between the second minimum transmittance and the local maximum transmittance is less than about 15%, less than about 10%, or less than about 5%. In some embodiments, transmittance at each of the first minimum transmittance and the second minimum

transmittance is greater than about 5%, greater than about 5% and less than about 20%, greater than about 5% and less than about 10%. In some embodiments, the local maximum transmittance is from about 5% to about 20%, 5% to about 10%, or about 10% to about 20%.

[0045] In some embodiments, the saddleback transmittance valley is a transmittance valley between a first transmittance peak and a second transmittance peak. The first transmittance peak may be positioned at a wavelength from about 520 nm to about 560 nm, and the second transmittance peak positioned at a wavelength from about 610 nm to about 650 nm. Transmittance of the first transmittance peak is from about 10% to about 40%, about 10% to about 20%, or about 30% to about 40%. Transmittance of the second transmittance peak is from about 20% to about 50%, about 20% to about 30%, about 40% to about 50% .

[0046] In some embodiments, the saddleback transmittance valley can be between a lower edge portion and an upper edge portion. A difference in transmittance between a transmittance at the lower edge portion and the minimum transmittance is less than about 25%. A transmittance at the upper edge portion and the minimum transmittance is less than about 40%.

[0047] Each transmittance valley can have a respective transmittance bandwidth defined as a full width of the each transmittance valley at certain offset from the minimum transmittance of the each transmittance valley, such as the minimum transmittance plus 1%, the minimum transmittance plus 5%, the minimum transmittance plus 10%, the minimum transmittance plus 15%, or the minimum transmittance plus 30%. For example, if the minimum transmittance is 20%, the bandwidth of the minimum transmittance plus 10% would be measured as corresponding to 30% transmittance. A spectral bandwidth of the saddleback transmittance valley at the local minimum transmittance plus 10% is less than or equal to about 40 nm. In some embodiments, a spectral bandwidth of the saddleback transmittance valley at the local minimum transmittance plus 25% of the local minimum transmittance is less than or equal to about 40 nm. In some embodiments, the spectral bandwidth at the minimum transmittance plus 20% is greater than or equal to about 40 nm.

[0048] In some embodiments, an absorbance spectral profile of the lens **200**, indicating an optical density of the lens at specific wavelengths, comprises a saddleback absorbance

peak. The saddleback absorbance peak may have a local minimum absorbance located between a first maximum absorbance and a second maximum absorbance. In some embodiments, an optical density at the first maximum absorbance of the saddleback peak is from about 0.5 to about 1.5, about 0.5 to about 1, or about 1 to about 1.5. In some embodiments, the local minimum absorbance is positioned at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, about 584 nm, about 585 nm, or about 586 nm.

[0049] In some embodiments, the saddleback absorbance peak is an absorbance peak between a first absorbance minimum and a second absorbance minimum. The first absorbance minimum is positioned at a wavelength from about 520 nm to about 560 nm or from about 520 nm to about 540 nm. The second absorbance minimum is positioned at a wavelength from about 610 nm to about 650 nm or from about 620 nm to about 640 nm.

[0050] In some embodiments, the transmittance spectral profile of lens **200** includes a transmittance valley. The transmittance valley has a minimum transmittance positioned at a wavelength from about 465 nm to about 505 nm, from about 470 nm to about 480 nm, from about 485 nm to about 505 nm, about 476 nm, about 477 nm, about 478 nm, about 499 nm, about 500 nm, or about 501 nm. The minimum transmittance of the transmittance valley is less than about 25%. In some embodiments, the transmittance valley may be a saddleback transmittance valley.

[0051] In some embodiments, an absorbance spectral profile of the lens **200** comprises an absorbance peak. The absorbance peak may have a maximum absorbance positioned at a wavelength from about 465 nm to about 505 nm, from about 470 nm to about 480 nm, from about 485 nm to about 505 nm, at about 476 nm, at about 477 nm, at about 478 nm, at about 499 nm, at about 500 nm, or at about 501 nm.

[0052] In some embodiments, an average transmittance of the lens **200** in a spectral range of about 480 nm to about 530 nm is greater than about 5%, greater than about 6%, greater than about 7%, greater than about 8%, greater than about 10%, greater than about 15%, or greater than about 25%.

[0053] In some embodiments, a visible light transmission (as defined by EN1836) is from about 10% to about 50%, from about 10% to about 45%, from about 10% to about 40%, from about 10% to about 30%, from about 10% to about 20%, from about 15% to about 35%, from about 15% to about 25%, from about 15% to about 20%, from about 10% to

about 15%, from about 20% to about 40%, from about 25% to about 35%, or from about 30% to about 35%.

[0054] In some embodiments, a CIE chromaticity x value of lens **200** is from about 0.45 to about 0.85, from about 0.50 to about 0.8, from about 0.55 to about 0.75, from about 0.60 to about 0.7, from about 0.45 to about 0.5, from about 0.5 to about 0.55, from about 0.55 to about 0.6, from about 0.6 to about 0.65, from about 0.65 to about 0.75, from about 0.75 to about 0.8, or from about 0.8 to about 0.85.

[0055] In some embodiments, a CIE chromaticity y value of lens **200** is from about 0.45 to about 0.85, from about 0.50 to about 0.8, from about 0.55 to about 0.75, from about 0.60 to about 0.7, from about 0.45 to about 0.5, from about 0.5 to about 0.55, from about 0.55 to about 0.6, from about 0.6 to about 0.65, from about 0.65 to about 0.75, from about 0.75 to about 0.8, or from about 0.8 to about 0.85.

[0056] In some embodiments, a scotopic transmission of the lens **200** is less than or equal to about 45%, less than equal to about 40%, less than or equal to about 35%, less than or equal to about 30%, less than or equal to about 25%, less than or equal to about 20%, less than or equal to about 15%, or less than or equal to about 10%.

[0057] Fig. 2B shows a cross-sectional view of lens **220**, according to some embodiments. Lens **220** can be an embodiment of lenses **102A** and **102B** (shown in Fig. 1) or lens **200** (shown in Fig. 2A). The discussion of lenses **102A** and **102B**, and lens **200** applies to lens **220**, unless mentioned otherwise. Further, the discussion of elements with the same annotations in Figs. 1, 2A and 2B applies to each other, unless mentioned otherwise. As shown in Fig. 2B, lens **220** can have front surface **108** and rear surface **110**, lens body **208**, and a chroma enhancement layer **214** coupled to lens body **208**.

[0058] Chroma enhancement layer **214** can be placed over lens body **208**'s front surface **212** and/or lens body **208**'s rear surface **210**. Chroma enhancement layer **214** may be an embodiment of optical filter 104. In some embodiments, chroma enhancement layer **214** can physically contact lens body **208**. Chroma enhancement layer **214** can be configured to provide the chroma enhancement for lens **220**. Chroma enhancement layer **214** can be further configured to preferentially transmit or attenuate light in the one or more chroma enhancement windows to provide enhanced chroma values. For example, an environment can predominantly reflect or emit a color, where chroma enhancement layer **214** can be adapted to attenuate or enhance an optical transmittance for one or more wavelengths

associated with the predominantly reflected or emitted color. In some embodiments, optical filter **104** may also be at least partially incorporated in lens body **208**.

[0059] In some embodiments, lens **220** can further include one or more functional layers (not shown in Fig. 2B), such as an optical filter configured to provide an optical filtering, a polarizer configured to provide a polarization, an electro-chromic layer configured to provide an electrochromism, a reflection layer configured to provide a partial reflection of incoming visible light, an absorption layer configured to provide a partial or complete absorption of infrared light, a color enhancement layer, a color alteration layer, an anti-static functional layer, an anti-fog functional layer, a scratch resistance layer, a mechanical durability layer, a hydrophobic functional layer, a reflective functional layer, a darkening functional layer, an aesthetic functional layer including tinting, a glue layer, a mechanical protection layer configured to provide mechanical protection to lenses **102A** and **102B**, to reduce stresses within lens **220**, or to improve bonding or adhesion among the layers in lens **220**, a physical vapor deposition (PVD) layer, or any combination of these. In some embodiments, the chroma enhancement filter **214** can be at least partially incorporated into the one or more functional layers in lens **220**. In some embodiments, the one or more functional layers in lens **220** can be impregnated with, loaded with, or otherwise include the chroma enhancement filters.

[0060] Fig. 2C shows a cross-sectional view of lens **240**, according to some embodiments. Lens **240** can be an embodiment of lenses **102A** and **102B** shown in Fig. 1, lens **220** shown in Fig. 2A, or lens **220** shown in Fig. 2B. The discussion of lenses **102A**, **102B**, **200**, and **220** applies to lens **240**, unless mentioned otherwise. Further, the discussion of elements with the same annotations in Figs. 1, 2A, 2B, and 2C applies to each other, unless mentioned otherwise.

[0061] As shown in Fig. 2C, lens **240** can include lens body **208**, a hard coat layer **216** disposed over lens body **208**'s front surface **212**, and a hard coat layer **218** disposed over lens body **208**'s rear surface **210**. Further, lens **240** can also include an anti-reflection layer **222**. In some embodiments, lens **240** can also include a second anti-reflection layer **224**.

[0062] In some embodiments, optical filter **104** may be incorporated or partially incorporated in one or more of the lens body **208**, the hard coat layer **216**, or the hard coat layer **218**. In addition or alternatively, optical filter **104** may be incorporated in one or

more chroma enhancement layers such as chroma enhancement layer **214** not shown in FIG. 2C.

[0063] In some embodiments, hard coat layers **216** and **218** can include a polymeric material configured to increase an abrasion resistance, a mechanical durability, and/or chemical resistance of lens **240**. Hard coat layer **216** can be disposed over lens body **208**'s front surface **212**, and can have a surface **226** facing outwards (e.g., away from eyewear **100**'s wearer). Hard coat layer **218** can be disposed over lens body **208**'s rear surface **210**, and can have a surface **228** facing inwards (e.g., towards eyewear **100**'s wearer). In some embodiments, hard coat layer **216** and/or hard coat layer **218** can be impregnated with, loaded with, or otherwise include chroma enhancement filters.

[0064] As a result, hard coat layers **216** and **218** can protect lens body **208** from being damaged (e.g., scratched), thus avoiding degrading lenses **102A** and **102B**. In some embodiments, hard coat layers **216** and **218** can have substantially identical material and/or thickness to each other.

[0065] Anti-reflection layer **222** can be disposed over lens **240**'s front surface **108** and can be configured to reduce an optical reflectivity from front surface **110** across or over the visible spectral range. As shown in Fig. 2C, anti-reflection layer **222** can be disposed over hard coat layer **216**'s outward surface **226**. In some embodiments, anti-reflection layer **222** can have an exposed surface **232** representing lens **240**'s front surface **108**. In some embodiments, an optical reflectivity from anti-reflection layer **224**'s surface **230** can be less than about 80%, less than about 60%, less than about 40%, less than about 20%, less than about 15%, less than about 10%, or less than about 5% across or over the visible spectral range.

[0066] Anti-reflection layer **224** can be disposed over lens **240**'s rear surface **110**, and can be configured to reduce an optical reflectivity from rear surface **110** across or over the visible spectral range. As shown in Fig. 2C, anti-reflection layer **224** can be disposed over hard coat layer **218**'s inward surface **228**. In some embodiments, anti-reflection layer **224** can have an exposed surface **230** representing lens **240**'s rear surface **110**. In some embodiments, an optical reflectivity from anti-reflection layer **224**'s surface **230** can be less than about 80%, less than about 60%, less than about 40%, less than about 20%, less than about 15%, less than about 10%, or less than about 5% across or over the visible spectral range.

[0067] In some embodiments, lens **240** can further include one or more functional layers (not shown in Fig. 2C), such as an optical filter configured to provide optical filtering, a polarizer configured to provide polarization, an electro-chromic layer configured to provide electrochromism, a reflection layer configured to provide a partial reflection of incoming visible light, an absorption layer configured to provide a partial or complete absorption of infrared light, a color enhancement layer, a color alteration layer, an anti-static functional layer, an anti-fog functional layer, a scratch resistance layer, a mechanical durability layer, a hydrophobic functional layer, a reflective functional layer, a darkening functional layer, an aesthetic functional layer including tinting, a glue layer, a mechanical protection layer configured to provide mechanical protection to lenses **102A** and **102B**, to reduce stresses within lens **240**, or to improve bonding or adhesion among the layers in lens **240**, a physical vapor deposition (PVD) layer, or any combination of these.

[0068] Fig. 3A illustrates an optical transmittance profile **300T**, according to some embodiments. Fig. 3B illustrates a respective optical absorbance profile **300A**, according to some embodiments. It would be understood that optical characteristics exhibited in Figs. 3A and 3B are merely illustrative and not intended to be limiting, unless mentioned otherwise. For example, optical transmittance profile **300T** can represent an optical transmittance of optical filter **104**, lens **200**, lens **220**, or lens **240** that includes a chroma enhancement filter.

[0069] Optical transmittance profile **300T** can include one or more transmittance valleys, such as valleys **304T**, **306T**, **308T** each having a minimum transmittance in one or more spectral bands. Such transmittance valleys (e.g., valleys **304T**, **306T**, **308T**) can filter out or attenuate undesired spectral wavelengths of light. Accordingly, optical transmittance profile **300T** can provide chroma enhancement in the one or more spectral bands while maintaining a minimal desired transmission at each wavelength. Optical transmittance profile **300T** can also include one or more transmittance peaks such as peak **302T**.

[0070] A transmittance valley can be defined by a position of a minimum optical transmittance in a portion of a spectral band between lower and upper edge portions of the spectral band, the lower and upper edge portions having an optical transmittance that is substantially greater than the minimum optical transmittance. On the other hand, an absorbance peak can be defined by a position of a maximum absorbance in a portion of a

spectral band between lower and upper edge portions of the spectral band, the upper and lower edge portions having an optical absorbance substantially below the maximum absorbance. An optical transmittance valley can be associated with a respective optical absorbance peak. For example, an optical filter can have an optical characteristic including an optical reflectivity R , an optical transmittance T , an optical absorptance A_P , and an optical absorbance A_B . Optical absorptance A_P can be about equal to $(1-T-R)$, and optical absorbance A_B can be about equal to the magnitude of the logarithm of optical transmittance T , such as $-\log_{10}(T)$. In some embodiments, the optical reflectivity R can be relatively wavelength-insensitive as compared to the optical transmittance T , the optical absorptance A_P , and the optical absorbance A_B . Therefore, in some embodiments, the optical transmittance valley and the respective absorbance peak can be positioned at about the same wavelength. Accordingly, each of the transmittance valleys in a spectrum can be regarded as an absorbance peak in the spectrum. For example, each of valleys **304T**, **306T**, and **308T** illustrated in optical transmittance profile **300T** can be hereinafter represented as absorbance peaks **304A**, **306A**, and **308A** in optical absorbance profile **300A**. As such, in referring to Fig. 3B, optical absorbance profile **300A** can include an absorbance peak **304A** associated with valley **304T**, an absorbance peak **306A** associated with valley **306T**, and an absorbance peak **308A** associated with valley **308T**.

[0071] In some embodiments, one or more of the transmittance valleys may include a saddleback transmittance valley. A saddleback transmittance valley may include a minimum optical transmittance followed by a local maximum optical transmittance, followed by another minimum optical transmittance (e.g., transmittance at increasing wavelengths). The middle portion of the spectral band between the lower and upper edge portions may include a local maximum optical transmittance. In some aspects, the minimum optical transmittance may be a minimum transmittance relative to transmittance at surrounding wavelengths. In some embodiments, the saddleback transmittance valley can be defined by a position of the local maximum optical transmittance. On the other hand, a saddleback absorbance peak can have a local minimum absorbance. The middle portion of the spectral band between the lower and upper edge portions may include the local minimum absorbance. The local minimum absorbance may be positioned between two maximum absorbance. The upper and lower edge portions may have an optical absorbance substantially below the local minimum absorbance and the maximum

absorbance. The saddleback absorbance peak may be defined by a position of the local minimum absorbance.

[0072] Referring to Fig. 3A, in some embodiments, transmittance valley **304T** can be a saddleback transmittance valley. Transmittance valley **304T** may include a first minimum **310T**, a local maximum **312T**, and a second minimum **314T**.

[0073] Local maximum **312T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, about 582 nm, about 583 nm, about 584 nm, about 585 nm, or about 586 nm. First minimum **310T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, about 575 nm, about 576 nm, about 577 nm, about 578 nm, about 579 nm, or about 580 nm. Second minimum **314T** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0074] In some embodiments, transmittance at local maximum **312T** is from about 10% to about 40%, from about 10% to about 30%, from about 20% to about 25%, or about 24%. In some embodiments, transmittance at first minimum **310T** is greater than about 5%, greater than about 10%, greater than about 20% and less than about 30%, greater than about 20% and less than about 25%, about 21%, about 22%, or about 23%. In some embodiments, transmittance at second minimum **314T** is greater than about 5%, greater than about 10%, greater than about 10% and less than about 15%, about 11%, about 12%, about 13%, or about 14%.

[0075] In some embodiments, a difference in transmittance between transmittance at first minimum **310T** and transmittance at local maximum **312T** is less than about 5%, less than about 4%, less than about 3%, or less than about 2%. In some aspects, a difference in transmittance at local maximum **312T** and transmittance at second minimum **314T** is greater than about 5% and less than about 15%, greater than about 10% and less than 15%, about 11%, or about 12%.

[0076] As discussed previously herein, transmittance valley **304T** can be between a lower edge portion (e.g., closer to about 565 nm) and an upper edge portion (e.g., closer to about 610 nm) of the spectral band (e.g., between about 570 nm and about 600 nm). Transmittance at the lower edge portion and the upper edge portion can be greater than that of first minimum **310T**, second minimum **314T**, and local maximum **312T**. For

example, a difference in transmittance between a transmittance at the lower edge portion and the first minimum **310T** may be between about 30% to about 35%. A difference between a transmittance at the upper edge portion and second minimum **314T** is between about 35% to about 55%, or between about 50% to about 55%.

[0077] Each transmittance valley in optical transmittance profile **300T** can have a respective transmittance bandwidth defined as a full width of the each transmittance valley at certain offset from the minimum transmittance of the each transmittance valley, such as the minimum transmittance plus 1%, the minimum transmittance plus 5%, the minimum transmittance plus 10%, the minimum transmittance plus 15%, or the minimum transmittance plus 30%. For example, if the minimum transmittance is 20%, the bandwidth of the minimum transmittance plus 10% would be measured as corresponding to 30% transmittance.

[0078] In some embodiments, transmittance valley **304T** can have a transmittance bandwidth of less than about 40 nm, less than about 20 nm, or less than about 15 nm at the minimum transmittance plus 5% (transmittance at second minimum **314T**). In some embodiments, transmittance valley **304T** can have a transmittance bandwidth of less than about 40 nm, less than about 30 nm, or less than about 20 nm at the minimum transmittance plus 10%. In some embodiments, transmittance valley **304T** can have a transmittance bandwidth of less than about 40 nm or less than about 35 nm at the minimum transmittance plus 15%. In some embodiments, transmittance valley **304T** can have a transmittance bandwidth of less than about 40 nm or less than about 35 nm at the minimum transmittance plus 20%.

[0079] In some embodiments, transmittance valley **308T** can have a transmittance bandwidth of less than about 15 nm, less than about 15 nm, or less than about 20 nm at minimum transmittance plus 5%, the minimum transmittance plus 10%, or the minimum transmittance plus 20%, respectively.

[0080] In some embodiments, transmittance valley **306T** can have a transmittance bandwidth of less than about 25 nm, less than about 30 nm, or less than about 50 nm at minimum transmittance plus 5%, the minimum transmittance plus 10%, or the minimum transmittance plus 20%, respectively.

- [0081] In some embodiments, the maximum transmittance of the transmittance peak **302T** is greater than or equal to about 50%, is greater than or equal to about 55%, or is greater than or equal to about 60%.
- [0082] In some embodiments, the maximum transmittance of transmittance peak **302T** is at a wavelength from about 430 nm to about 480 nm, or from about 430 nm to about 450 nm.
- [0083] In some embodiments, a minimum transmittance of the valley **306T** is less than about 25%, between about 15% and about 20%, or about 16%.
- [0084] In some embodiments, the minimum transmittance of valley **306T** is at a wavelength from about 465 nm to about 505 nm, from about 485 nm to about 505 nm, from about 490 nm to about 505 nm, about 495 nm to about 505 nm, at about 498 nm, at about 499 nm, or at about 500 nm.
- [0085] In some embodiments, a minimum transmittance of the valley **308T** is from about 25% to about 35%, or from about 25% to about 30%.
- [0086] In some embodiments, the minimum transmittance of valley **308T** is at a wavelength from about 630 nm to about 680 nm, from about 650 nm to about 670 nm, or about 660 nm to about 665 nm.
- [0087] Referring to Fig. 3B, in some embodiments, absorbance peak **304A** can be a saddleback peak. Absorbance peak **304A** can include a first maximum **310A**, a local minimum **312A**, and a second maximum **314A**. First maximum **310A** can be associated with first minimum **310T**. Local maximum **312T** can be associated with local minimum **312A**. Second maximum **314A** can be associated with second minimum **314T**.
- [0088] Local minimum **312A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, about 582 nm, about 583 nm, about 584 nm, about 585 nm, or about 586 nm. First maximum **310A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, at about 579 nm, or at about 580 nm. Second maximum **314A** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.
- [0089] Absorbance peak **304A** can have a maximum optical density (e.g., optical absorbance A_B) from about 0.5 to about 1.5, from about 0.5 to about 1, about 0.9, about

0.8, about 0.7, or about 0.6, and can be positioned in a spectral band from about 570 nm to about 600 nm. Accordingly, optical densities at a lower edge portion (e.g., closer to about 565 nm) and a upper edge portion (e.g., closer to about 610 nm) of the spectral band (e.g., between about 570 nm and about 600 nm) can be less than that of absorbance peak **304A**. Namely, absorbance peak **304A** can have greater absorbance than the lower edge and the upper edge portions of the spectral band. Similarly, absorbance peak **306A** can have a maximum optical density less than or equal to 1, less than or equal to 0.8, or between about 0.7 to about 0.9, and can be positioned in a spectral band from about 485 nm to about 505 nm.

[0090] In some embodiments, optical density at local minimum **312A** is from about 0.5 to about 1, from about 0.5 to about 0.75, or from about 0.55 to about 0.65. In some embodiments, optical density at first maximum **310A** is from about 0.5 to about 1, from about 0.5 to about 0.75, or from about 0.55 to about 0.65. In some embodiments, optical density at second minimum **314A** is from about 0.5 to about 1.25, from about 0.75 to about 1, or from about 0.85 to about 1.

[0091] In some embodiments, absorbance peak **306A** can have a maximum optical density from about 0.5 to about 1, from about 0.6 to about 0.8, or from about 0.7 to about 0.8.

[0092] In some embodiments, a scotopic transmission of the lens **200** is less than or equal to about 45%, about 40%, or about 41%.

[0093] In some embodiments, a visible light transmission (as defined by EN1836) of lens **200** is from about 20% to about 60%, from about 30% to about 50%, from about 35% to about 45%, about 41%, about 42%, or about 43%.

[0094] Fig. 4A illustrates an optical transmittance profile **400T**, according to some embodiments. Fig. 4B illustrates a respective optical absorbance profile **400A**, according to some embodiments. It would be understood that optical characteristics exhibited in Figs. 4A and 4B are merely illustrative and not intended to be limiting, unless mentioned otherwise. For example, optical transmittance profile **400T** can represent an optical transmittance of optical filter **104**, lens **200**, lens **220**, or lens **240** that includes a chroma enhancement filter.

[0095] Optical transmittance profile **400T** can include one or more transmittance valleys, such as valleys **404T**, **406T**, **408T** each having a minimum transmittance in one or more

spectral bands. Such transmittance valleys (e.g., valleys **404T**, **406T**, **408T**) can filter out or attenuate undesired spectral wavelengths of light. Accordingly, optical transmittance profile **400T** can provide chroma enhancement in the one or more spectral bands while maintaining a minimal desired transmission at each wavelength. Optical transmittance profile **400T** can also include one or more transmittance peaks such as peak **402T**.

[0096] In some embodiments, the optical transmittance valley and the respective absorbance peak can be positioned at about the same wavelength. Accordingly, each of the transmittance valleys in a spectrum can be regarded as an absorbance peak in the spectrum. For example, each of valleys **404T**, **406T**, and **408T** illustrated in optical transmittance profile **400T** can be hereinafter represented as absorbance peaks **404A**, **406A**, and **408A** in optical absorbance profile **400A**. As such, in referring to Fig. 4B, optical absorbance profile **400A** can include an absorbance peak **404A** associated with valley **404T**, an absorbance peak **406A** associated with valley **406T**, and an absorbance peak **408A** associated with valley **408T**.

[0097] Referring to Fig. 4A, in some embodiments, transmittance valley **404T** can be a saddleback transmittance valley. Transmittance valley **404T** may include a first minimum **410T**, a local maximum **412T**, and a second minimum **414T**.

[0098] Local maximum **412T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 582 nm, at about 583 nm, at about 584 nm, at about 585 nm, or at about 586 nm. First minimum **410T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, at about 579 nm, or at about 580 nm. Second minimum **414T** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0099] In some embodiments, transmittance at local maximum **412T** is from about 10% to about 40%, from about 10% to about 30%, from about 10% to about 20%, from about 15% to about 20%, about 16%, about 17%, or about 18%. In some embodiments, transmittance at first minimum **410T** is greater than about 5%, greater than about 10%, between about 10% and about 20%, between 15% to about 20%, about 16%, or about 17%. In some embodiments, transmittance at second minimum **414T** is greater than about

5%, greater than about 8%, greater than about 8% and less than about 12%, about 9%, about 10%, about 11%, or about 12%.

[0100] In some embodiments, a difference in transmittance between transmittance at first minimum **410T** and transmittance at local maximum **412T** is less than about 5%, less than about 4%, less than about 3%, or less than about 2%. In some aspects, a difference in transmittance at local maximum **412T** and transmittance at second minimum **414T** is greater than about 5% and less than about 10%, about 7%, or about 8%.

[0101] As discussed previously herein, transmittance valley **404T** can be between a lower edge portion (e.g., closer to about 565 nm) and an upper edge portion (e.g., closer to about 610 nm) of the spectral band (e.g., between about 570 nm and about 600 nm). Transmittance at the lower edge portion and the upper edge portion can be greater than that of first minimum **410T**, second minimum **414T**, local maximum **412T**. For example, a difference in transmittance between a transmittance at the lower edge portion and the first minimum **410T** may be between about 15% to about 25%. A difference between a transmittance at the upper edge portion and second minimum **414T** is between about 30% to about 45%, or between about 35% to about 40%.

[0102] In some embodiments, transmittance valley **404T** can have a transmittance bandwidth of less than about 40 nm, less than about 30 nm, or less than about 20 nm at the minimum transmittance plus 5% (transmittance at second minimum **414T**). In some embodiments, transmittance valley **404T** can have a transmittance bandwidth of less than about 40 nm or less than about 35 nm at the minimum transmittance plus 10%. In some embodiments, transmittance valley **404T** can have a transmittance bandwidth of less than about 40 nm at the minimum transmittance plus 15%. In some embodiments, transmittance valley **404T** can have a transmittance bandwidth of less than about 45 nm at the minimum transmittance plus 20%.

[0103] In some embodiments, transmittance valley **408T** can have a transmittance bandwidth of less than about 15 nm, less than about 15 nm, or less than about 20 nm at minimum transmittance plus 5%, the minimum transmittance plus 10%, or the minimum transmittance plus 20%, respectively.

[0104] In some embodiments, transmittance valley **406T** can have a transmittance bandwidth of less than about 25 nm, less than about 30 nm, or less than about 50 nm at

minimum transmittance plus 5%, the minimum transmittance plus 10%, or the minimum transmittance plus 20%, respectively.

- [0105] In some embodiments, the maximum transmittance of the transmittance peak **402T** is greater than or equal to about 30%, is greater than or equal to about 35%, or is greater than or equal to about 35% and less than or equal to about 40%.
- [0106] In some embodiments, the maximum transmittance of transmittance peak **402T** is at a wavelength from about 430 nm to about 480 nm, or from about 430 nm to about 450 nm.
- [0107] In some embodiments, a minimum transmittance of the valley **406T** is less than or equal to about 25%, between about 10% and about 15%, about 11%, or about 12%, or about 13%.
- [0108] In some embodiments, the minimum transmittance of valley **406T** is at a wavelength from about 465 nm to about 505 nm, from about 485 nm to about 505 nm, from about 490 nm to about 505 nm, about 495 nm to about 505 nm, at about 498 nm, at about 499 nm, or at about 500 nm.
- [0109] In some embodiments, a minimum transmittance of the valley **408T** is between about 15% to about 35%, or between about 20% to about 25%.
- [0110] In some embodiments, the minimum transmittance of valley **408T** is at a wavelength from about 630 nm to about 680 nm, from about 650 nm to about 670 nm, or about 660 nm to about 665 nm.
- [0111] Referring to Fig. 4B, in some embodiments, absorbance peak **404A** can be a saddleback peak. Absorbance peak **404A** can include a first maximum **410A**, a local minimum **412A**, and a second maximum **414A**. First maximum **410A** can be associated with first minimum **410T**. Local maximum **412T** can be associated with local minimum **412A**. Second maximum **414A** can be associated with second minimum **414T**.
- [0112] Local minimum **412A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, about 582 nm, at about 583 nm, at about 584 nm, at about 585 nm, or at about 586 nm. First maximum **410A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, at about 579 nm, or at about 580 nm. Second maximum **414A** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about

598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0113] In some embodiments, optical density at local minimum **412A** is from about 0.5 to about 1, from about 0.6 to about 0.8, or from about 0.7 to about 0.8. In some embodiments, optical density at first maximum **410A** is from about 0.5 to about 1, from about 0.75 to about 0.95, or from about 0.8 to about 0.82. In some embodiments, optical density at second minimum **414A** is from about 0.75 to about 1.25, from about 0.9 to about 1.1, or from about 1 to about 1.05.

[0114] In some embodiments, absorbance peak **406A** can have a maximum optical density from about 0.75 to about 1.25, from about 0.85 to about 1.15, or from about 0.9 to about 1.

[0115] In some embodiments, absorbance peak **408A** can have a maximum optical density from about 0.4 to about 0.8, from about 0.5 to about 0.7, or from about 0.6 to about 0.7.

[0116] In some embodiments, a scotopic transmission of the lens **200** is less than or equal to about 45%, is less than about 35%, is less than about 30%, about 26%, about 27%, or about 28%.

[0117] In some embodiments, a visible light transmission (as defined by EN1836) of lens **200** is from about 10% to about 50%, from about 15% to about 45%, from about 20% to about 40%, from about 20% to about 35%, or from about 25% to about 30%.

[0118] Fig. 5A illustrates an optical transmittance profile **500T**, according to some embodiments. Fig. 5B illustrates a respective optical absorbance profile **500A**, according to some embodiments. It would be understood that optical characteristics exhibited in Figs. 5A and 5B are merely illustrative and not intended to be limiting, unless mentioned otherwise. For example, optical transmittance profile **500T** can represent an optical transmittance of optical filter **104**, lens **200**, lens **220**, or lens **240** that includes a chroma enhancement filter.

[0119] Optical transmittance profile **500T** can include one or more transmittance valleys, such as valleys **504T**, **506T**, **508T** each having a minimum transmittance in one or more spectral bands. Such transmittance valleys (e.g., valleys **504T**, **506T**, **508T**) can filter out or attenuate undesired spectral wavelengths of light. Accordingly, optical transmittance profile **500T** can provide chroma enhancement in the one or more spectral bands while

maintaining a minimal desired transmission at each wavelength. Optical transmittance profile **500T** can also include one or more transmittance peaks such as peak **502T**.

[0120] In some embodiments, the optical transmittance valley and the respective absorbance peak can be positioned at about the same wavelength. Accordingly, each of the transmittance valleys in a spectrum can be regarded as an absorbance peak in the spectrum. For example, each of valleys **504T**, **506T**, and **508T** illustrated in optical transmittance profile **500T** can be hereinafter represented as absorbance peaks **504A**, **506A**, and **508A** in optical absorbance profile **500A**. As such, in referring to Fig. 5B, optical absorbance profile **500A** can include an absorbance peak **504A** associated with valley **504T**, an absorbance peak **506A** associated with valley **506T**, and an absorbance peak **508A** associated with valley **508T**.

[0121] Referring to Fig. 5A, in some embodiments, transmittance valley **504T** can be a saddleback transmittance valley. Transmittance valley **504T** may include a first minimum **510T**, a local maximum **512T**, and a second minimum **514T**.

[0122] Local maximum **512T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, about 582 nm, about 583 nm, about 584 nm, about 585 nm, or about 586 nm. First minimum **510T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, at about 579 nm, or at about 580 nm. Second minimum **514T** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0123] In some embodiments, transmittance at local maximum **512T** is from about 10% to about 30%, from about 15% to about 25%, from about 17% to about 22%, about 18%, about 19%, or about 20%. In some embodiments, transmittance at first minimum **510T** is greater than about 5%, greater than about 10%, between about 10% and about 25%, between 15% to about 20%, about 17%, about 18%, or about 19%. In some embodiments, transmittance at second minimum **514T** is greater than about 5%, greater than about 8%, greater than about 8% and less than about 12%, about 8%, about 9%, about 10%, or about 11%.

[0124] In some embodiments, a difference in transmittance between transmittance at first minimum **510T** and transmittance at local maximum **512T** is less than about 5%, less

than about 4%, less than about 3%, or less than about 2%. In some aspects, a difference in transmittance at local maximum **512T** and transmittance at second minimum **514T** is greater than about 5% and less than about 15%, about 9%, about 10%, or about 11%.

[0125] As discussed previously herein, transmittance valley **504T** can be between a lower edge portion (e.g., closer to about 565 nm) and an upper edge portion (e.g., closer to about 610 nm) of the spectral band (e.g., between about 570 nm and about 600 nm). Transmittance at the lower edge portion and the upper edge portion can be greater than that of first minimum **510T**, second minimum **514T**, local maximum **512T**. For example, a difference in transmittance between a transmittance at the lower edge portion and the first minimum **510T** may be between about 15% to about 30%, between about 20% to about 30%, or about 27%. A difference between a transmittance at the upper edge portion and second minimum **514T** is between about 35% to about 55%, or between about 40% to about 50%.

[0126] In some embodiments, transmittance valley **504T** can have a transmittance bandwidth of less than about 40 nm, less than about 20 nm, or less than about 15 nm at the minimum transmittance plus 5% (transmittance at second minimum **514T**). In some embodiments, transmittance valley **504T** can have a transmittance bandwidth of less than about 40 nm, less than about 30 nm, or less than about 20 nm at the minimum transmittance plus 10%. In some embodiments, transmittance valley **504T** can have a transmittance bandwidth of less than about 40 nm or less than about 35 nm at the minimum transmittance plus 15%. In some embodiments, transmittance valley **504T** can have a transmittance bandwidth of less than about 40 nm at the minimum transmittance plus 20%.

[0127] In some embodiments, transmittance valley **508T** can have a transmittance bandwidth of less than about 15 nm, less than about 15 nm, or less than about 20 nm at minimum transmittance plus 5%, the minimum transmittance plus 10%, or the minimum transmittance plus 20%, respectively.

[0128] In some embodiments, transmittance valley **506T** can have a transmittance bandwidth of less than about 25 nm, less than about 30 nm, or less than about 50 nm at minimum transmittance plus 5%, the minimum transmittance plus 10%, or the minimum transmittance plus 20%, respectively.

- [0129] In some embodiments, the maximum transmittance of the transmittance peak **502T** is greater than or equal to about 30%, is greater than or equal to about 35%, or is greater than or equal to about 40% and less than or equal to about 50%.
- [0130] In some embodiments, the maximum transmittance of transmittance peak **502T** is at a wavelength from about 430 nm to about 480 nm, or from about 430 nm to about 450 nm.
- [0131] In some embodiments, a minimum transmittance of the valley **506T** is less than or equal to about 25%, between about 7% and about 18%, about 10% to about 15%, about 12%, about 13%, or about 14%.
- [0132] In some embodiments, the minimum transmittance of valley **506T** is at a wavelength from about 465 nm to about 505 nm, from about 485 nm to about 505 nm, from about 490 nm to about 505 nm, about 495 nm to about 505 nm, at about 498 nm, at about 499 nm, or at about 500 nm.
- [0133] In some embodiments, a minimum transmittance of the valley **508T** is between about 20% to about 30%, or between about 22% to about 26%.
- [0134] In some embodiments, the minimum transmittance of valley **508T** is at a wavelength from about 630 nm to about 680 nm, from about 650 nm to about 670 nm, about 660 nm to about 665 nm, or at about 662 nm.
- [0135] Referring to Fig. 5B, in some embodiments, absorbance peak **504A** can be a saddleback peak. Absorbance peak **504A** can include a first maximum **510A**, a local minimum **512A**, and a second maximum **514A**. First maximum **510A** can be associated with first minimum **510T**. Local maximum **512T** can be associated with local minimum **512A**. Second maximum **514A** can be associated with second minimum **514T**.
- [0136] Local minimum **512A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 582 nm, at about 583 nm, at about 584 nm, at about 585 nm, or at about 586 nm. First maximum **510A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, at about 579 nm, or at about 580 nm. Second maximum **514A** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

- [0137] In some embodiments, optical density at local minimum **512A** is from about 0.5 to about 1, from about 0.6 to about 0.8, or from about 0.65 to about 0.75. In some embodiments, optical density at first maximum **510A** is from about 0.5 to about 1, or from about 0.7 to about 0.8. In some embodiments, optical density at second minimum **514A** is from about 0.75 to about 1.25, from about 0.9 to about 1.1, or from about 0.95 to about 1.05.
- [0138] In some embodiments, absorbance peak **506A** can have a maximum optical density from about 0.7 to about 1.1, from about 0.75 to about 1.05, or from about 0.85 to about 1.
- [0139] In some embodiments, absorbance peak **508A** can have a maximum optical density from about 0.4 to about 0.8, from about 0.5 to about 0.7, or from about 0.6 to about 0.65.
- [0140] In some embodiments, a scotopic transmission of the lens **200** is less than or equal to about 45%, is less than about 40%, is less than about 35%, about 34%, about 33%, or about 32%.
- [0141] In some embodiments, a visible light transmission (as defined by EN1836) of lens **200** is from about 15% to about 55%, from about 25% to about 45%, from about 30% to about 40%, about 34%, about 35%, or about 36%.
- [0142] Fig. 6A illustrates an optical transmittance profile **600T**, according to some embodiments. Fig. 6B illustrates a respective optical absorbance profile **600A**, according to some embodiments. It would be understood that optical characteristics exhibited in Figs. 6A and 6B are merely illustrative and not intended to be limiting, unless mentioned otherwise. For example, optical transmittance profile **600T** can represent an optical transmittance of optical filter **104**, lens **200**, lens **220**, or lens **240** that includes a chroma enhancement filter.
- [0143] Optical transmittance profile **600T** can include one or more transmittance valleys, such as valleys **604T**, **606T**, **608T** each having a minimum transmittance in one or more spectral bands. Such transmittance valleys (e.g., valleys **604T**, **606T**, **608T**) can filter out or attenuate undesired spectral wavelengths of light. Accordingly, optical transmittance profile **600T** can provide chroma enhancement in the one or more spectral bands while maintaining a minimal desired transmission at each wavelength. Optical transmittance profile **600T** can also include one or more transmittance peaks such as peak **602T**.

- [0144] In some embodiments, the optical transmittance valley and the respective absorbance peak can be positioned at about the same wavelength. Accordingly, each of the transmittance valleys in a spectrum can be regarded as an absorbance peak in the spectrum. For example, each of valleys **604T**, **606T**, and **608T** illustrated in optical transmittance profile **600T** can be hereinafter represented as absorbance peaks **604A**, **606A**, and **608A** in optical absorbance profile **600A**. As such, in referring to Fig. 6B, optical absorbance profile **600A** can include an absorbance peak **604A** associated with valley **604T**, an absorbance peak **606A** associated with valley **606T**, and an absorbance peak **608A** associated with valley **608T**.
- [0145] Referring to Fig. 6A, in some embodiments, transmittance valley **604T** can be a saddleback transmittance valley. Transmittance valley **604T** may include a first minimum **610T**, a local maximum **612T**, and a second minimum **614T**.
- [0146] Local maximum **612T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 582 nm, at about 583 nm, at about 584 nm, at about 585 nm, or at about 586 nm. First minimum **610T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, at about 579 nm, or at about 580 nm. Second minimum **614T** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, about 595 nm, about 596 nm, or about 597 nm.
- [0147] In some embodiments, transmittance at local maximum **612T** is from about 1% to about 20%, from about 5% to about 15%, from about 7% to about 10%, about 8%, or about 9%. In some embodiments, transmittance at first minimum **610T** is greater than about 5%, greater than about 6%, between about 5% and about 10%, about 7%, about 8%, or about 9%. In some embodiments, transmittance at second minimum **614T** is greater than about 1%, greater than about 2%, greater than about 3% and less than about 5%, about 4%, or about 5%.
- [0148] In some embodiments, a difference in transmittance between transmittance at first minimum **610T** and transmittance at local maximum **612T** is less than about 5%, less than about 4%, less than about 3%, less than about 2%, or less than about 1%. In some aspects, a difference in transmittance at local maximum **612T** and transmittance at second

minimum **614T** is greater than about 2% and less than about 6%, about 3%, about 5%, or about 4%.

[0149] As discussed previously herein, transmittance valley **604T** can be between a lower edge portion (e.g., closer to about 565 nm) and an upper edge portion (e.g., closer to about 610 nm) of the spectral band (e.g., between about 570 nm and about 600 nm). Transmittance at the lower edge portion and the upper edge portion can be greater than that of first minimum **610T**, second minimum **614T**, local maximum **612T**. For example, a difference in transmittance between a transmittance at the lower edge portion and the first minimum **610T** may be between about 5% to about 15%, between about 7% to about 12%, about 10%, or about 11%. A difference between a transmittance at the upper edge portion and second minimum **614T** is between about 10% to about 30%, between about 15% to about 25%, about 17%, about 18%, or about 19%.

[0150] In some embodiments, transmittance valley **604T** can have a transmittance bandwidth of less than about 45 nm, less than about 40 nm, or less than about 35 nm at the minimum transmittance plus 5% (transmittance at second minimum **614T**). In some embodiments, transmittance valley **604T** can have a transmittance bandwidth of less than about 50 nm, less than about 45 nm, or less than about 40 nm at the minimum transmittance plus 10%.

[0151] In some embodiments, transmittance valley **608T** can have a transmittance bandwidth of less than about 25 nm at minimum transmittance plus 5% and a transmittance bandwidth of less than about 25 nm at minimum transmittance plus 10%, respectively.

[0152] In some embodiments, the maximum transmittance of the transmittance peak **602T** is greater than or equal to about 5%, is greater than or equal to about 10%, or is greater than or equal to about 20% and less than or equal to about 25%.

[0153] In some embodiments, the maximum transmittance of transmittance peak **602T** is at a wavelength from about 430 nm to about 480 nm, from about 435 nm to about 455 nm, or from about 445 nm to about 450 nm.

[0154] In some embodiments, transmittance valley **606T** can be a saddleback transmittance valley. Transmittance valley **606T** may include a first minimum **616T**, a local maximum **618T**, and a second minimum **620T**.

- [0155] In some embodiments, the second minimum **620T** of valley **606T** is at a wavelength from about 465 nm to about 505 nm, from about 485 nm to about 505 nm, from about 490 nm to about 505 nm, about 495 nm to about 505 nm, at about 497 nm, at about 498 nm, at about 499 nm, or at about 500 nm.
- [0156] In some embodiments, local maximum **618T** is at wavelength from about 475 nm to about 495 nm, from about 480 nm to about 490 nm, at about 483 nm, at about 484 nm, or at about 485 nm. In some embodiments, first minimum **616T** is at wavelength from about 470 nm to about 490 nm, from about 475 nm to about 485 nm, at about 478 nm, at about 479 nm, or at about 480 nm.
- [0157] In some embodiments, a minimum transmittance of the valley **606T** is less than or equal to about 25%, between about 7% and about 18%, about 10% to about 15%, about 11%, about 12%, about 13%, or about 14%.
- [0158] In some embodiments, a minimum transmittance of the valley **608T** is between about 5% to about 20%, between about 10% to about 15%, about 13%, about 14%, or about 15%.
- [0159] In some embodiments, the minimum transmittance of valley **608T** is at a wavelength from about 630 nm to about 680 nm, from about 650 nm to about 670 nm, about 655 nm to about 665 nm, at about 658 nm, at about 659 nm, or at about 660 nm.
- [0160] Referring to Fig. 6B, in some embodiments, absorbance peak **604A** can be a saddleback peak. Absorbance peak **604A** can include a first maximum **610A**, a local minimum **612A**, and a second maximum **614A**. First maximum **610A** can be associated with first minimum **610T**. Local maximum **612T** can be associated with local minimum **612A**. Second maximum **614A** can be associated with second minimum **614T**.
- [0161] Local minimum **612A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 581 nm, at about 582 nm, at about 583 nm, at about 584 nm, or at about 585 nm. First maximum **610A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 574 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, or at about 579 nm. Second maximum **614A** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

- [0162] In some embodiments, optical density at local minimum **612A** is from about 0.5 to about 1.5, from about 0.75 to about 1.25, or from about 0.95 to about 1.1. In some embodiments, optical density at first maximum **610A** is from about 0.5 to about 1.5, or from about 0.75 to about 1.25. In some embodiments, optical density at second minimum **614A** is from about 0.75 to about 1.7, from about 1 to about 1.5, or from about 1.2 to about 1.4.
- [0163] In some embodiments, absorbance peak **606A** can be a saddleback peak. Absorbance peak **606A** can include a first maximum **616A**, a local minimum **618A**, and a second maximum **620A**. First maximum **616A** can be associated with first minimum **616T**. Local maximum **618T** can be associated with local minimum **618A**. Second maximum **620A** can be associated with second minimum **620T**.
- [0164] In some embodiments, absorbance peak **606A** can have a maximum optical density from about 0.5 to about 1.5, from about 0.75 to about 1.25, or from about 0.85 to about 1.05.
- [0165] In some embodiments, absorbance peak **608A** can have a maximum optical density from about 0.5 to about 1.2, from about 0.6 to about 1.1, or from about 0.7 to about 0.9.
- [0166] In some embodiments, a scotopic transmission of the lens **200** is less than or equal to about 35%, is less than about 30%, is less than about 25%, is less than about 20%, about 16%, about 17%, or about 16%.
- [0167] In some embodiments, a visible light transmission (as defined by EN1836) of lens **200** is from about 5% to about 30%, from about 10% to about 20%, about 14%, about 15%, or about 16%.
- [0168] Fig. 7A illustrates an optical transmittance profile **700T**, according to some embodiments. Fig. 7B illustrates a respective optical absorbance profile **700A**, according to some embodiments. It would be understood that optical characteristics exhibited in Figs. 7A and 7B are merely illustrative and not intended to be limiting, unless mentioned otherwise. For example, optical transmittance profile **700T** can represent an optical transmittance of optical filter **104**, lens **200**, lens **220**, or lens **240** that includes a chroma enhancement filter.
- [0169] Optical transmittance profile **700T** can include one or more transmittance valleys, such as valleys **704T**, **706T**, **708T** each having a minimum transmittance in one or more

spectral bands. Such transmittance valleys (e.g., valleys **704T**, **706T**, **708T**) can filter out or attenuate undesired spectral wavelengths of light. Accordingly, optical transmittance profile **700T** can provide chroma enhancement in the one or more spectral bands while maintaining a minimal desired transmission at each wavelength. Optical transmittance profile **700T** can also include one or more transmittance peaks such as peak **702T**.

[0170] In some embodiments, the optical transmittance valley and the respective absorbance peak can be positioned at about the same wavelength. Accordingly, each of the transmittance valleys in a spectrum can be regarded as an absorbance peak in the spectrum. For example, each of valleys **704T**, **706T**, and **708T** illustrated in optical transmittance profile **700T** can be hereinafter represented as absorbance peaks **704A**, **706A**, and **708A** in optical absorbance profile **700A**. As such, in referring to Fig. 7B, optical absorbance profile **700A** can include an absorbance peak **704A** associated with valley **704T**, an absorbance peak **706A** associated with valley **706T**, and an absorbance peak **708A** associated with valley **708T**.

[0171] Referring to Fig. 7A, in some embodiments, transmittance valley **704T** can be a saddleback transmittance valley. Transmittance valley **704T** may include a first minimum **710T**, a local maximum **712T**, and a second minimum **714T**.

[0172] Local maximum **712T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 582 nm, at about 583 nm, at about 584 nm, at about 585 nm, or at about 586 nm. First minimum **710T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, at about 579 nm, or at about 580 nm. Second minimum **714T** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0173] In some embodiments, transmittance at local maximum **712T** is from about 1% to about 20%, from about 5% to about 15%, from about 7% to about 10%, about 8%, about 9%, or about 10%. In some embodiments, transmittance at first minimum **710T** is greater than about 5%, greater than about 6%, between about 5% and about 10%, about 7%, about 8%, or about 9%. In some embodiments, transmittance at second minimum **714T** is

greater than about 1%, greater than about 2%, greater than about 3% and less than about 6%, about 4%, or about 5%.

[0174] In some embodiments, a difference in transmittance between transmittance at first minimum **710T** and transmittance at local maximum **712T** is less than about 5%, less than about 4%, less than about 3%, less than about 2%, or less than about 1%. In some aspects, a difference in transmittance at local maximum **712T** and transmittance at second minimum **714T** is greater than about 2% and less than about 6%, about 3%, about 5%, or about 4%.

[0175] As discussed previously herein, transmittance valley **704T** can be between a lower edge portion (e.g., closer to about 565 nm) and an upper edge portion (e.g., closer to about 610 nm) of the spectral band (e.g., between about 570 nm and about 600 nm).

Transmittance at the lower edge portion and the upper edge portion can be greater than that of first minimum **710T**, second minimum **714T**, local maximum **712T**. For example, a difference in transmittance between a transmittance at the lower edge portion and the first minimum **710T** may be between about 5% to about 18%, between about 10% to about 15%, or about 12%. A difference between a transmittance at the upper edge portion and second minimum **714T** is between about 10% to about 30%, between about 15% to about 25%, about 21%, about 22%, or about 23%.

[0176] In some embodiments, transmittance valley **704T** can have a transmittance bandwidth of less than about 45 nm at the minimum transmittance plus 10% (transmittance at second minimum **714T**).

[0177] In some embodiments, transmittance valley **708T** can have a transmittance bandwidth of less than about 15 nm at minimum transmittance plus 5% and a transmittance bandwidth of less than about 25 nm at minimum transmittance plus 10%, respectively.

[0178] In some embodiments, the maximum transmittance of the transmittance peak **702T** is between about 15% to about 35%, between about 20% to about 30%, or about 20% to about 25%.

[0179] In some embodiments, the maximum transmittance of transmittance peak **702T** is at a wavelength from about 430 nm to about 480 nm, or from about 435 nm to about 455 nm, or from about 445 nm to about 450 nm.

- [0180] In some embodiments, transmittance valley **706T** can be a saddleback transmittance valley. Transmittance valley **706T** may include a first minimum **716T**, a local maximum **718T**, and a second minimum **720T**.
- [0181] In some embodiments, a minimum transmittance of the valley **706T** is less than or equal to about 25%, between about 5% and about 25%, about 10% to about 15%, about 11%, about 12%, about 13%, or about 14%.
- [0182] In some embodiments, the second minimum **720T** of transmittance of valley **706T** is at a wavelength from about 465 nm to about 505 nm, from about 485 nm to about 505 nm, from about 490 nm to about 505 nm, about 495 nm to about 505 nm, at about 497 nm, at about 498 nm, at about 499 nm, or at about 500 nm.
- [0183] In some embodiments, local maximum **718T** is at wavelength from about 475 nm to about 495 nm, from about 480 nm to about 490 nm, at about 483 nm, at about 484 nm, or at about 485 nm. In some embodiments, first minimum **716T** is at wavelength from about 470 nm to about 490 nm, from about 475 nm to about 485 nm, at about 478 nm, at about 479 nm, or at about 480 nm.
- [0184] In some embodiments, a minimum transmittance of the valley **708T** is between about 5% to about 25%, between about 10% to about 20%, about 15%, about 16%, or about 17%.
- [0185] In some embodiments, the minimum transmittance of valley **708T** is at a wavelength from about 630 nm to about 680 nm, from about 650 nm to about 670 nm, about 655 nm to about 665 nm, at about 660 nm, at about 661 nm, at about 662 nm, or at about 663 nm.
- [0186] Referring to Fig. 7B, in some embodiments, absorbance peak **704A** can be a saddleback peak. Absorbance peak **704A** can include a first maximum **710A**, a local minimum **712A**, and a second maximum **714A**. First maximum **710A** can be associated with first minimum **710T**. Local maximum **712T** can be associated with local minimum **712A**. Second maximum **714A** can be associated with second minimum **714T**.
- [0187] Local minimum **712A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 581 nm, at about 582 nm, at about 583 nm, at about 584 nm, or at about 585 nm. First maximum **710A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 574 nm, at about 575 nm, at about 576 nm, at about 577

nm, at about 578 nm, or at about 579 nm. Second maximum **714A** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0188] In some embodiments, optical density at local minimum **712A** is from about 0.5 to about 1.5, from about 0.75 to about 1.25, or from about 0.95 to about 1.1. In some embodiments, optical density at first maximum **710A** is from about 0.5 to about 1.5, from about 0.75 to about 1.25, or from about 0.95 to about 1.1. In some embodiments, optical density at second minimum **714A** is from about 0.75 to about 1.7, from about 1 to about 1.5, or from about 1.2 to about 1.4.

[0189] In some embodiments, absorbance peak **706A** can be a saddleback peak. Absorbance peak **706A** can include a first maximum **716A**, a local minimum **718A**, and a second maximum **720A**. First maximum **716A** can be associated with first minimum **716T**. Local maximum **718T** can be associated with local minimum **718A**. Second maximum **720A** can be associated with second minimum **720T**.

[0190] In some embodiments, absorbance peak **706A** can have a maximum optical density from about 0.5 to about 1.5, from about 0.75 to about 1.25, or from about 0.85 to about 1.05.

[0191] In some embodiments, absorbance peak **708A** can have a maximum optical density from about 0.5 to about 1.2, from about 0.6 to about 1.1, or from about 0.7 to about 0.9.

[0192] In some embodiments, a scotopic transmission of the lens **200** is less than or equal to about 35%, is less than about 30%, is less than about 25%, is less than about 20%, about 19%, about 18%, or about 17%.

[0193] In some embodiments, a visible light transmission (as defined by EN1836) of lens **200** is from about 5% to about 30%, from about 10% to about 20%, about 16%, about 17%, or about 18%.

[0194] Fig. 8A illustrates an optical transmittance profile **800T**, according to some embodiments. Fig. 8B illustrates a respective optical absorbance profile **800A**, according to some embodiments. It would be understood that optical characteristics exhibited in Figs. 8A and 8B are merely illustrative and not intended to be limiting, unless mentioned otherwise. For example, optical transmittance profile **800T** can represent an optical

transmittance of optical filter **104**, lens **200**, lens **220**, or lens **240** that includes a chroma enhancement filter.

[0195] Optical transmittance profile **800T** can include one or more transmittance valleys, such as valleys **804T**, **806T**, **808T** each having a minimum transmittance in one or more spectral bands. Such transmittance valleys (e.g., valleys **804T**, **806T**, **808T**) can filter out or attenuate undesired spectral wavelengths of light. Accordingly, optical transmittance profile **800T** can provide chroma enhancement in the one or more spectral bands while maintaining a minimal desired transmission at each wavelength. Optical transmittance profile **800T** can also include one or more transmittance peaks such as peak **802T**.

[0196] In some embodiments, the optical transmittance valley and the respective absorbance peak can be positioned at about the same wavelength. Accordingly, each of the transmittance valleys in a spectrum can be regarded as an absorbance peak in the spectrum. For example, each of valleys **804T**, **806T**, and **808T** illustrated in optical transmittance profile **800T** can be hereinafter represented as absorbance peaks **804A**, **806A**, and **808A** in optical absorbance profile **800A**. As such, in referring to Fig. 8B, optical absorbance profile **800A** can include an absorbance peak **804A** associated with valley **804T**, an absorbance peak **806A** associated with valley **806T**, and an absorbance peak **808A** associated with valley **808T**.

[0197] Referring to Fig. 8A, in some embodiments, transmittance valley **804T** can be a saddleback transmittance valley. Transmittance valley **804T** may include a first minimum **810T**, a local maximum **812T**, and a second minimum **814T**.

[0198] Local maximum **812T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, about 582 nm, about 583 nm, about 584 nm, at about 585 nm, or at about 586 nm. First minimum **810T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, at about 579 nm, or at about 580 nm. Second minimum **814T** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0199] In some embodiments, transmittance at local maximum **812T** is from about 1% to about 15%, from about 5% to about 10%, about 7%, about 8%, or about 9%. In some embodiments, transmittance at first minimum **810T** is greater than about 5%, greater than

about 6%, between about 5% and about 10%, about 6%, about 7%, or about 8%. In some embodiments, transmittance at second minimum **814T** is greater than about 1%, greater than about 2%, greater than about 3% and less than about 6%, about 4%, about 5%, or about 6%.

[0200] In some embodiments, a difference in transmittance between transmittance at first minimum **810T** and transmittance at local maximum **812T** is less than about 5%, less than about 4%, less than about 3%, less than about 2%, or less than about 1%. In some aspects, a difference in transmittance at local maximum **812T** and transmittance at second minimum **814T** is greater than about 2% and less than about 6%, about 3%, about 4%, or about 5%.

[0201] As discussed previously herein, transmittance valley **804T** can be between a lower edge portion (e.g., closer to about 565 nm) and an upper edge portion (e.g., closer to about 610 nm) of the spectral band (e.g., between about 570 nm and about 600 nm). Transmittance at the lower edge portion and the upper edge portion can be greater than that of first minimum **810T**, second minimum **814T**, local maximum **812T**. For example, a difference in transmittance between a transmittance at the lower edge portion and the first minimum **810T** may be between about 1% to about 16%, between about 5% to about 10%, about 7%, about 8%, or about 9%. A difference between a transmittance at the upper edge portion and second minimum **814T** is between about 10% to about 30%, between about 15% to about 25%, about 21%, about 22%, or about 23%.

[0202] In some embodiments, transmittance valley **804T** can have a transmittance bandwidth of less than about 35 nm at the minimum transmittance plus 5% (transmittance at second minimum **814T**) and a transmittance bandwidth of less than about 35 nm at the minimum transmittance plus 10%.

[0203] In some embodiments, transmittance valley **808T** can have a transmittance bandwidth of less than about 15 nm at minimum transmittance plus 5% and a transmittance bandwidth of less than about 25 nm at minimum transmittance plus 10%, respectively.

[0204] In some embodiments, the maximum transmittance of the transmittance peak **802T** is between about 15% to about 35%, between about 20% to about 30%, or about 20% to about 25%.

- [0205] In some embodiments, the maximum transmittance of transmittance peak **802T** is at a wavelength from about 430 nm to about 480 nm, from about 435 nm to about 455 nm, or from about 445 nm to about 450 nm.
- [0206] In some embodiments, transmittance valley **806T** can be a saddleback transmittance valley. Transmittance valley **806T** may include a first minimum **816T**, a local maximum **818T**, and a second minimum **820T**.
- [0207] In some embodiments, a minimum transmittance of the valley **806T** is less than or equal to about 25%, between about 5% and about 25%, about 8% to about 15%, about 10%, about 11%, or about 12%.
- [0208] In some embodiments, the second minimum **820T** of valley **806T** is at a wavelength from about 465 nm to about 505 nm, from about 485 nm to about 505 nm, from about 490 nm to about 505 nm, about 495 nm to about 505 nm, at about 497 nm, at about 498 nm, at about 499 nm, or at about 500 nm.
- [0209] In some embodiments, local maximum **818T** is at wavelength from about 475 nm to about 495 nm, from about 480 nm to about 490 nm, at about 483 nm, at about 484 nm, or at about 485 nm. In some embodiments, first minimum **816T** is at wavelength from about 470 nm to about 490 nm, from about 475 nm to about 485 nm, at about 478 nm, at about 479 nm, or at about 480 nm.
- [0210] In some embodiments, a minimum transmittance of the valley **808T** is between about 5% to about 25%, between about 10% to about 20%, about 14%, about 15%, or about 16%.
- [0211] In some embodiments, the minimum transmittance of valley **808T** is at a wavelength from about 630 nm to about 680 nm, from about 650 nm to about 670 nm, about 655 nm to about 665 nm, at about 662 nm, at about 663 nm, or at about 664 nm.
- [0212] Referring to Fig. 8B, in some embodiments, absorbance peak **804A** can be a saddleback peak. Absorbance peak **804A** can include a first maximum **810A**, a local minimum **812A**, and a second maximum **814A**. First maximum **810A** can be associated with first minimum **810T**. Local maximum **812T** can be associated with local minimum **812A**. Second maximum **814A** can be associated with second minimum **814T**.
- [0213] Local minimum **812A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 581 nm, at about 582 nm, at about 583 nm, at about 584 nm, or at about 585 nm. First

maximum **810A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 574 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, or at about 579 nm. Second maximum **814A** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0214] In some embodiments, optical density at local minimum **812A** is from about 0.5 to about 1.5, from about 0.75 to about 1.25, or from about 0.95 to about 1.1. In some embodiments, optical density at first maximum **810A** is from about 0.5 to about 1.5, from about 0.75 to about 1.25, or from about 1 to about 1.2. In some embodiments, optical density at second minimum **814A** is from about 0.75 to about 1.7, from about 1 to about 1.5, or from about 1.2 to about 1.4.

[0215] In some embodiments, absorbance peak **806A** can be a saddleback peak. Absorbance peak **806A** can include a first maximum **816A**, a local minimum **818A**, and a second maximum **820A**. First maximum **816A** can be associated with first minimum **816T**. Local maximum **818T** can be associated with local minimum **818A**. Second maximum **820A** can be associated with second minimum **820T**.

[0216] In some embodiments, absorbance peak **806A** can have a maximum optical density from about 0.5 to about 1.5, from about 0.75 to about 1.25, or from about 0.95 to about 1.05.

[0217] In some embodiments, absorbance peak **808A** can have a maximum optical density from about 0.5 to about 1.2, from about 0.6 to about 1.1, or from about 0.7 to about 0.9.

[0218] In some embodiments, a scotopic transmission of the lens **200** is less than or equal to about 35%, is less than about 30%, is less than about 25%, is less than about 20%, about 14%, about 15%, or about 16%.

[0219] In some embodiments, a visible light transmission (as defined by EN1836) of lens **200** is from about 5% to about 30%, from about 10% to about 20%, from about 12% to about 16%, about 13%, about 14%, or about 15%.

[0220] Fig. 9A illustrates an optical transmittance profile **900T**, according to some embodiments. Fig. 9B illustrates a respective optical absorbance profile **900A**, according to some embodiments. It would be understood that optical characteristics exhibited in

Figs. 9A and 9B are merely illustrative and not intended to be limiting, unless mentioned otherwise. For example, optical transmittance profile **900T** can represent an optical transmittance of optical filter **104**, lens **200**, lens **220**, or lens **240** that includes a chroma enhancement filter.

[0221] Optical transmittance profile **900T** can include one or more transmittance valleys, such as valleys **904T**, **906T**, **908T** each having a minimum transmittance in one or more spectral bands. Such transmittance valleys (e.g., valleys **904T**, **906T**, **908T**) can filter out or attenuate undesired spectral wavelengths of light. Accordingly, optical transmittance profile **900T** can provide chroma enhancement in the one or more spectral bands while maintaining a minimal desired transmission at each wavelength. Optical transmittance profile **900T** can also include one or more transmittance peaks such as peak **902T**.

[0222] In some embodiments, the optical transmittance valley and the respective absorbance peak can be positioned at about the same wavelength. Accordingly, each of the transmittance valleys in a spectrum can be regarded as an absorbance peak in the spectrum. For example, each of valleys **904T**, **906T**, and **908T** illustrated in optical transmittance profile **900T** can be hereinafter represented as absorbance peaks **904A**, **906A**, and **908A** in optical absorbance profile **900A**. As such, in referring to Fig. 9B, optical absorbance profile **900A** can include an absorbance peak **904A** associated with valley **904T**, an absorbance peak **906A** associated with valley **906T**, and an absorbance peak **908A** associated with valley **908T**.

[0223] Referring to Fig. 9A, In some embodiments, transmittance valley **904T** can be a saddleback transmittance valley. Transmittance valley **904T** may include a first minimum **910T**, a local maximum **912T**, and a second minimum **914T**.

[0224] Local maximum **912T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 582 nm, at about 583 nm, at about 584 nm, at about 585 nm, or at about 586 nm. First minimum **910T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, at about 579 nm, or at about 580 nm. Second minimum **914T** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0225] In some embodiments, transmittance at local maximum **912T** is from about 1% to about 20%, from about 3% to about 15%, from about 5% to about 10%, about 6%, about 7%, or about 8%. In some embodiments, transmittance at first minimum **910T** is greater than about 5%, greater than about 6%, between about 4% and about 8%, about 6%, about 7%, or about 8%. In some embodiments, transmittance at second minimum **914T** is greater than about 1%, greater than about 2%, greater than about 3% and less than about 6%, about 3%, about 4%, or about 5%.

[0226] In some embodiments, a difference in transmittance between transmittance at first minimum **910T** and transmittance at local maximum **912T** is less than about 5%, less than about 4%, less than about 3%, less than about 2%, or less than about 1%. In some aspects, a difference in transmittance at local maximum **912T** and transmittance at second minimum **914T** is greater than about 2% and less than about 6%, about 3%, about 5%, or about 4%.

[0227] As discussed previously herein, transmittance valley **904T** can be between a lower edge portion (e.g., closer to about 565 nm) and an upper edge portion (e.g., closer to about 610 nm) of the spectral band (e.g., between about 570 nm and about 600 nm). Transmittance at the lower edge portion and the upper edge portion can be greater than that of first minimum **910T**, second minimum **914T**, local maximum **912T**. For example, a difference in transmittance between a transmittance at the lower edge portion and the first minimum **910T** may be between about 1% to about 16%, between about 5% to about 12%, about 7%, about 8%, or about 9%. A difference between a transmittance at the upper edge portion and second minimum **914T** is between about 5% to about 25%, between about 10% to about 20%, between about 12% to about 18%, about 15%, about 16%, or about 17%.

[0228] In some embodiments, transmittance valley **904T** can have a transmittance bandwidth of less than about 45 nm, less than about 40 nm, or less than about 35 nm at the minimum transmittance plus 5% (transmittance at second minimum **914T**). In some embodiments, transmittance valley **904T** can have a transmittance bandwidth of less than about 50 nm, less than about 45 nm, or less than about 40 nm at the minimum transmittance plus 10%.

[0229] In some embodiments, transmittance valley **908T** can have a transmittance bandwidth of less than about 25 nm at minimum transmittance plus 5%.

- [0230] In some embodiments, the maximum transmittance of the transmittance peak **902T** is between about 5% to about 30%, between about 10% to about 25%, or about 15% to about 20%.
- [0231] In some embodiments, the maximum transmittance of transmittance peak **902T** is at a wavelength from about 430 nm to about 480 nm, or from about 435 nm to about 455 nm, or from about 445 nm to about 450 nm.
- [0232] In some embodiments, transmittance valley **906T** can be a saddleback transmittance valley. Transmittance valley **906T** may include a first minimum **916T**, a local maximum **918T**, and a second minimum **920T**.
- [0233] In some embodiments, a minimum transmittance of the valley **906T** is less than or equal to about 25%, between about 5% and about 15%, about 7% to about 12%, about 8%, about 9%, or about 10%.
- [0234] In some embodiments, the second minimum **920T** of valley **906T** is at a wavelength from about 465 nm to about 505 nm, from about 485 nm to about 505 nm, from about 490 nm to about 505 nm, about 495 nm to about 505 nm, at about 497 nm, at about 498 nm, at about 499 nm, or at about 500 nm.
- [0235] In some embodiments, local maximum **918T** is at wavelength from about 475 nm to about 495 nm, from about 480 nm to about 490 nm, at about 483 nm, at about 484 nm, or at about 485 nm. In some embodiments, first minimum **916T** is at wavelength from about 470 nm to about 490 nm, from about 475 nm to about 485 nm, at about 478 nm, at about 479 nm, or at about 480 nm.
- [0236] In some embodiments, a minimum transmittance of the valley **908T** is between about 5% to about 25%, between about 10% to about 20%, about 11%, about 12%, or about 13%.
- [0237] In some embodiments, the minimum transmittance of valley **908T** is at a wavelength from about 630 nm to about 680 nm, from about 650 nm to about 670 nm, about 655 nm to about 665 nm, at about 660 nm, at about 661 nm, at about 662 nm, or at about 663 nm.
- [0238] Referring to Fig. 9B, in some embodiments, absorbance peak **904A** can be a saddleback peak. Absorbance peak **904A** can include a first maximum **910A**, a local minimum **912A**, and a second maximum **914A**. First maximum **910A** can be associated

with first minimum **910T**. Local maximum **912T** can be associated with local minimum **912A**. Second maximum **914A** can be associated with second minimum **914T**.

- [0239] Local minimum **912A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 581 nm, at about 582 nm, at about 583 nm, at about 584 nm, or at about 585 nm. First maximum **910A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 574 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, or at about 579 nm. Second maximum **914A** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.
- [0240] In some embodiments, optical density at local minimum **912A** is from about 0.5 to about 1.5, from about 0.75 to about 1.3, or from about 1 to about 1.2. In some embodiments, optical density at first maximum **910A** is from about 0.75 to about 1.5, from about 1 to about 1.4, or from about 1.1 to about 1.3. In some embodiments, optical density at second minimum **914A** is from about 1 to about 1.9, from about 1.2 to about 1.6, or from about 1.3 to about 1.5.
- [0241] In some embodiments, absorbance peak **906A** can be a saddleback peak. Absorbance peak **906A** can include a first maximum **916A**, a local minimum **918A**, and a second maximum **920A**. First maximum **916A** can be associated with first minimum **916T**. Local maximum **918T** can be associated with local minimum **918A**. Second maximum **920A** can be associated with second minimum **920T**.
- [0242] In some embodiments, absorbance peak **906A** can have a maximum optical density from about 0.5 to about 1.5, from about 0.75 to about 1.25, or from about 0.95 to about 1.1.
- [0243] In some embodiments, absorbance peak **908A** can have a maximum optical density from about 0.5 to about 1.2, from about 0.6 to about 1.1, or from about 0.8 to about 1.
- [0244] In some embodiments, a scotopic transmission of the lens **200** is less than or equal to about 30%, is less than about 25%, is less than about 20%, is less than about 15%, about 12%, about 13%, or about 14%.

- [0245] In some embodiments, a visible light transmission (as defined by EN1836) of lens **200** is from about 5% to about 25%, from about 7% to about 15%, about 11%, about 12%, or about 13%.
- [0246] Fig. 10A illustrates an optical transmittance profile **1000T**, according to some embodiments. Fig. 10B illustrates a respective optical absorbance profile **1000A**, according to some embodiments. It would be understood that optical characteristics exhibited in Figs. 10A and 10B are merely illustrative and not intended to be limiting, unless mentioned otherwise. For example, optical transmittance profile **1000T** can represent an optical transmittance of optical filter **104**, lens **200**, lens **220**, or lens **240** that includes a chroma enhancement filter.
- [0247] Optical transmittance profile **1000T** can include one or more transmittance valleys, such as valleys **1004T**, **1006T**, **1008T** each having a minimum transmittance in one or more spectral bands. Such transmittance valleys (e.g., valleys **1004T**, **1006T**, **1008T**) can filter out or attenuate undesired spectral wavelengths of light. Accordingly, optical transmittance profile **1000T** can provide chroma enhancement in the one or more spectral bands while maintaining a minimal desired transmission at each wavelength. Optical transmittance profile **700T** can also include one or more transmittance peaks such as peak **1002T**.
- [0248] In some embodiments, the optical transmittance valley and the respective absorbance peak can be positioned at about the same wavelength. Accordingly, each of the transmittance valleys in a spectrum can be regarded as an absorbance peak in the spectrum. For example, each of valleys **1004T**, **1006T**, and **1008T** illustrated in optical transmittance profile **1000T** can be hereinafter represented as absorbance peaks **1004A**, **1006A**, and **1008A** in optical absorbance profile **1000A**. As such, in referring to Fig. 7B, optical absorbance profile **1000A** can include an absorbance peak **1004A** associated with valley **1004T**, an absorbance peak **1006A** associated with valley **1006T**, and an absorbance peak **1008A** associated with valley **1008T**.
- [0249] Referring to Fig. 10A, in some embodiments, transmittance valley **1004T** can be a saddleback transmittance valley. Transmittance valley **1004T** may include a first minimum **1010T**, a local maximum **1012T**, and a second minimum **1014T**.
- [0250] Local maximum **1012T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 582

nm, at about 583 nm, at about 584 nm, at about 585 nm, or at about 586 nm. First minimum **1010T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, at about 579 nm, or at about 580 nm. Second minimum **1014T** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0251] In some embodiments, transmittance at local maximum **1012T** is from about 1% to about 20%, from about 5% to about 15%, from about 6% to about 10%, about 7%, about 8%, or about 9%. In some embodiments, transmittance at first minimum **1010T** is greater than about 5%, greater than about 6%, between about 5% and about 10%, about 6%, about 7%, or about 8%. In some embodiments, transmittance at second minimum **1014T** is from about 2% to about 6%, about 3%, about 4%, or about 5%.

[0252] In some embodiments, a difference in transmittance between transmittance at first minimum **1010T** and transmittance at local maximum **1012T** is less than about 5%, less than about 4%, less than about 3%, less than about 2%, or less than about 1%. In some aspects, a difference in transmittance at local maximum **1012T** and transmittance at second minimum **1014T** is greater than about 2% and less than about 6%, about 2%, about 3%, or about 4%.

[0253] As discussed previously herein, transmittance valley **1004T** can be between a lower edge portion (e.g., closer to about 565 nm) and an upper edge portion (e.g., closer to about 610 nm) of the spectral band (e.g., between about 570 nm and about 600 nm). Transmittance at the lower edge portion and the upper edge portion can be greater than that of first minimum **1010T**, second minimum **1014T**, local maximum **1012T**. For example, a difference in transmittance between a transmittance at the lower edge portion and the first minimum **1010T** may be between about 2% to about 10%, between about 4% to about 8%, or about 6%. A difference between a transmittance at the upper edge portion and second minimum **1014T** is between about 10% to about 30%, between about 15% to about 25%, about 20%, about 21%, or about 22%.

[0254] In some embodiments, transmittance valley **1004T** can have a transmittance bandwidth of less than about 45 nm, less than about 40 nm, or less than about 35 nm at the minimum transmittance plus 5% (transmittance at second minimum **1014T**). In some

embodiments, transmittance valley **1004T** can have a transmittance bandwidth of less than about 50 nm, less than about 45 nm, or less than about 40 nm at the minimum transmittance plus 10%.

[0255] In some embodiments, transmittance valley **1008T** can have a transmittance bandwidth of less than about 20 nm at minimum transmittance plus 5% and a transmittance bandwidth of less than about 25 nm at minimum transmittance plus 10%, respectively.

[0256] In some embodiments, the maximum transmittance of the transmittance peak **1002T** is between about 5% to about 20% or between about 10% to about 15%.

[0257] In some embodiments, the maximum transmittance of transmittance peak **1002T** is at a wavelength from about 430 nm to about 480 nm, from about 435 nm to about 455 nm, or from about 445 nm to about 450 nm.

[0258] In some embodiments, transmittance valley **1006T** can be a saddleback transmittance valley. Transmittance valley **1006T** may include a first minimum **1016T**, a local maximum **1018T**, and a second minimum **1020T**.

[0259] In some embodiments, a minimum transmittance of the valley **1006T** is less than or equal to about 25%, between about 1% and about 10%, about 2% to about 7%, about 4%, about 5%, or about 6%.

[0260] In some embodiments, second minimum **1020T** of valley **1006T** is at a wavelength from about 465 nm to about 505 nm, from about 485 nm to about 505 nm, from about 490 nm to about 505 nm, about 495 nm to about 505 nm, about 497 nm, at about 498 nm, at about 499 nm, or at about 500 nm.

[0261] In some embodiments, local maximum **1018T** is at wavelength from about 475 nm to about 495 nm, from about 480 nm to about 490 nm, at about 483 nm, at about 484 nm, or at about 485 nm. In some embodiments, first minimum **1016T** is at wavelength from about 470 nm to about 490 nm, from about 475 nm to about 485 nm, at about 478 nm, at about 479 nm, or at about 480 nm.

[0262] In some embodiments, a minimum transmittance of the valley **1008T** is between about 5% to about 25%, between about 10% to about 20%, about 16%, about 17%, or about 18%.

[0263] In some embodiments, the minimum transmittance of valley **1008T** is at a wavelength from about 630 nm to about 680 nm, from about 650 nm to about 670 nm,

about 655 nm to about 665 nm, at about 660 nm, at about 661 nm, at about 662 nm, or at about 663 nm.

[0264] Referring to Fig. 10B, in some embodiments, absorbance peak **1004A** can be a saddleback peak. Absorbance peak **1004A** can include a first maximum **1010A**, a local minimum **1012A**, and a second maximum **1014A**. First maximum **1010A** can be associated with first minimum **1010T**. Local maximum **1012T** can be associated with local minimum **1012A**. Second maximum **1014A** can be associated with second minimum **1014T**.

[0265] Local minimum **1012A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 581 nm, at about 582 nm, at about 583 nm, at about 584 nm, or at about 585 nm. First maximum **1010A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 574 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, or at about 579 nm. Second maximum **1014A** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0266] In some embodiments, optical density at local minimum **1012A** is from about 0.5 to about 1.5, from about 0.9 to about 1.4, or from about 0.9 to about 1.2. In some embodiments, optical density at first maximum **1010A** is from about 0.75 to about 1.6, from about 1 to about 1.4, or from about 1.1 to about 1.3. In some embodiments, optical density at second minimum **1014A** is from about 1 to about 1.7, from about 1.1 to about 1.5, or from about 1.2 to about 1.4.

[0267] In some embodiments, absorbance peak **1006A** can be a saddleback peak. Absorbance peak **1006A** can include a first maximum **1016A**, a local minimum **1018A**, and a second maximum **1020A**. First maximum **1016A** can be associated with first minimum **1016T**. Local maximum **1018T** can be associated with local minimum **1018A**. Second maximum **1020A** can be associated with second minimum **1020T**.

[0268] In some embodiments, absorbance peak **1006A** can have a maximum optical density from about 1 to about 1.6, from about 1.1 to about 1.5, or from about 1.2 to about 1.4.

- [0269] In some embodiments, absorbance peak **1008A** can have a maximum optical density from about 0.5 to about 1.2, from about 0.6 to about 1.1, or from about 0.7 to about 0.9.
- [0270] In some embodiments, a scotopic transmission of the lens **200** is less than or equal to about 25%, is less than about 20%, is less than about 15%, about 8%, about 9%, or about 10%.
- [0271] In some embodiments, a visible light transmission (as defined by EN1836) of lens **200** is from about 5% to about 20%, from about 7% to about 15%, about 10%, about 11%, or about 12%.
- [0272] Fig. 11A illustrates an optical transmittance profile **1100T**, according to some embodiments. Fig. 11B illustrates a respective optical absorbance profile **1100A**, according to some embodiments. It would be understood that optical characteristics exhibited in Figs. 11A and 11B are merely illustrative and not intended to be limiting, unless mentioned otherwise. For example, optical transmittance profile **1100T** can represent an optical transmittance of optical filter **104**, lens **200**, lens **220**, or lens **240** that includes a chroma enhancement filter.
- [0273] Optical transmittance profile **1100T** can include one or more transmittance valleys, such as valleys **1104T**, **1106T**, **1108T** each having a minimum transmittance in one or more spectral bands. Such transmittance valleys (e.g., valleys **1104T**, **1106T**, **1108T**) can filter out or attenuate undesired spectral wavelengths of light. Accordingly, optical transmittance profile **1100T** can provide chroma enhancement in the one or more spectral bands while maintaining a minimal desired transmission at each wavelength. Optical transmittance profile **1100T** can also include one or more transmittance peaks such as peak **1102T**.
- [0274] In some embodiments, the optical transmittance valley and the respective absorbance peak can be positioned at about the same wavelength. Accordingly, each of the transmittance valleys in a spectrum can be regarded as an absorbance peak in the spectrum. For example, each of valleys **1104T**, **1106T**, and **1108T** illustrated in optical transmittance profile **1100T** can be hereinafter represented as absorbance peaks **1104A**, **1106A**, and **1108A** in optical absorbance profile **1100A**. As such, in referring to Fig. 11B, optical absorbance profile **1100A** can include an absorbance peak **1104A** associated with

valley **1104T**, an absorbance peak **1106A** associated with valley **1106T**, and an absorbance peak **1108A** associated with valley **1108T**.

[0275] Referring to Fig. 11A, in some embodiments, transmittance valley **1104T** can be a saddleback transmittance valley. Transmittance valley **1104T** may include a first minimum **1110T**, a local maximum **1112T**, and a second minimum **1114T**.

[0276] Local maximum **1112T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 582 nm, at about 583 nm, at about 584 nm, at about 585 nm, or at about 586 nm. First minimum **1110T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, at about 579 nm, or at about 580 nm. Second minimum **1114T** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0277] In some embodiments, transmittance at local maximum **1112T** is from about 1% to about 20%, from about 5% to about 15%, about 7%, about 8%, or about 9%. In some embodiments, transmittance at first minimum **1110T** is from about 2% to about 10%, from about 4% to about 8%, about 5%, about 6%, or about 7%. In some embodiments, transmittance at second minimum **1114T** is from about 2% to about 10%, from about 4% to about 8%, about 5%, about 6%, or about 7%.

[0278] In some embodiments, a difference in transmittance between transmittance at first minimum **1110T** and transmittance at local maximum **1112T** is less than about 5%, less than about 4%, less than about 3%, or less than about 2%. In some aspects, a difference in transmittance at local maximum **1112T** and transmittance at second minimum **1114T** is greater than about 2% and less than about 6%, about 3%, about 4%, or about 5%.

[0279] As discussed previously herein, transmittance valley **1104T** can be between a lower edge portion (e.g., closer to about 565 nm) and an upper edge portion (e.g., closer to about 610 nm) of the spectral band (e.g., between about 570 nm and about 600 nm). Transmittance at the lower edge portion and the upper edge portion can be greater than that of first minimum **1110T**, second minimum **1114T**, local maximum **1112T**. For example, a difference in transmittance between a transmittance at the lower edge portion and the first minimum **1110T** may be from about 5% to about 25%, from about 10% to

about 20%, about 15%, about 16%, or about 17%. A difference between a transmittance at the upper edge portion and second minimum **1114T** is from about 10% to about 30%, from about 15% to about 25%, about 19%, about 18%, or about 17%.

[0280] In some embodiments, transmittance valley **1104T** can have a transmittance bandwidth of less than about 45 nm, less than about 40 nm, or less than about 35 nm at the minimum transmittance plus 5%. In some embodiments, transmittance valley **1104T** can have a transmittance bandwidth of less than about 50 nm, less than about 45 nm, or less than about 40 nm at the minimum transmittance plus 10%.

[0281] In some embodiments, transmittance valley **1108T** can have a transmittance bandwidth of less than about 25 nm at minimum transmittance plus 5%.

[0282] In some embodiments, the maximum transmittance of the transmittance peak **1102T** is between about 15% to about 35%, between about 20% to about 30%, or about 25% to about 30%.

[0283] In some embodiments, the maximum transmittance of transmittance peak **1102T** is at a wavelength from about 430 nm to about 480 nm, or from about 435 nm to about 455 nm, or from about 445 nm to about 450 nm.

[0284] In some embodiments, transmittance valley **1106T** can be a saddleback transmittance valley. Transmittance valley **1106T** may include a first minimum **1116T**, a local maximum **1118T**, and a second minimum **1120T**.

[0285] In some embodiments, a minimum transmittance of the valley **1106T** is less than or equal to about 25%, from about 5% and about 15%, from about 7% to about 12%, about 9%, about 10%, or about 11%.

[0286] In some embodiments, the second minimum **1120T** of valley **1106T** is at a wavelength from about 465 nm to about 505 nm, from about 485 nm to about 505 nm, from about 490 nm to about 505 nm, about 495 nm to about 505 nm, at about 497 nm, at about 498 nm, at about 499 nm, or at about 500 nm.

[0287] In some embodiments, local maximum **1118T** is at wavelength from about 475 nm to about 495 nm, from about 480 nm to about 490 nm, at about 483 nm, at about 484 nm, or at about 485 nm. In some embodiments, first minimum **1116T** is at wavelength from about 470 nm to about 490 nm, from about 475 nm to about 485 nm, at about 478 nm, at about 479 nm, or at about 480 nm.

- [0288] In some embodiments, a minimum transmittance of the valley **1108T** is between about 5% to about 25%, between about 7% to about 16%, about 11%, about 12%, or about 13%.
- [0289] In some embodiments, the minimum transmittance of valley **1108T** is at a wavelength from about 630 nm to about 680 nm, from about 650 nm to about 670 nm, about 655 nm to about 665 nm, at about 659 nm, at about 660 nm, at about 661 nm, or at about 662 nm.
- [0290] Referring to Fig. 11B, in some embodiments, absorbance peak **1104A** can be a saddleback peak. Absorbance peak **1104A** can include a first maximum **1110A**, a local minimum **1112A**, and a second maximum **1114A**. First maximum **1110A** can be associated with first minimum **1110T**. Local maximum **1112T** can be associated with local minimum **1112A**. Second maximum **1114A** can be associated with second minimum **1114T**.
- [0291] Local minimum **1112A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 584 nm, at about 585 nm, at about 586 nm, at about 587 nm, or at about 588 nm. First maximum **1110A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 577 nm, at about 578 nm, or at about 579 nm. Second maximum **1114A** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.
- [0292] In some embodiments, optical density at local minimum **1112A** is from about 0.5 to about 1.5, from about 0.75 to about 1.25, or from about 1 to about 1.2. In some embodiments, optical density at first maximum **1110A** is from about 1 to about 1.4, or from about 1.1 to about 1.3. In some embodiments, optical density at second minimum **1114A** is from about 1 to about 1.6, from about 1.1 to about 1.5, or from about 1.2 to about 1.4.
- [0293] Referring to Fig. 11B, in some embodiments, absorbance peak **1106A** can be a saddleback peak. Absorbance peak **1106A** can include a first maximum **1116A**, a local minimum **1118A**, and a second maximum **1120A**. First maximum **1116A** can be associated with first minimum **1116T**. Local maximum **1118T** can be associated with

local minimum **1118A**. Second maximum **1120A** can be associated with second minimum **1120T**.

- [0294] In some embodiments, absorbance peak **1106A** can have a maximum optical density from about 0.5 to about 1.5, from about 0.75 to about 1.25, or from about 0.85 to about 1.05.
- [0295] In some embodiments, absorbance peak **1108A** can have a maximum optical density from about 0.6 to about 1.2, from about 0.7 to about 1.1, or from about 0.8 to about 1.
- [0296] In some embodiments, a scotopic transmission of the lens **200** is less than or equal to about 35%, is less than about 30%, is less than about 25%, is less than about 20%, about 16%, about 17%, or about 18%.
- [0297] In some embodiments, a visible light transmission (as defined by EN1836) of lens **200** is from about 5% to about 30%, from about 10% to about 20%, about 16%, about 17%, or about 18%.
- [0298] Fig. 12A illustrates an optical transmittance profile **1200T**, according to some embodiments. Fig. 12B illustrates a respective optical absorbance profile **1200A**, according to some embodiments. It would be understood that optical characteristics exhibited in Figs. 12A and 12B are merely illustrative and not intended to be limiting, unless mentioned otherwise. For example, optical transmittance profile **1200T** can represent an optical transmittance of optical filter **104**, lens **200**, lens **220**, or lens **240** that includes a chroma enhancement filter.
- [0299] Optical transmittance profile **1200T** can include one or more transmittance valleys, such as valleys **1204T**, **1206T**, **1208T** each having a minimum transmittance in one or more spectral bands. Such transmittance valleys (e.g., valleys **1204T**, **1206T**, **1208T**) can filter out or attenuate undesired spectral wavelengths of light. Accordingly, optical transmittance profile **1200T** can provide chroma enhancement in the one or more spectral bands while maintaining a minimal desired transmission at each wavelength. Optical transmittance profile **1200T** can also include one or more transmittance peaks such as peak **1202T**.
- [0300] In some embodiments, the optical transmittance valley and the respective absorbance peak can be positioned at about the same wavelength. Accordingly, each of the transmittance valleys in a spectrum can be regarded as an absorbance peak in the

spectrum. For example, each of valleys **1204T**, **1206T**, and **1208T** illustrated in optical transmittance profile **1200T** can be hereinafter represented as absorbance peaks **1204A**, **1206A**, and **1208A** in optical absorbance profile **1200A**. As such, in referring to Fig. 12B, optical absorbance profile **1200A** can include an absorbance peak **1204A** associated with valley **1204T**, an absorbance peak **1206A** associated with valley **1206T**, and an absorbance peak **1208A** associated with valley **1208T**.

[0301] Referring to Fig. 12A, in some embodiments, transmittance valley **1204T** can be a saddleback transmittance valley. Transmittance valley **1204T** may include a first minimum **1210T**, a local maximum **1212T**, and a second minimum **1214T**.

[0302] Local maximum **1212T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 584 nm, at about 585 nm, at about 586 nm, at about 587 nm, or at about 588 nm. First minimum **1210T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, at about 579 nm, or at about 580 nm. Second minimum **1214T** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0303] In some embodiments, transmittance at local maximum **1212T** is from about 1% to about 20%, from about 5% to about 15%, about 7%, about 8%, or about 9%. In some embodiments, transmittance at first minimum **1210T** is from about 2% to about 10%, from about 4% to about 8%, about 5%, about 6%, or about 7%. In some embodiments, transmittance at second minimum **1214T** is from about 2% to about 10%, from about 3% to about 8%, about 4%, about 5%, or about 6%.

[0304] In some embodiments, a difference in transmittance between transmittance at first minimum **1210T** and transmittance at local maximum **1212T** is less than about 5%, less than about 4%, less than about 3%, or less than about 2%. In some aspects, a difference in transmittance at local maximum **1212T** and transmittance at second minimum **1214T** is greater than about 2% and less than about 5%, about 2%, or about 3%.

[0305] As discussed previously herein, transmittance valley **1204T** can be between a lower edge portion (e.g., closer to about 565 nm) and an upper edge portion (e.g., closer to about 610 nm) of the spectral band (e.g., between about 570 nm and about 600 nm).

Transmittance at the lower edge portion and the upper edge portion can be greater than that of first minimum **1210T**, second minimum **1214T**, local maximum **1212T**. For example, a difference in transmittance between a transmittance at the lower edge portion and the first minimum **1210T** may be from about 5% to about 20%, from about 7% to about 15%, about 10%, about 11%, or about 12%. A difference between a transmittance at the upper edge portion and second minimum **1214T** is from about 10% to about 30%, from about 15% to about 25%, about 19%, about 20%, or about 21%.

- [0306] In some embodiments, transmittance valley **1204T** can have a transmittance bandwidth of less than about 45 nm, less than about 40 nm, or less than about 35 nm at the minimum transmittance plus 5%. In some embodiments, transmittance valley **1204T** can have a transmittance bandwidth of less than about 50 nm, less than about 45 nm, or less than about 40 nm at the minimum transmittance plus 10%.
- [0307] In some embodiments, transmittance valley **1208T** can have a transmittance bandwidth of less than about 25 nm at minimum transmittance plus 5%.
- [0308] In some embodiments, the maximum transmittance of the transmittance peak **1202T** is between about 15% to about 40%, between about 20% to about 35%, or between about 25% to about 30%.
- [0309] In some embodiments, the maximum transmittance of transmittance peak **1202T** is at a wavelength from about 430 nm to about 480 nm, or from about 435 nm to about 455 nm, or from about 445 nm to about 450 nm.
- [0310] In some embodiments, transmittance valley **1206T** can be a saddleback transmittance valley. Transmittance valley **1206T** may include a first minimum **1216T**, a local maximum **1218T**, and a second minimum **1220T**.
- [0311] In some embodiments, a minimum transmittance of the valley **1206T** is less than or equal to about 25%, from about 2% and about 9%, from about 3% to about 8%, about 7%, about 8%, or about 9%.
- [0312] In some embodiments, second minimum **1220T** of valley **1206T** is at a wavelength from about 465 nm to about 505 nm, from about 485 nm to about 505 nm, from about 490 nm to about 505 nm, about 495 nm to about 505 nm, at about 496 nm, at about 497 nm, at about 498 nm, or at about 499 nm.
- [0313] In some embodiments, local maximum **1218T** is at wavelength from about 475 nm to about 495 nm, from about 480 nm to about 490 nm, at about 483 nm, at about 484

nm, or at about 485 nm. In some embodiments, first minimum **1216T** is at wavelength from about 470 nm to about 490 nm, from about 475 nm to about 485 nm, at about 478 nm, at about 479 nm, or at about 480 nm.

[0314] In some embodiments, a minimum transmittance of the valley **1208T** is between about 5% to about 25%, between about 7% to about 16%, about 10%, about 11%, or about 12%.

[0315] In some embodiments, the minimum transmittance of valley **1208T** is at a wavelength from about 630 nm to about 680 nm, from about 650 nm to about 670 nm, about 655 nm to about 665 nm, at about 659 nm, at about 661 nm, at about 662 nm, or at about 663 nm.

[0316] Referring to Fig. 12B, in some embodiments, absorbance peak **1204A** can be a saddleback peak. Absorbance peak **1204A** can include a first maximum **1210A**, a local minimum **1212A**, and a second maximum **1214A**. First maximum **1210A** can be associated with first minimum **1210T**. Local maximum **1212T** can be associated with local minimum **1212A**. Second maximum **1214A** can be associated with second minimum **1214T**.

[0317] Local minimum **1212A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 584 nm, at about 585 nm, at about 586 nm, at about 587 nm, or at about 588 nm. First maximum **1210A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 577 nm, at about 578 nm, or at about 579 nm. Second maximum **1214A** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0318] In some embodiments, optical density at local minimum **1212A** is from about 0.5 to about 1.5, from about 0.75 to about 1.25, or from about 1 to about 1.2. In some embodiments, optical density at first maximum **1210A** is from about 1 to about 1.4, or from about 1.1 to about 1.3. In some embodiments, optical density at second minimum **1214A** is from about 1 to about 1.4, or from about 1.1 to about 1.3.

[0319] In some embodiments, absorbance peak **1206A** can be a saddleback peak. Absorbance peak **1206A** can include a first maximum **1216A**, a local minimum **1218A**, and a second maximum **1220A**. First maximum **1216A** can be associated with first

minimum **1216T**. Local maximum **1218T** can be associated with local minimum **1218A**. Second maximum **1220A** can be associated with second minimum **1220T**.

- [0320] In some embodiments, absorbance peak **1206A** can have a maximum optical density from about 0.5 to about 1.5, from about 0.75 to about 1.25, or from about 0.85 to about 1.05.
- [0321] In some embodiments, absorbance peak **1208A** can have a maximum optical density from about 0.8 to about 1.2 or from about 0.9 to about 1.1.
- [0322] In some embodiments, a scotopic transmission of the lens **200** is less than or equal to about 35%, is less than about 30%, is less than about 25%, is less than about 20%, about 13%, about 14%, or about 15%.
- [0323] In some embodiments, a visible light transmission (as defined by EN1836) of lens **200** is from about 5% to about 30%, from about 10% to about 20%, about 13%, about 14%, or about 15%.
- [0324] Fig. 13A illustrates an optical transmittance profile **1300T**, according to some embodiments. Fig. 13B illustrates a respective optical absorbance profile **1300A**, according to some embodiments. It would be understood that optical characteristics exhibited in Figs. 13A and 13B are merely illustrative and not intended to be limiting, unless mentioned otherwise. For example, optical transmittance profile **1300T** can represent an optical transmittance of optical filter **104**, lens **200**, lens **220**, or lens **240** that includes a chroma enhancement filter.
- [0325] Optical transmittance profile **1300T** can include one or more transmittance valleys, such as valleys **1304T**, **1306T**, **1308T** each having a minimum transmittance in one or more spectral bands. Such transmittance valleys (e.g., valleys **1304T**, **1306T**, **1308T**) can filter out or attenuate undesired spectral wavelengths of light. Accordingly, optical transmittance profile **1300T** can provide chroma enhancement in the one or more spectral bands while maintaining a minimal desired transmission at each wavelength. Optical transmittance profile **1300T** can also include one or more transmittance peaks such as peak **1302T**.
- [0326] In some embodiments, the optical transmittance valley and the respective absorbance peak can be positioned at about the same wavelength. Accordingly, each of the transmittance valleys in a spectrum can be regarded as an absorbance peak in the spectrum. For example, each of valleys **1304T**, **1306T**, and **1308T** illustrated in optical

transmittance profile **1300T** can be hereinafter represented as absorbance peaks **1304A**, **1306A**, and **1308A** in optical absorbance profile **1300A**. As such, in referring to Fig. 13B, optical absorbance profile **1300A** can include an absorbance peak **1304A** associated with valley **1304T**, an absorbance peak **1306A** associated with valley **1306T**, and an absorbance peak **1308A** associated with valley **1308T**.

[0327] Referring to Fig. 13A, in some embodiments, transmittance valley **1304T** can be a saddleback transmittance valley. Transmittance valley **1304T** may include a first minimum **1310T**, a local maximum **1312T**, and a second minimum **1314T**.

[0328] Local maximum **1312T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 584 nm, at about 585 nm, at about 586 nm, at about 587 nm, or at about 588 nm. First minimum **1310T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, at about 579 nm, or at about 580 nm. Second minimum **1314T** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0329] In some embodiments, transmittance at local maximum **1312T** is from about 1% to about 20%, from about 5% to about 15%, about 5%, about 6%, or about 7%. In some embodiments, transmittance at first minimum **1310T** is from about 2% to about 10%, from about 3% to about 8%, about 4%, about 5%, or about 6%. In some embodiments, transmittance at second minimum **1314T** is from about 2% to about 10%, from about 3% to about 8%, about 4%, about 5%, or about 6%.

[0330] In some embodiments, a difference in transmittance between transmittance at first minimum **1310T** and transmittance at local maximum **1312T** is less than about 5%, less than about 4%, less than about 3%, or less than about 2%. In some aspects, a difference in transmittance at local maximum **1312T** and transmittance at second minimum **1314T** is less than about 5%, less than about 4%, less than about 3%, or less than about 2%.

[0331] As discussed previously herein, transmittance valley **1304T** can be between a lower edge portion (e.g., closer to about 565 nm) and an upper edge portion (e.g., closer to about 610 nm) of the spectral band (e.g., between about 570 nm and about 600 nm). Transmittance at the lower edge portion and the upper edge portion can be greater than

that of first minimum **1310T**, second minimum **1314T**, local maximum **1312T**. For example, a difference in transmittance between a transmittance at the lower edge portion and the first minimum **1310T** may be from about 5% to about 20%, from about 7% to about 15%, about 10%, about 11%, or about 12%. A difference between a transmittance at the upper edge portion and second minimum **1314T** is from about 5% to about 25%, from about 10% to about 20%, about 14%, about 15%, or about 16%.

- [0332] In some embodiments, transmittance valley **1304T** can have a transmittance bandwidth of less than about 45 nm, less than about 40 nm, or less than about 35 nm at the minimum transmittance plus 5%. In some embodiments, transmittance valley **1304T** can have a transmittance bandwidth of less than about 50 nm, less than about 45 nm, or less than about 40 nm at the minimum transmittance plus 10%.
- [0333] In some embodiments, transmittance valley **1308T** can have a transmittance bandwidth of less than about 25 nm at minimum transmittance plus 5%.
- [0334] In some embodiments, the maximum transmittance of the transmittance peak **1302T** is between about 10% to about 30%, between about 15% to about 25%, or about 15% to about 20%.
- [0335] In some embodiments, the maximum transmittance of transmittance peak **1302T** is at a wavelength from about 430 nm to about 480 nm, from about 435 nm to about 455 nm, or from about 445 nm to about 450 nm.
- [0336] In some embodiments, transmittance valley **1306T** can be a saddleback transmittance valley. Transmittance valley **1306T** may include a first minimum **1316T**, a local maximum **1318T**, and a second minimum **1320T**.
- [0337] In some embodiments, a minimum transmittance of the valley **1306T** is less than or equal to about 25%, from about 2% and about 10%, from about 3% to about 9%, about 6%, about 7%, or about 8%.
- [0338] In some embodiments, second minimum **1320T** of valley **1306T** is at a wavelength from about 465 nm to about 505 nm, from about 485 nm to about 505 nm, from about 490 nm to about 505 nm, from about 495 nm to about 505 nm, at about 496 nm, at about 497 nm, at about 498 nm, or at about 499 nm.
- [0339] In some embodiments, local maximum **1318T** is at wavelength from about 475 nm to about 495 nm, from about 480 nm to about 490 nm, at about 483 nm, at about 484 nm, or at about 485 nm. In some embodiments, first minimum **1316T** is at wavelength

from about 470 nm to about 490 nm, from about 475 nm to about 485 nm, at about 478 nm, at about 479 nm, or at about 480 nm.

[0340] In some embodiments, a minimum transmittance of the valley **1308T** is between about 1% to about 20%, between about 5% to about 10%, about 7%, about 8%, or about 9%.

[0341] In some embodiments, the minimum transmittance of valley **1308T** is at a wavelength from about 630 nm to about 680 nm, from about 650 nm to about 670 nm, about 655 nm to about 665 nm, at about 659 nm, at about 660 nm, at about 661 nm, at about 662 nm, or at about 663 nm.

[0342] Referring to Fig. 13A, in some embodiments, absorbance peak **1304A** can be a saddleback peak. Absorbance peak **1304A** can include a first maximum **1310A**, a local minimum **1312A**, and a second maximum **1314A**. First maximum **1310A** can be associated with first minimum **1310T**. Local maximum **1312T** can be associated with local minimum **1312A**. Second maximum **1314A** can be associated with second minimum **1314T**.

[0343] Local minimum **1312A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 584 nm, at about 585 nm, at about 586 nm, at about 587 nm, or at about 588 nm. First maximum **1310A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 577 nm, at about 578 nm, or at about 579 nm. Second maximum **1314A** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0344] In some embodiments, optical density at local minimum **1312A** is from about 0.75 to about 1.85, from about 1 to about 1.5, or from about 1.1 to about 1.3. In some embodiments, optical density at first maximum **1310A** is from about 1 to about 1.6, or from about 1.2 to about 1.4. In some embodiments, optical density at second minimum **1314A** is from about 1 to about 1.6 or from about 1.2 to about 1.4.

[0345] In some embodiments, absorbance peak **1306A** can be a saddleback peak. Absorbance peak **1306A** can include a first maximum **1316A**, a local minimum **1318A**, and a second maximum **1320A**. First maximum **1316A** can be associated with first

minimum **1316T**. Local maximum **1318T** can be associated with local minimum **1318A**. Second maximum **1320A** can be associated with second minimum **1320T**.

- [0346] In some embodiments, absorbance peak **1306A** can have a maximum optical density from about 0.5 to about 1.5, from about 0.75 to about 1.25, or from about 0.95 to about 1.15.
- [0347] In some embodiments, absorbance peak **1308A** can have a maximum optical density from about 0.8 to about 1.2 or from about 0.9 to about 1.1.
- [0348] In some embodiments, a scotopic transmission of the lens **200** is less than or equal to about 35%, is less than about 30%, is less than about 25%, is less than about 20%, about 11%, about 12%, or about 13%.
- [0349] In some embodiments, a visible light transmission (as defined by EN1836) of lens **200** is from about 5% to about 30%, from about 10% to about 20%, about 11%, about 12%, or about 13%.
- [0350] Fig. 14A illustrates an optical transmittance profile **1400T**, according to some embodiments. Fig. 14B illustrates a respective optical absorbance profile **1400A**, according to some embodiments. It would be understood that optical characteristics exhibited in Figs. 14A and 14B are merely illustrative and not intended to be limiting, unless mentioned otherwise. For example, optical transmittance profile **1400T** can represent an optical transmittance of optical filter **104**, lens **200**, lens **220**, or lens **240** that includes a chroma enhancement filter.
- [0351] Optical transmittance profile **1400T** can include one or more transmittance valleys, such as valleys **1404T**, **1406T**, **1408T** each having a minimum transmittance in one or more spectral bands. Such transmittance valleys (e.g., valleys **1404T**, **1406T**, **1408T**) can filter out or attenuate undesired spectral wavelengths of light. Accordingly, optical transmittance profile **1400T** can provide chroma enhancement in the one or more spectral bands while maintaining a minimal desired transmission at each wavelength. Optical transmittance profile **1400T** can also include one or more transmittance peaks such as peak **1402T**.
- [0352] In some embodiments, the optical transmittance valley and the respective absorbance peak can be positioned at about the same wavelength. Accordingly, each of the transmittance valleys in a spectrum can be regarded as an absorbance peak in the spectrum. For example, each of valleys **1404T**, **1406T**, and **1408T** illustrated in optical

transmittance profile **1400T** can be hereinafter represented as absorbance peaks **1404A**, **1406A**, and **1408A** in optical absorbance profile **1400A**. As such, in referring to Fig. 14B, optical absorbance profile **1400A** can include an absorbance peak **1404A** associated with valley **1404T**, an absorbance peak **1406A** associated with valley **1406T**, and an absorbance peak **1408A** associated with valley **1408T**.

[0353] Referring to Fig. 14A, in some embodiments, transmittance valley **1404T** can be a saddleback transmittance valley. Transmittance valley **1404T** may include a first minimum **1410T**, a local maximum **1412T**, and a second minimum **1414T**.

[0354] Local maximum **1412T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 584 nm, at about 585 nm, at about 586 nm, at about 587 nm, or at about 588 nm. First minimum **1410T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, at about 579 nm, or at about 580 nm. Second minimum **1414T** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0355] In some embodiments, transmittance at local maximum **1412T** is from about 1% to about 20%, from about 5% to about 15%, about 6%, about 7%, or about 8%. In some embodiments, transmittance at first minimum **1410T** is substantially equal to the transmittance at second minimum **1414T**. In some embodiments, transmittance at first minimum **1410T** is from about 2% to about 10%, from about 3% to about 8%, about 4%, about 5%, or about 6%. In some embodiments, transmittance at second minimum **1414T** is from about 2% to about 10%, from about 3% to about 8%, about 4%, about 5%, or about 6%.

[0356] In some embodiments, a difference in transmittance between transmittance at first minimum **1410T** and transmittance at local maximum **1412T** is less than about 5%, less than about 4%, less than about 3%, or less than about 2%. In some aspects, a difference in transmittance at local maximum **1412T** and transmittance at second minimum **1414T** is less than about 5%, less than about 4%, less than about 3%, or less than about 2%.

[0357] As discussed previously herein, transmittance valley **1404T** can be between a lower edge portion (e.g., closer to about 565 nm) and an upper edge portion (e.g., closer to

about 610 nm) of the spectral band (e.g., between about 570 nm and about 600 nm). Transmittance at the lower edge portion and the upper edge portion can be greater than that of first minimum **1410T**, second minimum **1414T**, local maximum **1412T**. For example, a difference in transmittance between a transmittance at the lower edge portion and the first minimum **1410T** may be from about 5% to about 20%, from about 7% to about 15%, about 8%, about 9%, or about 10%. A difference between a transmittance at the upper edge portion and second minimum **1314T** is from about 5% to about 25%, from about 15% to about 25%, about 20%, about 21%, or about 22%.

- [0358] In some embodiments, transmittance valley **1404T** can have a transmittance bandwidth of less than about 45 nm, less than about 40 nm, or less than about 35 nm at the minimum transmittance plus 5% (transmittance at second minimum **1414T**). In some embodiments, transmittance valley **1404T** can have a transmittance bandwidth of less than about 50 nm, less than about 45 nm, or less than about 40 nm at the minimum transmittance plus 10%.
- [0359] In some embodiments, transmittance valley **1408T** can have a transmittance bandwidth of less than about 25 nm at minimum transmittance plus 5%.
- [0360] In some embodiments, the maximum transmittance of the transmittance peak **1402T** is from about 5% to about 20% or from about 10% to about 15%.
- [0361] In some embodiments, the maximum transmittance of transmittance peak **1402T** is at a wavelength from about 430 nm to about 480 nm, from about 435 nm to about 455 nm, or from about 445 nm to about 450 nm.
- [0362] In some embodiments, transmittance valley **1406T** can be a saddleback transmittance valley. Transmittance valley **1406T** may include a first minimum **1416T**, a local maximum **1418T**, and a second minimum **1420T**.
- [0363] In some embodiments, a minimum transmittance of the valley **1406T** is less than or equal to about 25%, from about 2% and about 10%, from about 3% to about 9%, about 4%, about 5%, or about 6%.
- [0364] In some embodiments, second minimum **1420T** of valley **1406T** is at a wavelength from about 465 nm to about 505 nm, from about 485 nm to about 505 nm, from about 490 nm to about 505 nm, about 495 nm to about 505 nm, at about 496 nm, at about 497 nm, at about 498 nm, or at about 499 nm. In some embodiments, local maximum **1418T** is at wavelength from about 475 nm to about 495 nm, from about 480

nm to about 490 nm, at about 483 nm, at about 484 nm, or at about 485 nm. In some embodiments, first minimum **1416T** is at wavelength from about 470 nm to about 490 nm, from about 475 nm to about 485 nm, at about 478 nm, at about 479 nm, or at about 480 nm.

[0365] In some embodiments, a minimum transmittance of the valley **1408T** is between about 1% to about 20%, between about 5% to about 15%, about 11%, about 12%, or about 13%.

[0366] In some embodiments, the minimum transmittance of valley **1408T** is at a wavelength from about 630 nm to about 680 nm, from about 650 nm to about 670 nm, about 655 nm to about 665 nm, at about 659 nm, at about 660 nm, at about 661 nm, at about 662 nm, or at about 663 nm.

[0367] Referring to Fig. 14B, in some embodiments, absorbance peak **1404A** can be a saddleback peak. Absorbance peak **1404A** can include a first maximum **1410A**, a local minimum **1412A**, and a second maximum **1414A**. First maximum **1410A** can be associated with first minimum **1410T**. Local maximum **1412T** can be associated with local minimum **1412A**. Second maximum **1414A** can be associated with second minimum **1414T**.

[0368] Local minimum **1412A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 584 nm, at about 585 nm, at about 586 nm, at about 587 nm, or at about 588 nm. First maximum **1410A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, about 577 nm, about 578 nm, or at about 579 nm. Second maximum **1414A** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0369] In some embodiments, optical density at local minimum **1412A** is from about 0.75 to about 1.85, from about 1 to about 1.5, or from about 1.1 to about 1.3. In some embodiments, optical density at first maximum **1410A** is from about 1 to about 1.6, or from about 1.2 to about 1.4. In some embodiments, optical density at second minimum **1414A** is from about 1 to about 1.6 or from about 1.2 to about 1.4.

[0370] In some embodiments, absorbance peak **1406A** can be a saddleback peak. Absorbance peak **1406A** can include a first maximum **1416A**, a local minimum **1418A**,

and a second maximum **1420A**. First maximum **1416A** can be associated with first minimum **1416T**. Local maximum **1418T** can be associated with local minimum **1418A**. Second maximum **1420A** can be associated with second minimum **1420T**.

- [0371] In some embodiments, absorbance peak **1406A** can have a maximum optical density from about 0.75 to about 1.75, from about 1 to about 1.55, or from about 1.25 to about 1.45.
- [0372] In some embodiments, absorbance peak **1408A** can have a maximum optical density from about 0.7 to about 1.2 or from about 0.8 to about 1.1.
- [0373] In some embodiments, a scotopic transmission of the lens **200** is less than or equal to about 35%, is less than about 30%, is less than about 25%, is less than about 20%, about 8%, about 9%, or about 10%.
- [0374] In some embodiments, a visible light transmission (as defined by EN1836) of lens **200** is from about 5% to about 30%, from about 10% to about 20%, about 10%, about 11%, or about 12%.
- [0375] Fig. 15A illustrates an optical transmittance profile **1500T**, according to some embodiments. Fig. 15B illustrates a respective optical absorbance profile **1500A**, according to some embodiments. It would be understood that optical characteristics exhibited in Figs. 15A and 15B are merely illustrative and not intended to be limiting, unless mentioned otherwise. For example, optical transmittance profile **1500T** can represent an optical transmittance of optical filter **104**, lens **200**, lens **220**, or lens **240** that includes a chroma enhancement filter.
- [0376] Optical transmittance profile **1500T** can include one or more transmittance valleys, such as valleys **1504T**, **1508T** each having a minimum transmittance in one or more spectral bands. Such transmittance valleys (e.g., valleys **1504T**, **1508T**) can filter out or attenuate undesired spectral wavelengths of light. Accordingly, optical transmittance profile **1500T** can provide chroma enhancement in the one or more spectral bands while maintaining a minimal desired transmission at each wavelength. Optical transmittance profile **1500T** can also include one or more transmittance peaks such as peak **1502T**.
- [0377] In some embodiments, the optical transmittance valley and the respective absorbance peak can be positioned at about the same wavelength. Accordingly, each of the transmittance valleys in a spectrum can be regarded as an absorbance peak in the

spectrum. For example, each of valleys **1504T** and **1508T** illustrated in optical transmittance profile **1500T** can be hereinafter represented as absorbance peaks **1504A** and **1508A** in optical absorbance profile **1500A**. As such, in referring to Fig. 15B, optical absorbance profile **1500A** can include an absorbance peak **1504A** associated with valley **1504T**, and an absorbance peak **1508A** associated with valley **1508T**.

[0378] Referring to Fig. 15A, in some embodiments, transmittance valley **1504T** can be a saddleback transmittance valley. Transmittance valley **1504T** may include a first minimum **1510T**, a local maximum **1512T**, and a second minimum **1514T**.

[0379] Local maximum **1512T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 584 nm, at about 585 nm, at about 586 nm, at about 587 nm, or at about 588 nm. First minimum **1510T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, at about 579 nm, or at about 580 nm. Second minimum **1514T** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0380] In some embodiments, transmittance at local maximum **1512T** is from about 1% to about 20%, from about 5% to about 15%, about 7%, about 8%, or about 9%. In some embodiments, transmittance at first minimum **1510T** is from about 2% to about 12%, from about 3% to about 8%, about 5%, about 6%, or about 7%. In some embodiments, transmittance at second minimum **1514T** is from about 2% to about 12%, from about 3% to about 8%, about 5%, about 6%, or about 7%.

[0381] In some embodiments, a difference in transmittance between transmittance at first minimum **1510T** and transmittance at local maximum **1512T** is less than about 5%, less than about 4%, or less than about 3%. In some aspects, a difference in transmittance at local maximum **1512T** and transmittance at second minimum **1514T** is less than about 5%, less than about 4%, or less than about 3%.

[0382] As discussed previously herein, transmittance valley **1504T** can be between a lower edge portion (e.g., closer to about 565 nm) and an upper edge portion (e.g., closer to about 610 nm) of the spectral band (e.g., between about 570 nm and about 600 nm). Transmittance at the lower edge portion and the upper edge portion can be greater than

that of first minimum **1510T**, second minimum **1514T**, local maximum **1512T**. For example, a difference in transmittance between a transmittance at the lower edge portion and the first minimum **1510T** may be from about 5% to about 15%, from about 7% to about 12%, about 8%, about 9%, or about 10%. A difference between a transmittance at the upper edge portion and second minimum **1514T** is from about 10% to about 30%, from about 15% to about 25%, about 19%, about 20%, or about 21%.

[0383] In some embodiments, transmittance valley **1504T** can have a transmittance bandwidth of less than about 45 nm, less than about 40 nm, or less than about 35 nm at the minimum transmittance plus 5% (transmittance at first minimum **1510T**). In some embodiments, transmittance valley **1504T** can have a transmittance bandwidth of less than about 50 nm, less than about 45 nm, or less than about 40 nm at the minimum transmittance plus 10%.

[0384] In some embodiments, transmittance valley **1508T** can have a transmittance bandwidth of less than about 25 nm, less than about 20 nm, or less than about 15 nm at minimum transmittance plus 5%.

[0385] In some embodiments, the maximum transmittance of the transmittance peak **1502T** is from about 15% to about 35%, from about 20% to about 30%, or from about 22% to about 27%.

[0386] In some embodiments, the maximum transmittance of transmittance peak **1502T** is at a wavelength from about 440 nm to about 510 nm or from about 460 nm to about 500 nm.

[0387] In some embodiments, a minimum transmittance of the valley **1508T** is between about 10% to about 30%, between about 15% to about 25%, about 18%, about 19%, or about 20%.

[0388] In some embodiments, the minimum transmittance of valley **1508T** is at a wavelength from about 630 nm to about 680 nm, from about 650 nm to about 670 nm, from about 655 nm to about 665 nm, at about 659 nm, at about 660 nm, at about 661 nm, at about 662 nm, or at about 663 nm.

[0389] Referring to Fig. 15B, in some embodiments, absorbance peak **1504A** can be a saddleback peak. Absorbance peak **1504A** can include a first maximum **1510A**, a local minimum **1512A**, and a second maximum **1514A**. First maximum **1510A** can be associated with first minimum **1510T**. Local maximum **1512T** can be associated with

local minimum **1512A**. Second maximum **1514A** can be associated with second minimum **1514T**.

- [0390] Local minimum **1512A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 584 nm, at about 585 nm, at about 586 nm, at about 587 nm, or at about 588 nm. First maximum **1510A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 577 nm, at about 578 nm, or at about 579 nm. Second maximum **1514A** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.
- [0391] In some embodiments, optical density at local minimum **1512A** is from about 0.5 to about 1.5, from about 0.75 to about 1.25, or from about 0.9 to about 1.1. In some embodiments, optical density at first maximum **1510A** is from about 0.9 to about 1.6, or from about 1.1 to about 1.4. In some embodiments, optical density at second minimum **1514A** is from about 0.9 to about 1.6, or from about 1.1 to about 1.4.
- [0392] In some embodiments, absorbance peak **1508A** can have a maximum optical density from about 0.3 to about 1.2 or from about 0.5 to about 1.
- [0393] In some embodiments, a scotopic transmission of the lens **200** is less than or equal to about 35%, is less than about 30%, is less than about 25%, is less than about 20%, about 17%, about 18%, or about 19%.
- [0394] In some embodiments, a visible light transmission (as defined by EN1836) of lens **200** is from about 5% to about 25%, from about 10% to about 20%, about 14%, about 15%, or about 16%.
- [0395] Fig. 16A illustrates an optical transmittance profile **1600T**, according to some embodiments. Fig. 16B illustrates a respective optical absorbance profile **1600A**, according to some embodiments. It would be understood that optical characteristics exhibited in Figs. 16A and 16B are merely illustrative and not intended to be limiting, unless mentioned otherwise. For example, optical transmittance profile **1600T** can represent an optical transmittance of optical filter **104**, lens **200**, lens **220**, or lens **240** that includes a chroma enhancement filter.
- [0396] Optical transmittance profile **1600T** can include one or more transmittance valleys, such as valleys **1604T**, **1606T**, **1608T** each having a minimum transmittance in

one or more spectral bands. Such transmittance valleys (e.g., valleys **1604T**, **1606T**, **1608T**) can filter out or attenuate undesired spectral wavelengths of light. Accordingly, optical transmittance profile **1600T** can provide chroma enhancement in the one or more spectral bands while maintaining a minimal desired transmission at each wavelength. Optical transmittance profile **1600T** can also include one or more transmittance peaks such as peak **1602T**.

[0397] In some embodiments, the optical transmittance valley and the respective absorbance peak can be positioned at about the same wavelength. Accordingly, each of the transmittance valleys in a spectrum can be regarded as an absorbance peak in the spectrum. For example, each of valleys **1604T**, **1606T**, and **1608T** illustrated in optical transmittance profile **1600T** can be hereinafter represented as absorbance peaks **1604A**, **1606A**, and **1608A** in optical absorbance profile **1600A**. As such, in referring to Fig. 16B, optical absorbance profile **1600A** can include an absorbance peak **1604A** associated with valley **1604T**, an absorbance peak **1606A** associated with valley **1606T**, and an absorbance peak **1608A** associated with valley **1608T**.

[0398] Referring to Fig. 16A, in some embodiments, transmittance valley **1604T** can be a saddleback transmittance valley. Transmittance valley **1604T** may include a first minimum **1610T**, a local maximum **1612T**, and a second minimum **1614T**.

[0399] Local maximum **1612T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, at about 584 nm, at about 585 nm, at about 586 nm, at about 587 nm, or at about 588 nm. First minimum **1610T** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 575 nm, at about 576 nm, at about 577 nm, at about 578 nm, at about 579 nm, or at about 580 nm. Second minimum **1614T** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

[0400] In some embodiments, transmittance at local maximum **1612T** is from about 1% to about 20%, from about 5% to about 15%, about 7%, about 8%, or about 9%. In some embodiments, transmittance at first minimum **1610T** is substantially equal to the transmittance at second minimum **1614T**. In some embodiments, transmittance at first minimum **1610T** is from about 2% to about 10%, from about 3% to about 8%, about 4%,

about 5%, or about 6%. In some embodiments, transmittance at second minimum **1614T** is from about 2% to about 10%, from about 3% to about 8%, about 5%, about 6%, or about 7%.

[0401] In some embodiments, a difference in transmittance between transmittance at first minimum **1610T** and transmittance at local maximum **1612T** is less than about 5%, less than about 4%, or less than about 3%. In some aspects, a difference in transmittance at local maximum **1612T** and transmittance at second minimum **1614T** is less than about 5%, less than about 4%, or less than about 3%.

[0402] As discussed previously herein, transmittance valley **1604T** can be between a lower edge portion (e.g., closer to about 565 nm) and an upper edge portion (e.g., closer to about 610 nm) of the spectral band (e.g., between about 570 nm and about 600 nm). Transmittance at the lower edge portion and the upper edge portion can be greater than that of first minimum **1610T**, second minimum **1614T**, local maximum **1612T**. For example, a difference in transmittance between a transmittance at the lower edge portion and the first minimum **1610T** may be from about 5% to about 20%, from about 7% to about 15%, about 7%, about 8%, or about 9%. A difference between a transmittance at the upper edge portion and second minimum **1614T** is from about 10% to about 25%, from about 15% to about 20%, about 16%, about 17%, or about 18%.

[0403] In some embodiments, transmittance valley **1604T** can have a transmittance bandwidth of less than about 45 nm, less than about 40 nm, or less than about 35 nm at the minimum transmittance plus 5% (transmittance at first minimum **1610T**). In some embodiments, transmittance valley **1604T** can have a transmittance bandwidth of less than about 50 nm, less than about 45 nm, or less than about 40 nm at the minimum transmittance plus 10%.

[0404] In some embodiments, transmittance valley **1608T** can have a transmittance bandwidth of less than about 25 nm at minimum transmittance plus 5% and a transmittance bandwidth of less than about 25 nm at minimum transmittance plus 10%, respectively.

[0405] In some embodiments, transmittance valley **1606T** can have a transmittance bandwidth of less than about 25 nm, or less than about 35 nm at minimum transmittance plus 5% or the minimum transmittance plus 10%, respectively.

- [0406] In some embodiments, the maximum transmittance of the transmittance peak **1602T** is from about 10% to about 30% or from about 15% to about 25%.
- [0407] In some embodiments, the maximum transmittance of transmittance peak **1602T** is at a wavelength from about 430 nm to about 480 nm, or from about 435 nm to about 455 nm, or from about 445 nm to about 450 nm.
- [0408] In some embodiments, a minimum transmittance of the valley **1606T** is less than or equal to about 25%, from about 1% and about 15%, from about 5% to about 10%, about 6%, about 7%, or about 8%.
- [0409] In some embodiments, the minimum transmittance of valley **1606T** is at a wavelength from about 470 nm to about 490 nm, from about 475 nm to about 485 nm, at about 480 nm, at about 481 nm, at about 482 nm, or at about 483 nm.
- [0410] In some embodiments, a minimum transmittance of the valley **1608T** is between about from about 5% and about 25%, from about 10% to about 20%, about 14%, about 15%, or about 16%.
- [0411] In some embodiments, the minimum transmittance of valley **1608T** is at a wavelength from about 630 nm to about 680 nm, from about 650 nm to about 670 nm, from about 655 nm to about 665 nm, at about 659 nm, at about 660 nm, at about 661 nm, at about 662 nm, or about 663 nm.
- [0412] Referring to Fig. 16B, in some embodiments, absorbance peak **1604A** can be a saddleback peak. Absorbance peak **1604A** can include a first maximum **1610A**, a local minimum **1612A**, and a second maximum **1614A**. First maximum **1610A** can be associated with first minimum **1610T**. Local maximum **1612T** can be associated with local minimum **1612A**. Second maximum **1614A** can be associated with second minimum **1614T**.
- [0413] Local minimum **1612A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 595 nm, from about 580 nm to about 590 nm, about 584 nm, about 585 nm, about 586 nm, about 587 nm, or about 588 nm. First maximum **1610A** is at a wavelength from about 570 nm to about 600 nm, from about 575 nm to about 580 nm, at about 577 nm, at about 578 nm, or at about 579 nm. Second maximum **1614A** is at a wavelength from about 580 nm to about 600 nm, from about 590 nm to about 600 nm, from about 592 nm to about 598 nm, at about 593 nm, at about 594 nm, at about 595 nm, at about 596 nm, or at about 597 nm.

- [0414] In some embodiments, optical density at local minimum **1612A** is from about 0.5 to about 1.5, from about 0.75 to about 1.25, or from about 0.9 to about 1.1. In some embodiments, optical density at first maximum **1610A** is from about 0.8 to about 1.6, or from about 1 to about 1.4. In some embodiments, optical density at second minimum **1614A** is from about 0.8 to about 1.6 or from about 1 to about 1.4.
- [0415] In some embodiments, absorbance peak **1606A** can have a maximum optical density from about 0.8 to about 1.4, from about 0.9 to about 1.3, or from about 1 to about 1.2.
- [0416] In some embodiments, absorbance peak **1608A** can have a maximum optical density from about 0.4 to about 1.2 or from about 0.6 to about 1.
- [0417] In some embodiments, a scotopic transmission of the lens **200** is less than or equal to about 35%, is less than about 30%, is less than about 25%, is less than about 20%, about 15%, about 16%, or about 17%.
- [0418] In some embodiments, a visible light transmission (as defined by EN1836) of lens **200** is from about 5% to about 30%, from about 10% to about 20%, about 14%, about 15%, or about 16%.
- [0419] In some embodiments, the lens (e.g., lens **200**) can have an overall color appearance that may not be grey/neutral. For example, a yellowness index YI E313 of the lens **200** may be greater than about 5 or greater than about 10.
- [0420] Fig. 17A illustrates an optical transmittance profile **1700T**, according to some embodiments. Fig. 17B illustrates a respective optical absorbance profile **1700A**, according to some embodiments. It would be understood that optical characteristics exhibited in Figs. 17A and 17B are merely illustrative and not intended to be limiting, unless mentioned otherwise. For example, optical transmittance profile **1700T** can represent an optical transmittance of optical filter **104**, lens **200**, lens **220**, or lens **240** that includes a chroma enhancement filter.
- [0421] Optical transmittance profile **1700T** can include one or more transmittance valleys, such as valleys **1704T** each having a minimum transmittance in one or more spectral bands. Such transmittance valleys (e.g., valleys **1704T**) can filter out or attenuate undesired spectral wavelengths of light. Accordingly, optical transmittance profile **1700T** can provide chroma enhancement in the one or more spectral bands while high

transmission. Optical transmittance profile **1700T** can also include one or more transmittance peaks such as peak **1702T**.

[0422] In some embodiments, the optical transmittance valley and the respective absorbance peak can be positioned at about the same wavelength. Accordingly, each of the transmittance valleys in a spectrum can be regarded as an absorbance peak in the spectrum. For example, valley **1704T** illustrated in optical transmittance profile **1700T** can be hereinafter represented as absorbance peak **1704A** in optical absorbance profile **1700A**. As such, in referring to Fig. 17B, optical absorbance profile **1700A** can include an absorbance peak **1704A** associated with valley **1704T**. Optical absorbance profile **1700A** may also include absorbance peak **1702A**.

[0423] Referring to Fig. 17A, in some embodiments, transmittance valley **1704T** can have a minimum transmittance at a wavelength from about 500 nm to about 650 nm, from about 525 nm to about 620 nm, from about 550 nm to about 600 nm, from about 560 to about 600, from about 565 nm to about 595 nm, from about 565 nm to about 590 nm, from about 570 nm to about 585 nm, from about 570 nm to about 580 nm.

[0424] In some embodiments, the minimum transmittance is from about 1% to about 10%, from about 1% to about 8%, from about 1% to about 6%, from about 1% to about 5%, or from about 2% to about 4%.

[0425] As discussed previously herein, transmittance valley **1704T** can be between a lower edge portion (e.g., closer to about 485 nm) and an upper edge portion (e.g., closer to about 600 nm) of the spectral band (e.g., between about 490 nm and about 595 nm). Transmittance at the lower edge portion and the upper edge portion can be greater than that a minimum transmittance of transmittance valley **1704T**. For example, a difference in transmittance between a transmittance at the lower edge portion and the minimum transmittance may be from about 40% to about 80%, from about 50% to about 70%, from about 55% to about 65%. A difference between a transmittance at the upper edge portion and the minimum transmittance is from about 60% to about 100%, from about 70% to about 90%, from about 75% to about 85%.

[0426] In some embodiments, transmittance valley **1704T** can have a transmittance bandwidth of less than about 15 nm, less than about 20 nm, less than about 25 nm, less than about 30 nm, less than about 70 nm, less than about 80 nm, or less than about 100 nm at minimum transmittance plus 5%, the minimum transmittance plus 10%, the

minimum transmittance plus 15%, the minimum transmittance plus 25%, the minimum transmittance plus 35%, the minimum transmittance plus 45%, or the minimum transmittance plus 55%, respectively.

[0427] In some embodiments, the maximum transmittance of the transmittance peak **1702T** is from about 40% to about 80%, from about 50% to about 70%, or from about 55% to about 65%, or from about 60% to about 65%.

[0428] In some embodiments, the maximum transmittance of transmittance peak **1702T** is at a wavelength from about 430 nm to about 480 nm, from about 440 nm to about 470 nm, or from about 455 nm to about 465 nm.

[0429] Referring to Fig. 17B, in some embodiments, absorbance peak **1704A** can have a maximum optical density from about 0.5 to about 2.5, from about 1 to about 2, from about 1.2 to about 1.9, or from about 1.5 to about 1.7.

[0430] In some embodiments, absorbance peak **1702A** can have a maximum optical density from about 0.5 to about 2.5, from about 1 to about 2.25, from about 1.5 to about 2, or from about 1.6 to about 1.8. Maximum optical density of absorbance peak **1702A** may be at a wavelength from about 395 nm to about 445 nm, from about 405 nm to about 435 nm, or from about 415 nm to about 425 nm.

[0431] In some embodiments, a scotopic transmission of the lens **200** is greater than or equal to about 35%, is from about 35% to about 55%, from about 40% to about 50%, about 45%, about 46%, or about 47%.

[0432] In some embodiments, a visible light transmission (as defined by EN1836) of lens **200** is from about 30% to about 50%, from about 35% to about 45%, about 39%, about 40%, or about 41%.

[0433] In some embodiments, the lens **200** have an ultraviolet (UV) transmission cutoff at a wavelength from about 410 nm to about 440 nm or from about 420 nm to about 435 nm.

[0434] In some embodiments, an E313 yellowness index of the lens **200** is from about 5 to about 20, from about 7 to about 15, or from about 10 to about 14.

[0435] In some embodiments, a method for forming a filter configured to provide chroma enhancement for an eyewear is provided. This disclosure is not limited to this operational description. It is to be appreciated that additional operations may be performed. Moreover, not all operations may be needed to perform the disclosure provided herein.

Further, some of the operations may be performed simultaneously, or in a different order than described. In some implementations, one or more other operations may be performed in addition to or in place of the presently described operations.

[0436] In some embodiments, a lens body with chroma enhancement is formed. In some embodiments, the process of forming the lens body can include providing an optically transparent material, and incorporating one or more wavelength filtering materials with the optically transparent material. Namely, the optically transparent material can be blended with the wavelength filtering materials to form the lens body. For example, one or more wavelength filtering dyes can be added to a molten resin before the resin is injected a mold cavity to form the lens body. By way of example and not limitation, the optically transparent material can include molten resin, polycarbonate (PC), allyl diglycol carbonate monomer (being sold under the brand name CR-39®), a resin layer (e.g., MR-8®), glass, nylon, polyurethane, polyethylene, polyureas, polyamide (PA), polyethylene terephthalate (PET), biaxially-oriented polyethylene terephthalate polyester film (BoPET, with one such polyester film sold under the brand name MYLAR®), acrylic (polymethyl methacrylate or PMMA), triacetate cellulose (TAC), a polymeric material, a co-polymer, a doped material, any other suitable material, or any combination thereof. By way of example and not limitation, the wavelength filtering materials and/or chroma enhancement material can include a dielectric stack, multilayer interference coatings, rare earth oxide additives, an organic dye, or a combination therefore. In some embodiments, the organic dye for the wavelength filtering material and chroma enhancement material can include ABS 473, ABS 574, or ABS 594 dye supplied by Exciton of Dayton, Ohio. In some embodiments, the process of forming the lens body can include forming a lens substrate, and forming a chroma enhancement filter over the lens substrate. By way of example and not limitation, a forming process of the lens substrate can include applying injection molding process, a thermoforming process, a casting process, or a machining process on the optically transparent material described above. By way of example and not limitation, the process of forming the chroma enhancement filter over the lens body can include placing the wavelength filtering material over one or more surfaces of the lens substrate using a deposition process, a coating process, an inkjet-printing process, an epitaxial process, a plating process, a material growth process (e.g., self-assembly growth), or a laminating process. In some embodiments, the process of

forming the lens body can include forming a chroma enhancement filtering wafer, and forming a lens substrate over the a chroma enhancement filtering wafer. By way of example and not limitation, the process of forming a chroma enhancement filtering wafer can include injection molding or casting a wafer that includes one or more wavelength filtering materials. By way of example and not limitation, the process of forming the lens body over the wavelength chroma enhancement wafer can include placing the chroma enhancement filtering wafer in a mold cavity and molding an optically transparent material, such as resin, over one or more surfaces of the wavelength filtering wafer in the mold cavity. As a result, after the optically transparent material (e.g., resin) is cooled down and hardened, the lens body can conform to the wavelength filtering wafer. It is noted that the above described embodiments for forming the lens body are exemplary and not limiting. Various implementations for forming the lens body are described, for example, in U.S. Patent Application No. 15/359,317, which is incorporated by reference herein and is made part of this disclosure.

[0437] In some embodiments, one or more functional layers can be formed over the lens body. By way of example and not limitation, each of the one or more functional layers can include a hard coat layer, an interference stack, a flash mirror, a photochromic layer, an electrochromic layer, an anti-static coating, a liquid containing layer, a trichoch filter, a glass layers, a hybrid glass-plastic layer, an index matching layers, or any combination of these. In some embodiments, the process of forming the one or more functional layers can include a laminating technique, a coating technique, a deposition technique, or any combination of these.

[0438] It would be understood that the above noted embodiments are merely illustrative and not limiting. Other examples of forming the lens body having chroma enhancement filtering are disclosed in U.S. Pat. Pub. No. 2017/0075143, entitled “Eyewear and lenses with multiple molded lens components,” filed November 22, 2016, and U.S. Pat. Pub. No. 2017/0102558, entitled “Eyewear with multiple functional layers,” filed October 28, 2016, which are incorporated herein by reference.

[0439] In some embodiments, an optical reflectivity from the lens body is reduced. The reduction of the optical reflectivity can include forming an anti-reflection layer over the lens body’s back surface and/or the lens body’s front surface. In some embodiments, in response to the anti-reflection layer’s refractive index being between air’s refractive index

(e.g., 1.0) and the lens body's refractive index, an optical reflectivity from the lens body's back surface can be reduced.

[0440] The foregoing disclosure outlines features of several embodiments so that those skilled in the art may better understand the aspects of the present disclosure. Those skilled in the art should appreciate that they may readily use the present disclosure as a basis for designing or modifying other processes and structures for carrying out the same purposes and/or achieving the same advantages of the embodiments introduced herein. Those skilled in the art should also realize that such equivalent constructions do not depart from the spirit and scope of the present disclosure, and that they may make various changes, substitutions, and alterations herein without departing from the spirit and scope of the present disclosure.

WHAT IS CLAIMED IS:

1. A lens for an eyewear, comprising :
 - an optical filter, wherein a transmittance spectral profile of the optical filter comprises a saddleback transmission valley having a local maximum transmittance, a first minimum transmittance, and a second minimum transmittance, wherein:
 - the local maximum transmittance of the transmittance valley is positioned at a first wavelength from about 570 nm to about 600 nm; and
 - wherein a difference in transmittance between the first minimum transmittance and the local maximum transmittance is less than about 15%.
2. The lens of claim 1, wherein the transmittance spectral profile further comprises another transmittance valley, the other transmittance valley having a third minimum transmittance positioned at a second wavelength from about 465 nm to about 505 nm, wherein the minimum transmittance of the other transmittance valley is less than about 25%.
3. The lens of claim 1 or 2, wherein a spectral bandwidth of the second transmittance valley at the third minimum transmittance plus 2% is less than or equal to about 30 nm.
4. The lens of claim 3, wherein the spectral bandwidth of the second transmittance valley at the third minimum transmittance plus 20% is greater than or equal to about 40 nm.
5. The lens of claim 3, wherein the spectral bandwidth of the second transmittance valley at the third minimum transmittance plus 5% is less than or equal to about 40 nm.
6. The lens of claim 2, wherein the second wavelength is from about 470 nm to about 480 nm.
7. The lens of claim 6, wherein the second wavelength is about 477 nm.

8. The lens of claim 2, wherein the second wavelength is from about 485 nm to about 505 nm.
9. The lens of claim 8, wherein the second wavelength is about 500 nm.
10. The lens of any preceding claim, wherein the first minimum transmittance and the second minimum transmittance are greater than about 5%.
11. The lens of claim 10, wherein the first minimum transmittance and the second minimum transmittance are greater than about 5% and less than about 20%.
12. The lens of claim 11, wherein the first minimum transmittance and the second minimum transmittance are greater than about 5% and less than about 10%.
13. The lens of any preceding claim, wherein the local maximum transmittance is from about 5% to about 20%.
14. The lens of any preceding claim, wherein the local maximum transmittance is from about 10% to about 20%.
15. The lens of any preceding claim, wherein the local maximum transmittance is about 16%.
16. The lens of any preceding claim, wherein the local maximum transmittance is from about 5% to about 10%.
17. The lens of any preceding claim, wherein the optical filter comprises one or more organic dyes.
18. The lens of any preceding claim, wherein a scotopic transmission of the optical filter is less than about 40%.

19. The lens of any preceding claim, wherein an E313 yellowness index of the lens is less than about 20.
20. The lens of any preceding claim, wherein a visible light transmission is from about 10% to about 50%.
21. The lens of any preceding claim, wherein a CIE chromaticity x value is from about 0.5 to about 0.7 and wherein a CIE chromaticity y value is from about 0.5 to about 0.7.
22. The lens of any preceding claim, wherein the first wavelength is from about 580 nm to about 590 nm.
23. The lens of any preceding claim, wherein the first wavelength is about 585 nm.
24. The lens of any preceding claim, wherein a difference between the first minimum and/or the second minimum transmittance and the local maximum transmittance is less than about 5%.
25. The lens of any preceding claim, wherein a difference between the first minimum transmittance and/or the second minimum transmittance and the local maximum transmittance is more than about 5%.
26. The lens of any preceding claim, wherein a spectral bandwidth of the saddleback transmittance valley at the local minimum transmittance plus 10% is less than or equal to about 40 nm.
27. The lens of any preceding claim, wherein a spectral bandwidth of the saddleback transmittance valley at the local minimum transmittance plus 25% of the local minimum transmittance is less than or equal to about 40 nm.

28. The lens of any preceding claim, wherein the saddleback transmittance valley is a transmittance valley between a first transmittance peak and a second transmittance peak, the first transmittance peak positioned at a third wavelength from about 520 nm to about 560 nm, the second transmittance peak positioned at a fourth wavelength from about 610 nm to about 650 nm.
29. The lens of claim 28, wherein a transmittance of the first transmittance peak is from about 10% to about 40% and a transmittance of the second transmittance peak is from about 20% to about 50%.
30. The lens of claim 29, wherein the transmittance of the first transmittance peak is from about 10% to about 20% and the transmittance of the second transmittance peak is from about 20% to about 30%.
31. The lens of claim 29, wherein the transmittance of the first transmittance peak is from about 30% to about 40% and the transmittance of the second transmittance peak is from about 40% to about 50%.
32. An eyewear including the lens of claim 1.
33. A lens for an eyewear, the lens configured to transmit visible light in one or more spectral bands, the one or more spectral bands comprising:
a saddleback transmission valley having a local maximum transmittance, a first minimum transmittance, and a second minimum transmittance, wherein the local maximum transmittance of the transmittance valley is positioned at a first wavelength from about 570 nm to about 600 nm; and
another transmittance valley, the other transmittance valley having a minimum transmittance positioned at a second wavelength from about 465 nm to about 505 nm wherein the minimum transmittance of the other transmittance valley is less than about 25%.

34. The lens of claim 33, wherein a visible light transmission is from about 10% to about 50%.
35. The lens of claim 34, wherein the visible light transmission is from about 15% to about 25%.
36. The lens of any of claims 33-35, wherein the first minimum transmittance and the second minimum transmittance are greater than about 5%.
37. The lens of any of claims 33-35, wherein the local maximum transmittance is from about 5% to about 20%.
38. The lens of claim 37, wherein the local maximum transmittance is from about 5% to about 10%.
39. The lens of claim 37, wherein the local maximum transmittance is from about 10% to about 20%.
40. The lens of any of claims 33-39, wherein a scotopic transmission of the optical filter is less than about 40%.
41. The lens of any of claims 33-39, wherein an E313 yellowness index of the lens is less than about 20.
42. The lens of any of claims 33-41, wherein the first wavelength is from about 580 nm to about 590 nm.
43. The lens of claim 42, wherein the first wavelength is about 585 nm.
44. The lens of any of claims 33-43, wherein the second wavelength is from about 470 nm to about 480 nm.

45. The lens of claim 44, wherein the second wavelength is about 477 nm.
46. The lens of claim 45, wherein the second wavelength is from about 485 nm to about 505 nm.
47. The lens of claim 46, wherein the second wavelength is about 500 nm.
48. The lens of any of claims 33-35, wherein the saddleback transmission valley has a first upper edge and a second upper edge, and wherein a difference in transmittance between a transmittance at the first upper edge and the first minimum transmittance is less than about 25% and a transmittance at the second upper edge and the second minimum transmittance is less than about 40%.
49. An eyewear including the lens of claim 33.
50. An lens for an eyewear, wherein:
 - a visible light transmission of the lens is from about 10% to about 50%; and
 - a spectral profile of the lens comprises a saddleback absorbance peak in a spectral range of about 570 nm to about 600 nm, the saddleback absorbance peak having a local minimum absorbance located between a first maximum absorbance and a second maximum absorbance, wherein an optical density at the first maximum absorbance of the saddleback peak at a first wavelength is from about 0.5 to about 1.5 and an average transmittance in a spectral range of about 480 nm to about 530 nm is greater than about 5%.
51. The lens of claim 50, wherein the spectral profile further comprises another absorbance peak, the another absorbance peak having a maximum absorbance positioned at a second wavelength from about 465 nm to about 505 nm.
52. The lens of claim 51, wherein the second wavelength is from about 470 nm to about 480 nm.

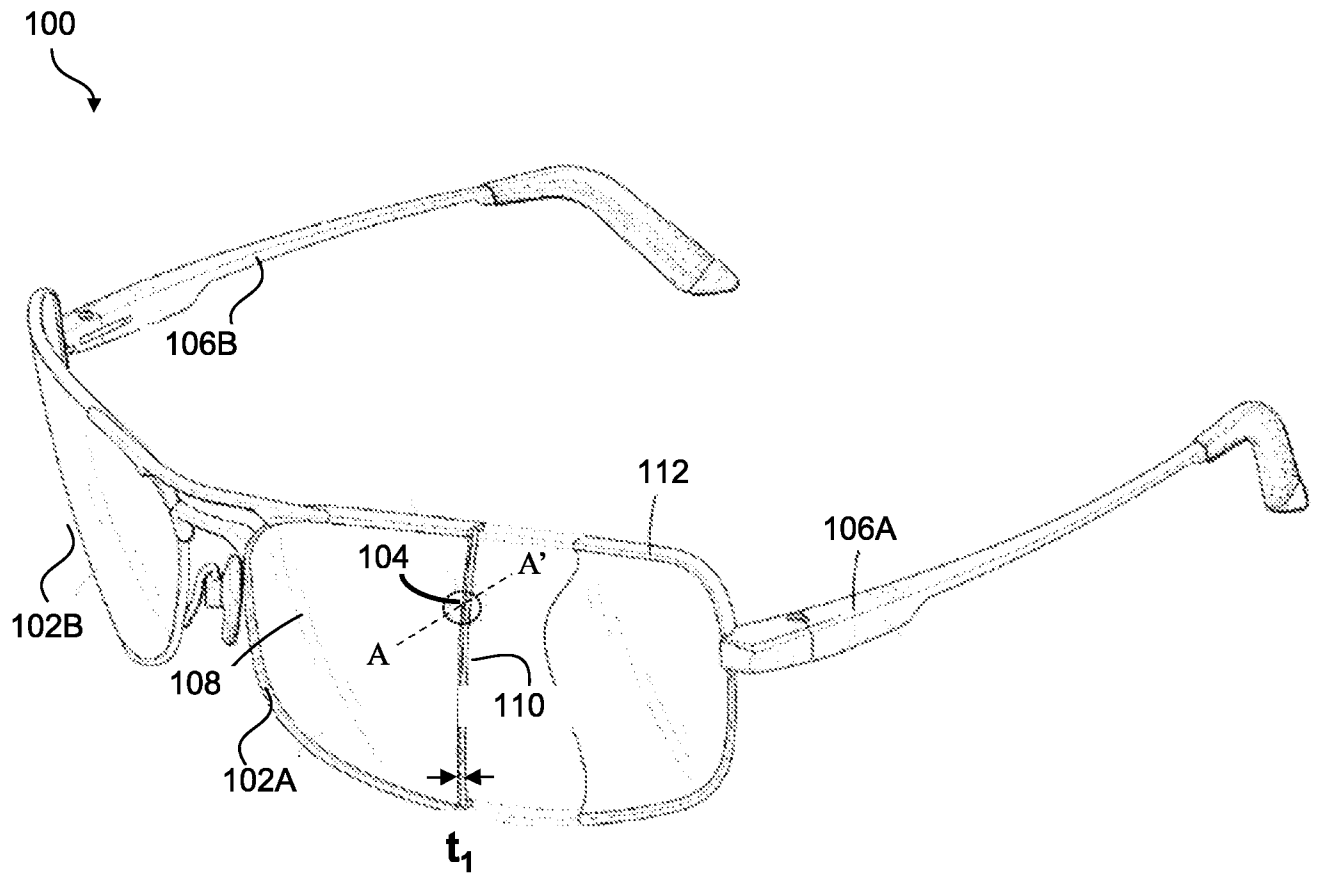
53. The lens of claim 51, wherein the second wavelength is from about 485 nm to about 505 nm.
54. The lens of any of claims 50-53, wherein the local minimum absorbance is positioned at a third wavelength from about 580 nm to about 590 nm.
55. The lens of claim 54, wherein the third wavelength is about 585 nm.
56. The lens of any of claims 50-55, wherein the optical density at the first maximum absorbance of the saddleback peak at a first wavelength is from about 0.5 to about 1.
57. The lens of any of claims 50-56, wherein the optical density at the first maximum absorbance of the saddleback peak at a first wavelength is from about 1 to about 1.5.
58. The lens of any of claims 50-57, wherein the saddleback absorbance peak is an absorbance peak between a first absorbance minimum and a second absorbance minimum,
the first absorbance minimum positioned at a fourth wavelength from about 520 nm to about 560 nm, the second absorbance minimum positioned at a fifth wavelength from about 610 nm to about 650 nm.
59. The lens of claim 58, wherein the fourth wavelength is from about 520 nm to about 540 nm and the fifth wavelength is from about 620 nm to about 640 nm.
60. The lens of any of claims 50-59, wherein the visible light transmission is from about 10% to about 30%.
61. An eyewear including the lens of claim 50.
62. A lens for an eyewear, wherein:
a visible light transmission of the lens is from about 35% to about 45%; and

a spectral profile of the lens comprises an absorbance peak having a maximum absorbance, wherein the maximum absorption is positioned at a first wavelength from about 570 nm to about 580 nm.

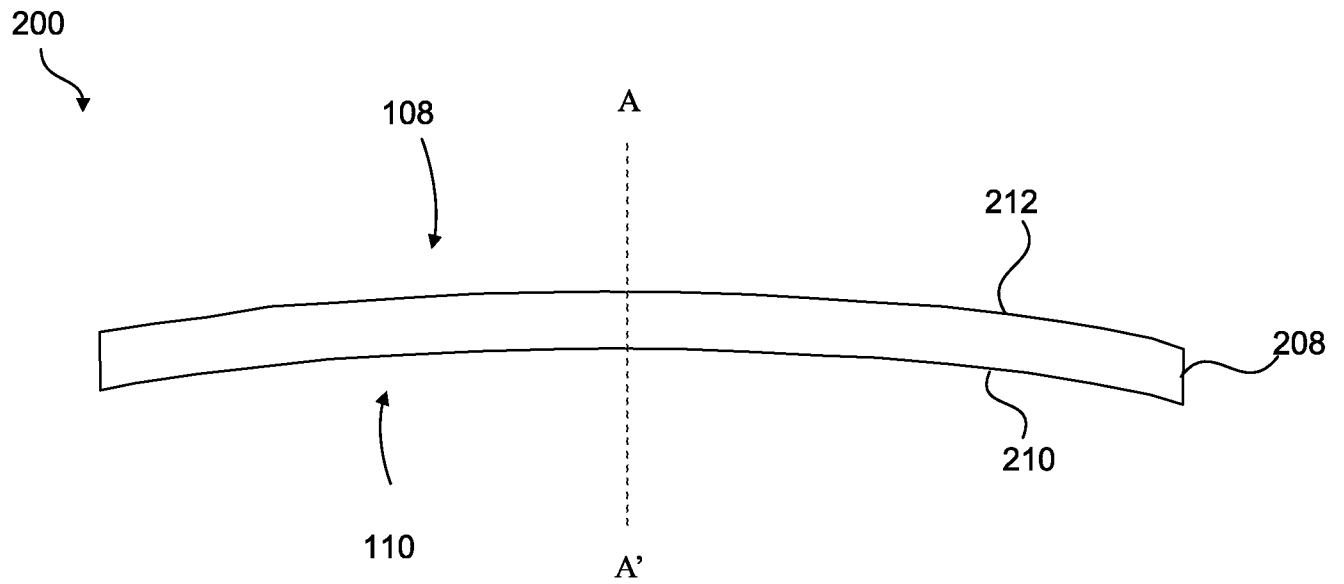
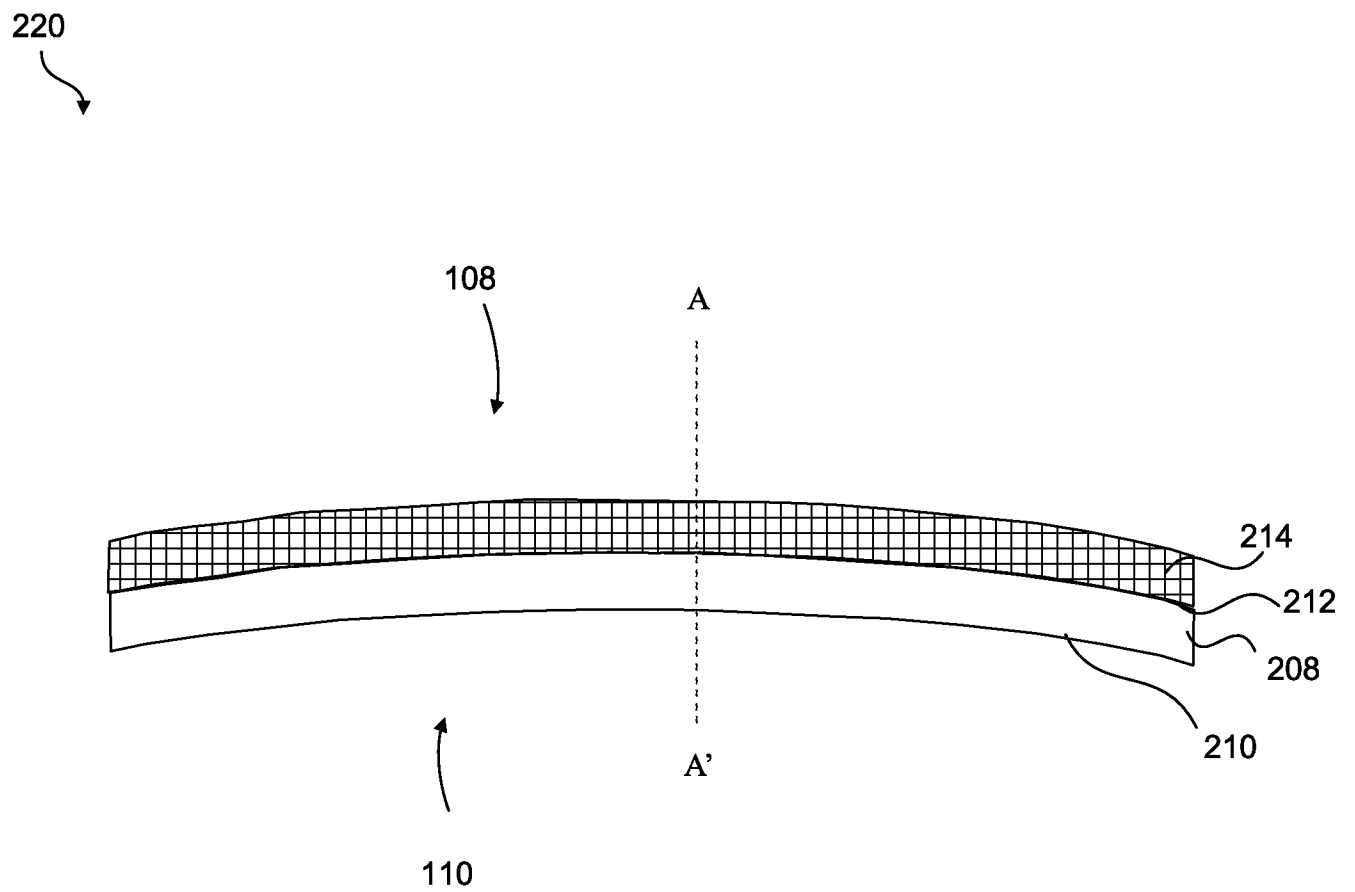
63. The lens of claim 62, wherein the spectral profile of the lens comprises another absorption peak having a second maximum absorbance, the second maximum absorbance positioned at a second wavelength from about 395 nm to about 445 nm.
64. The lens of claim 63, wherein the second wavelength is about 420 nm.
65. The lens of any of claims 60-64, wherein a transmittance at the first wavelength is less than about 10%.
66. The lens of any of claims 60-65, wherein the first wavelength is about 577 nm.
67. The lens of any of claims 60-66, wherein a scotopic transmission of the lens is greater than about 40% and less than about 50%.
68. The lens of any of claims 60-67, wherein an E313 yellowness index of the lens is less than about 15.
69. The lens of any of claims 60-68, wherein a spectral bandwidth of the transmittance valley at the minimum transmittance plus 55% is less than or equal to about 100 nm.
70. The lens of claim 69, wherein the spectral bandwidth of the transmittance valley at the minimum transmittance plus 10% is less than or equal to about 20 nm.
71. A lens for an eyewear, comprising :
an optical filter, wherein a transmittance spectral profile of the optical filter comprises a saddleback transmission valley having a local maximum transmittance, a first minimum transmittance, and a second minimum transmittance, wherein:

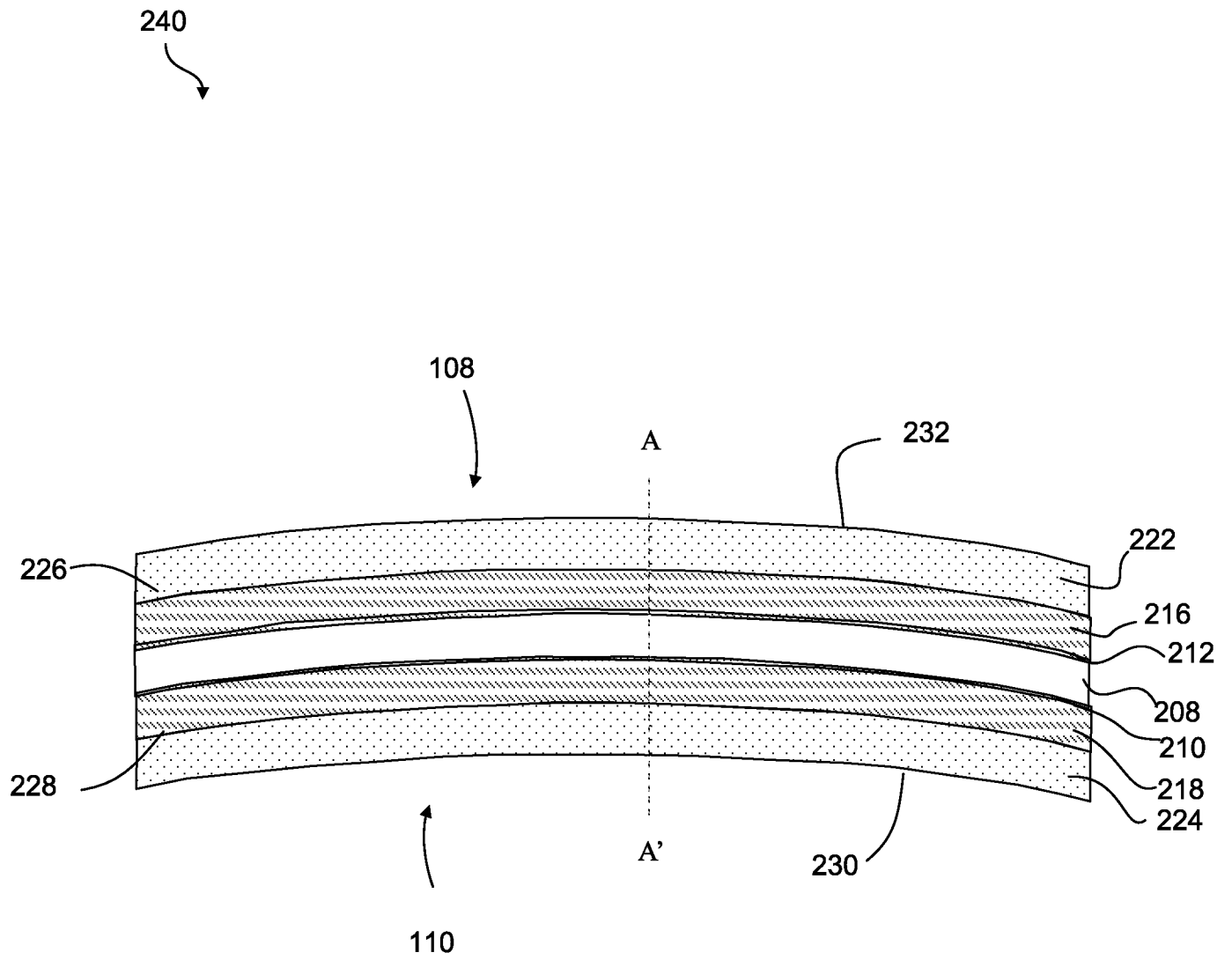
the local maximum transmittance of the transmittance valley is positioned at a first wavelength from about 570 nm to about 600 nm; and

wherein a difference in transmittance between the first minimum transmittance and the local maximum transmittance is less than 2%.

**FIG. 1**

2/33

**FIG. 2A****FIG. 2B**

**FIG. 2C**

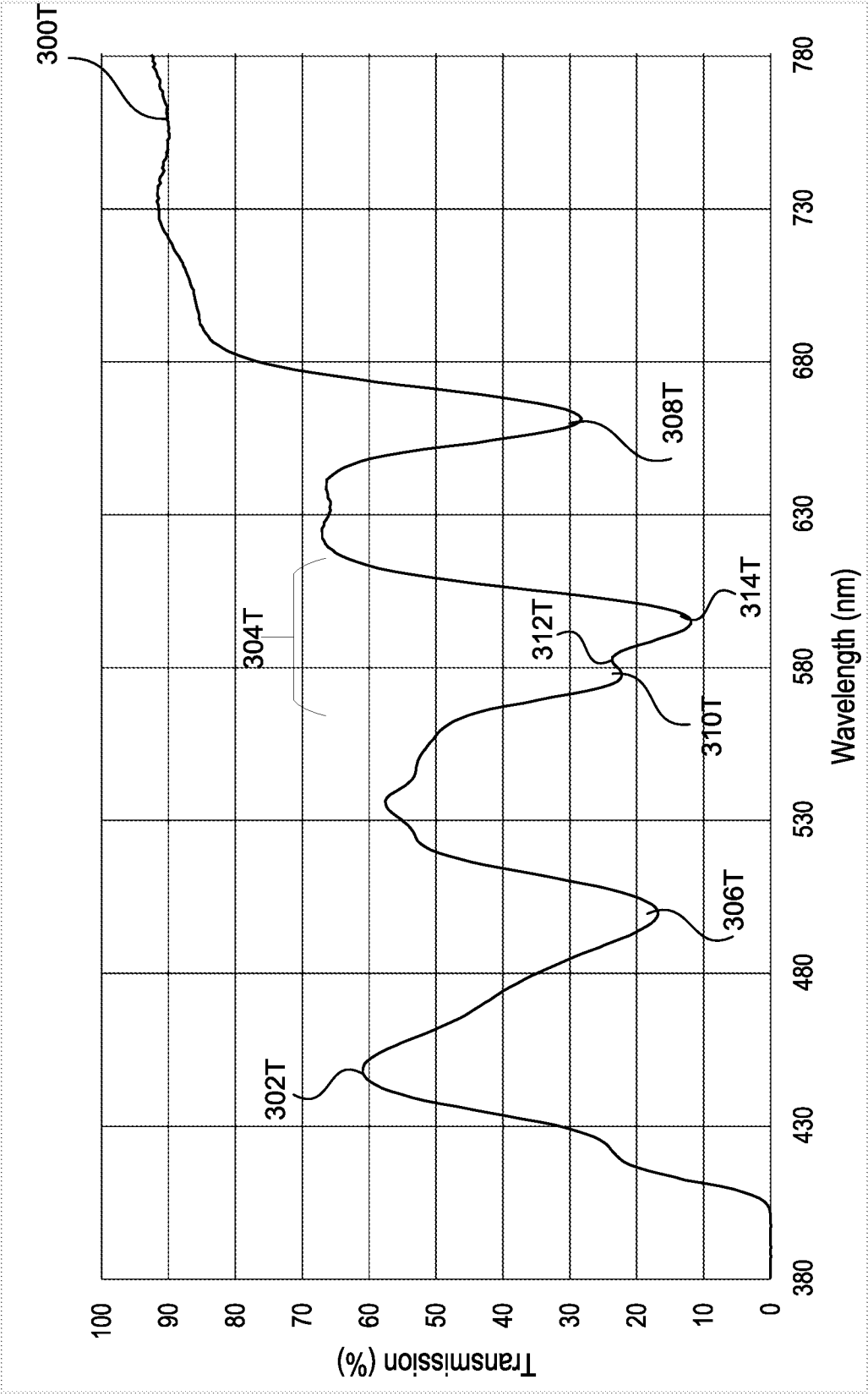


FIG. 3A

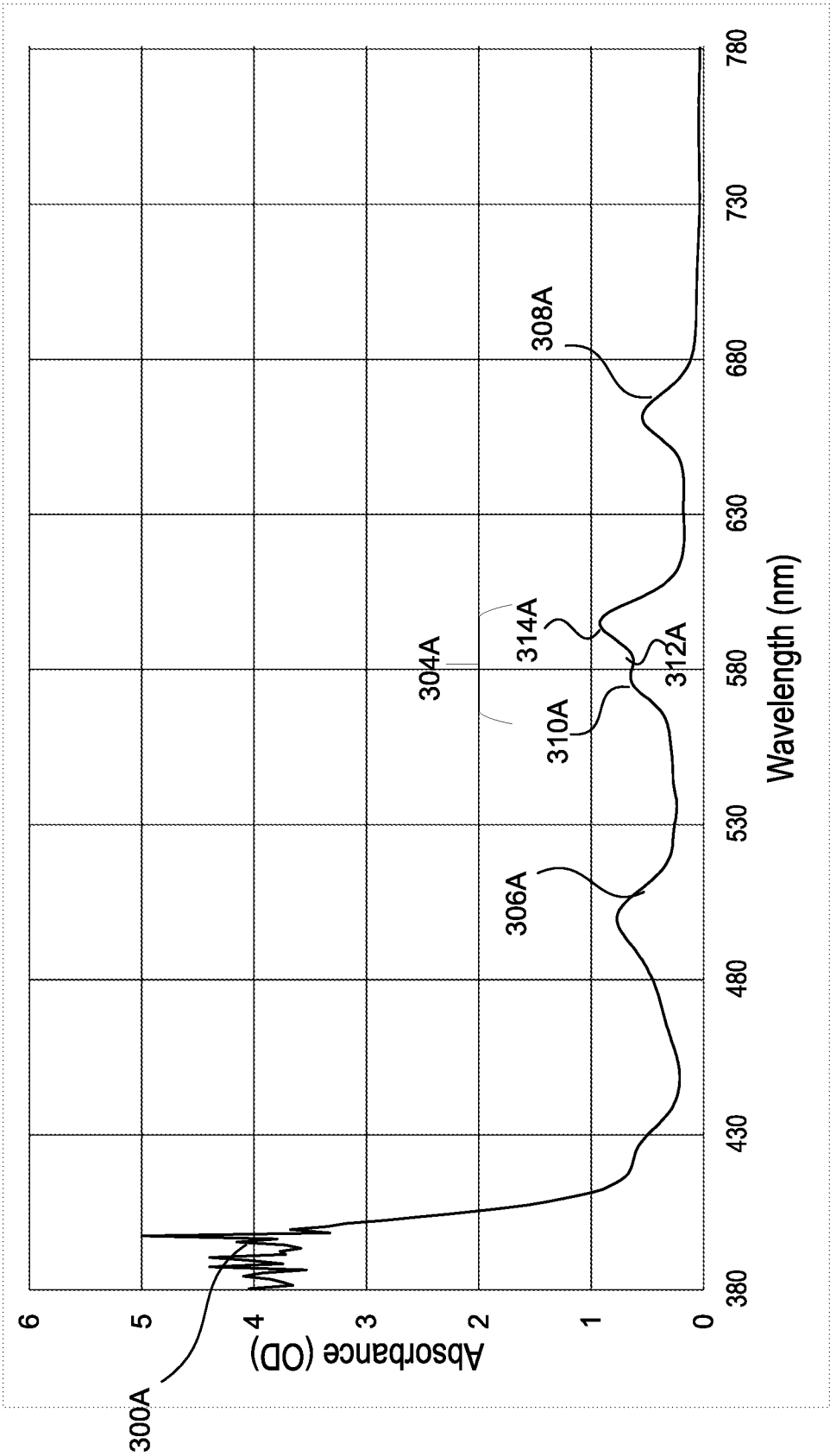


FIG. 3B

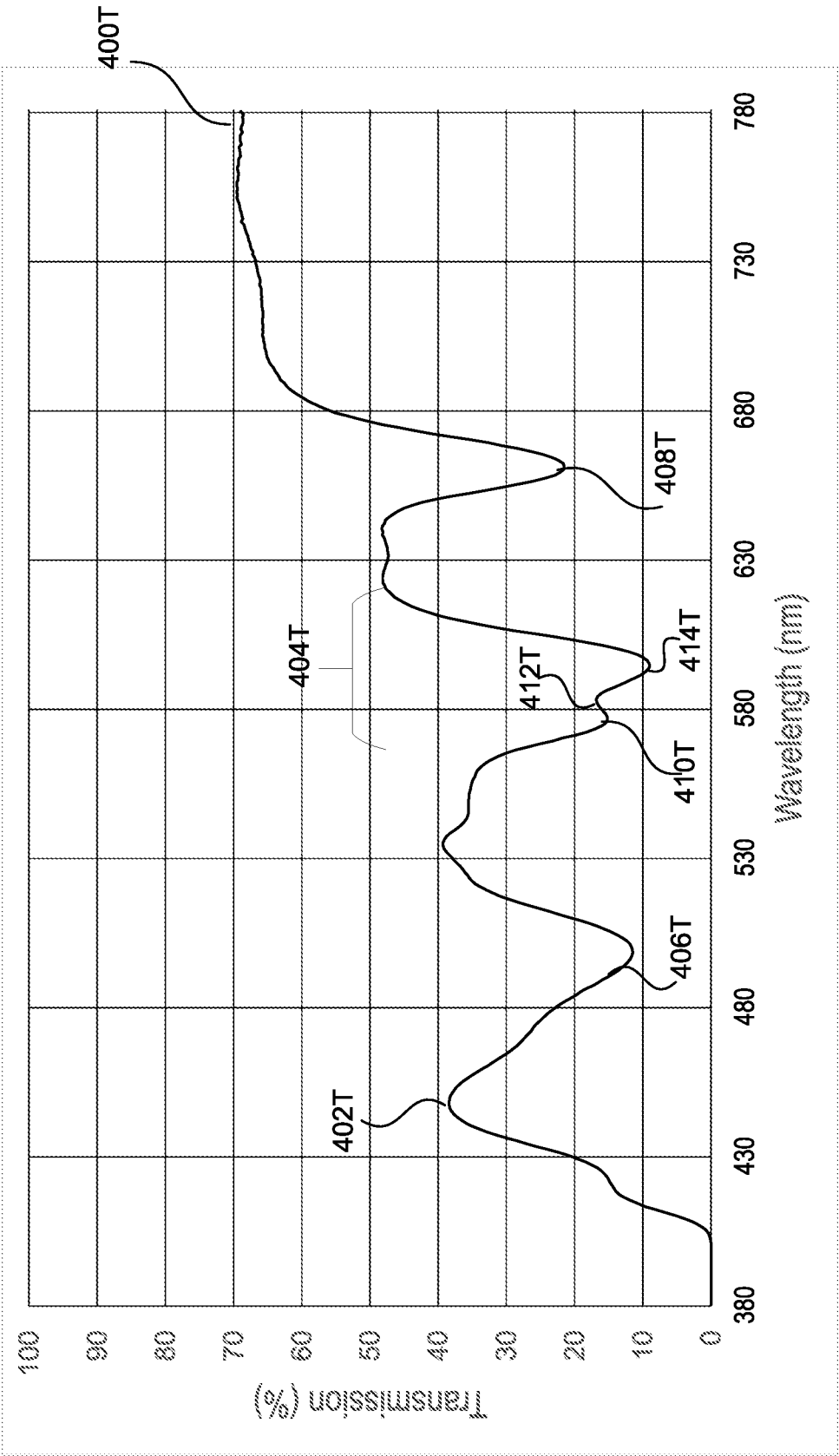


FIG. 4A

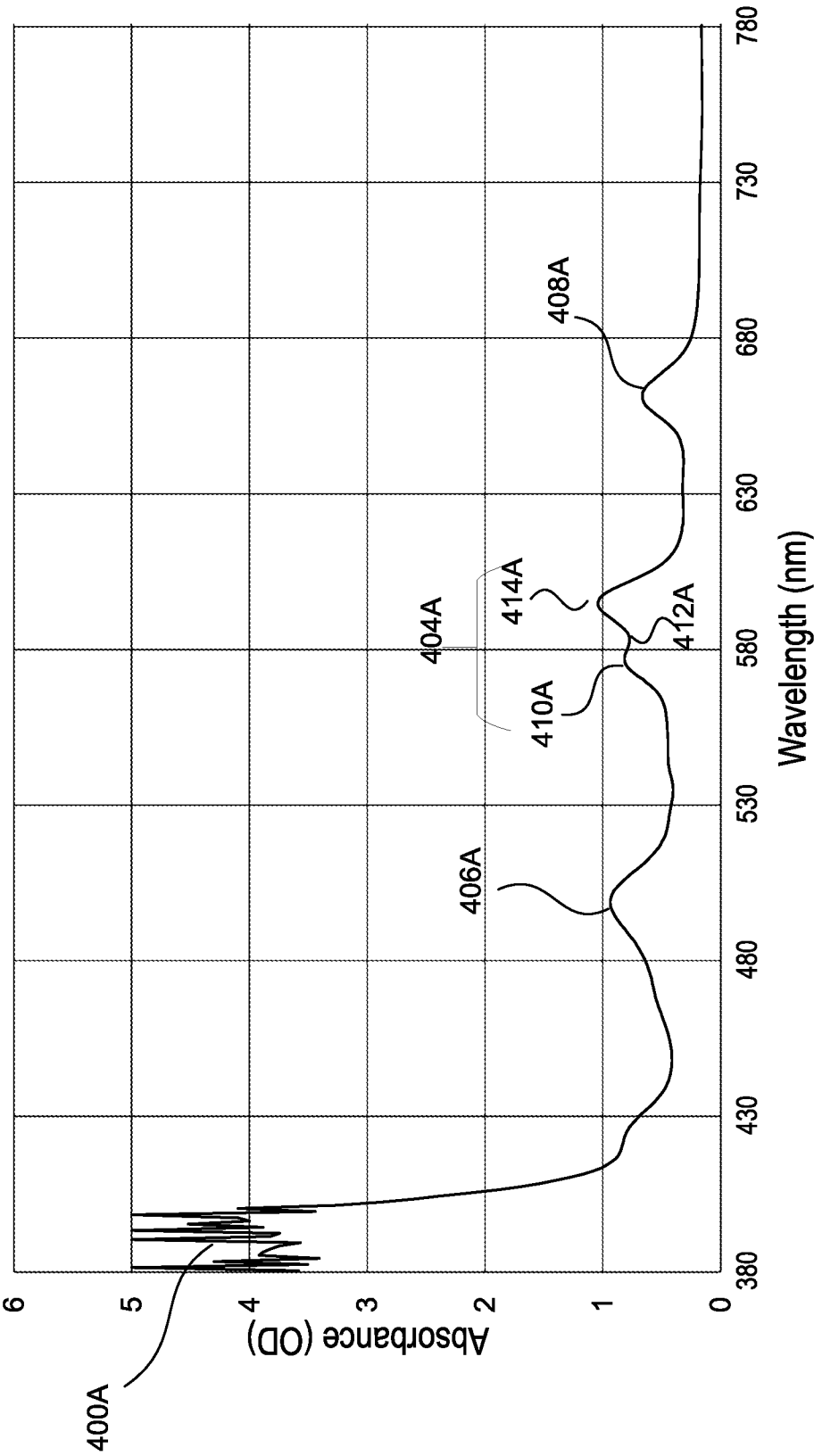


FIG. 4B

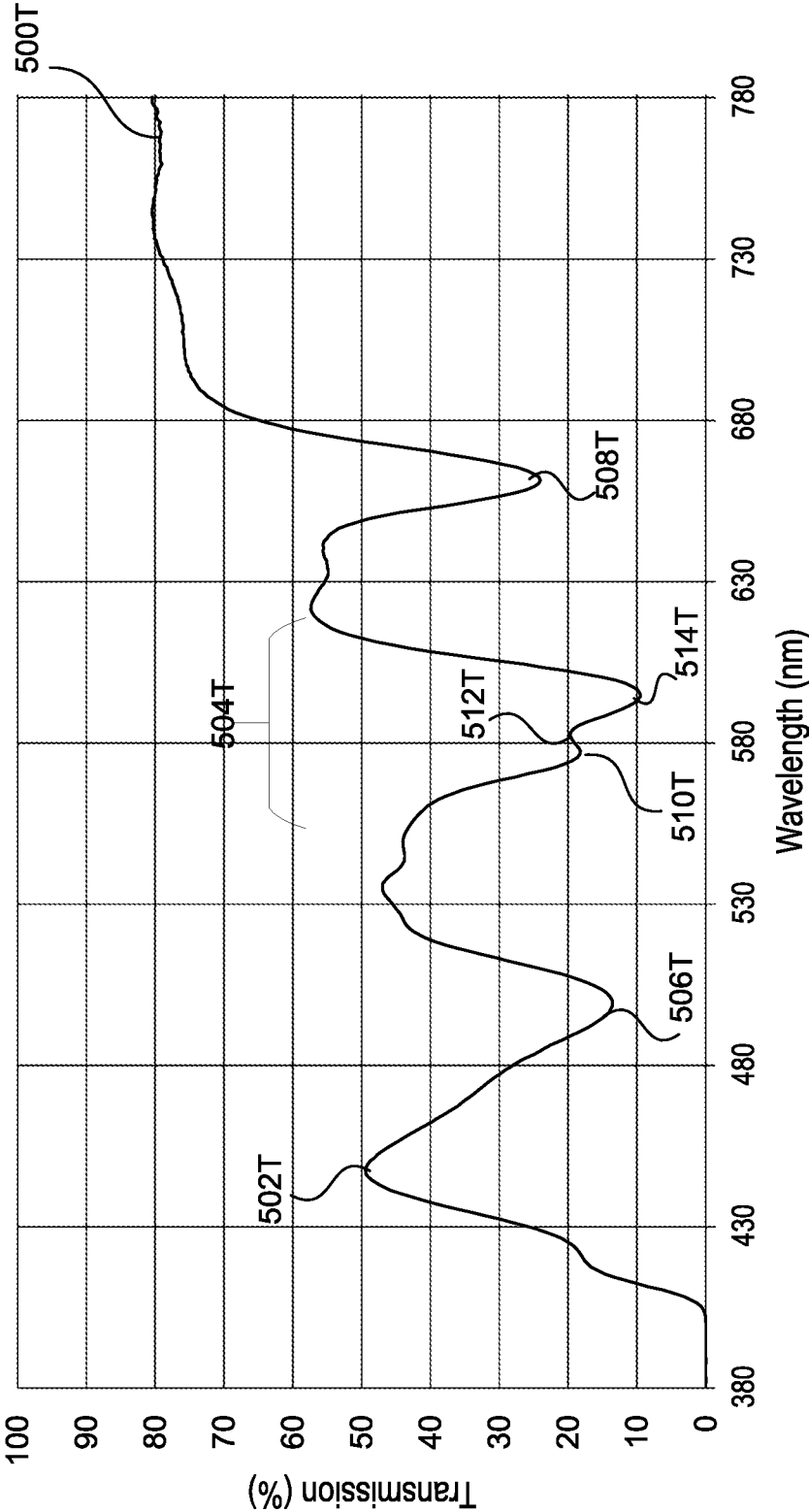


FIG. 5A

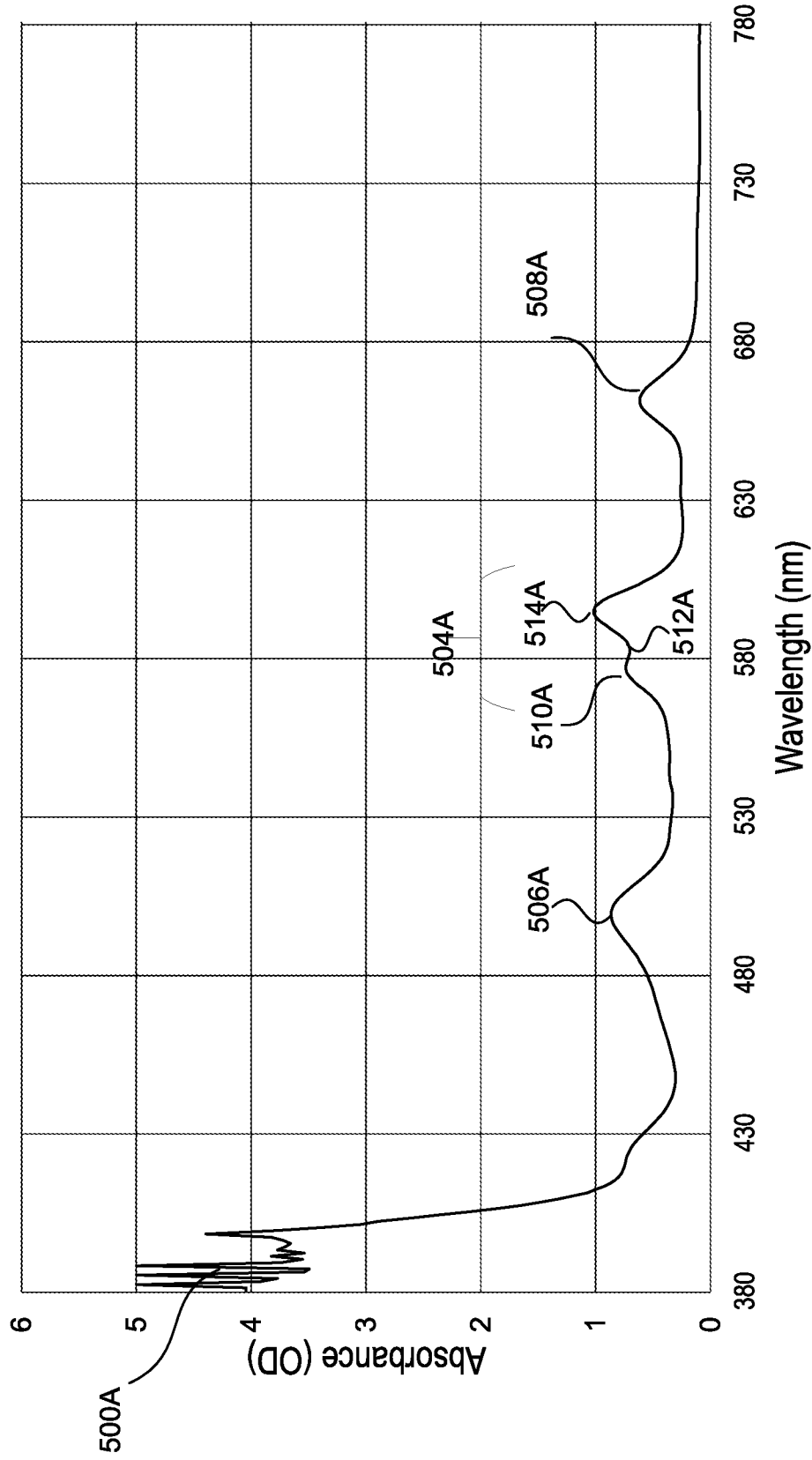


FIG. 5B

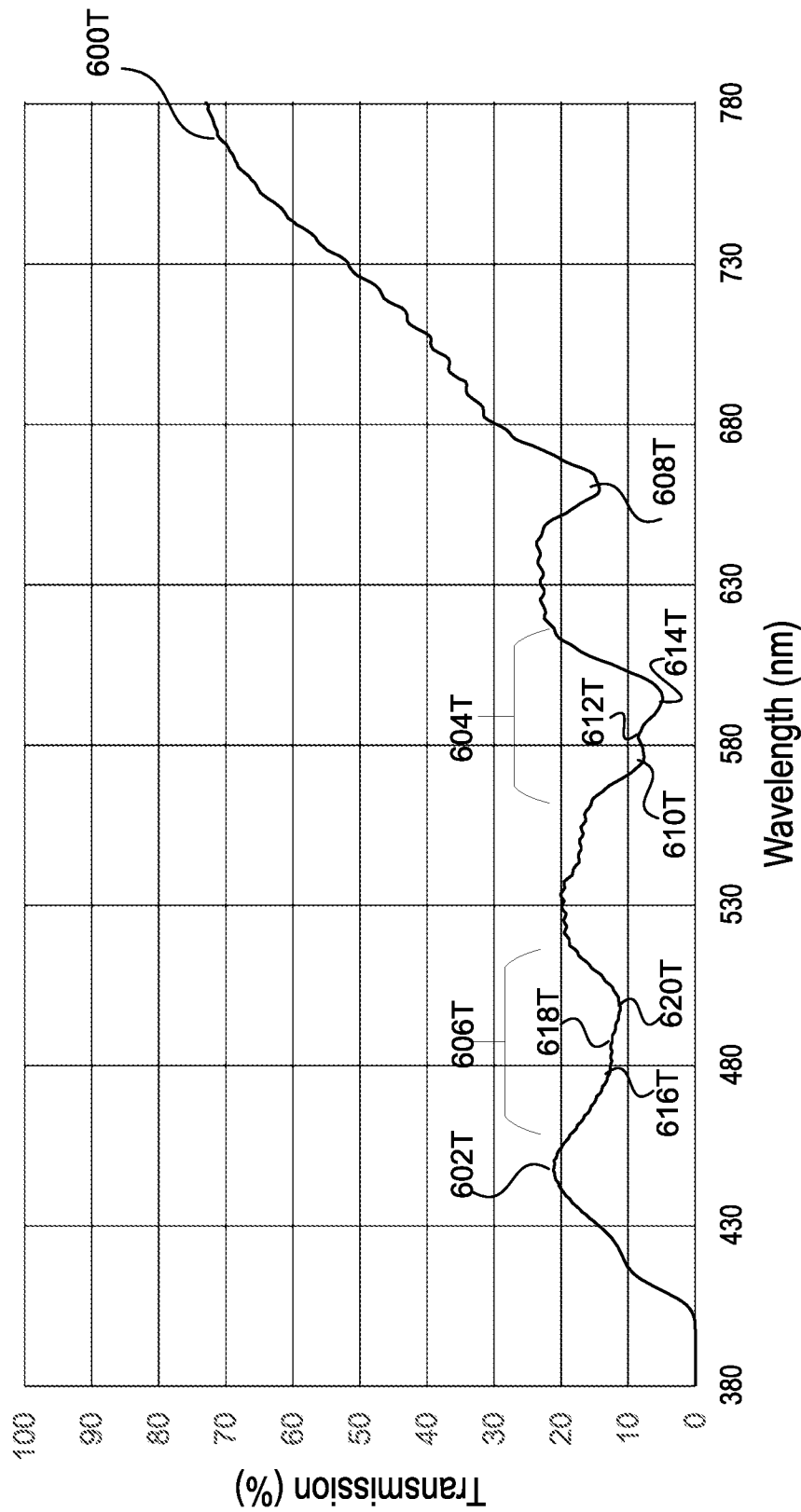


FIG. 6A

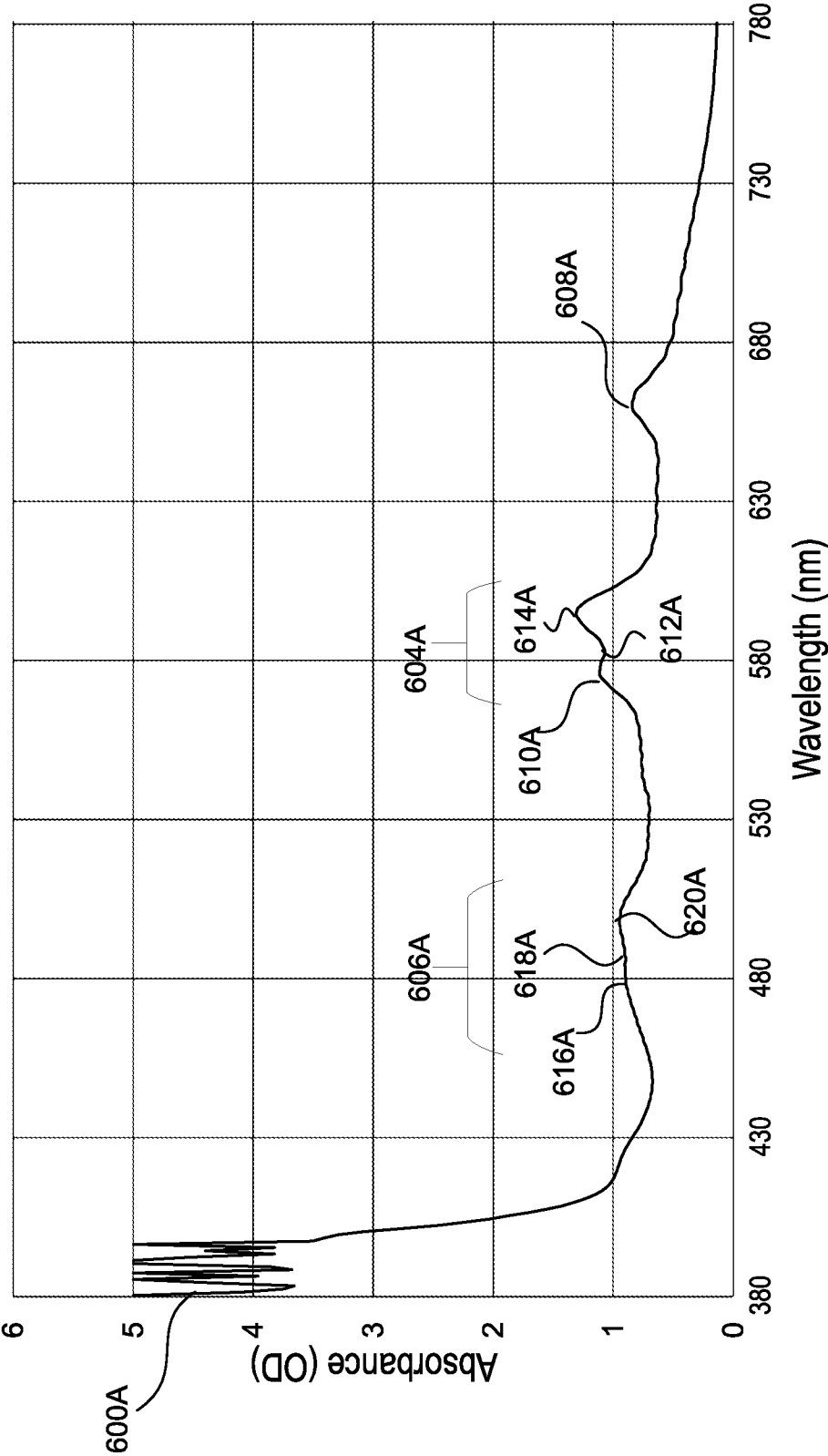


FIG. 6B

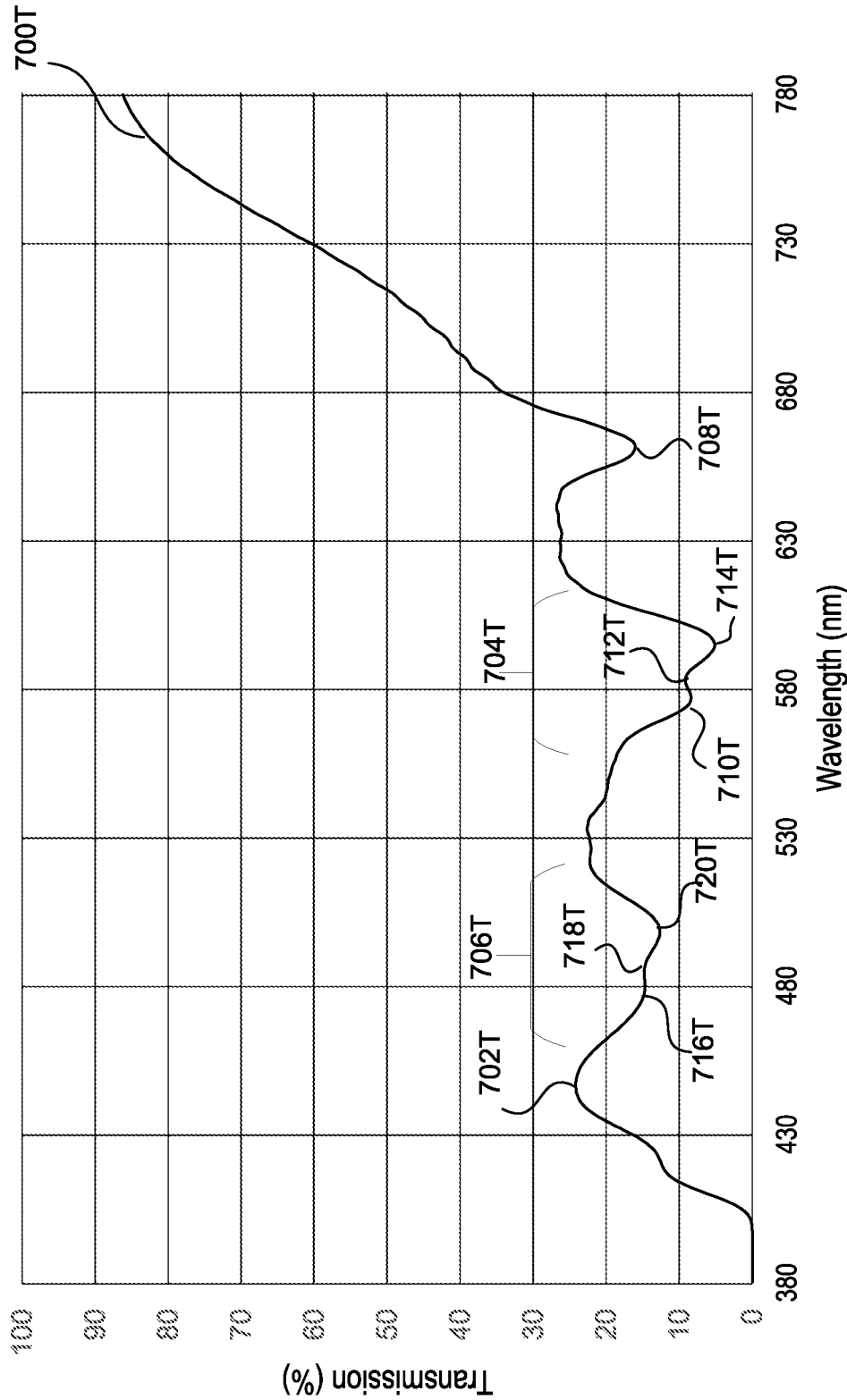


FIG. 7A

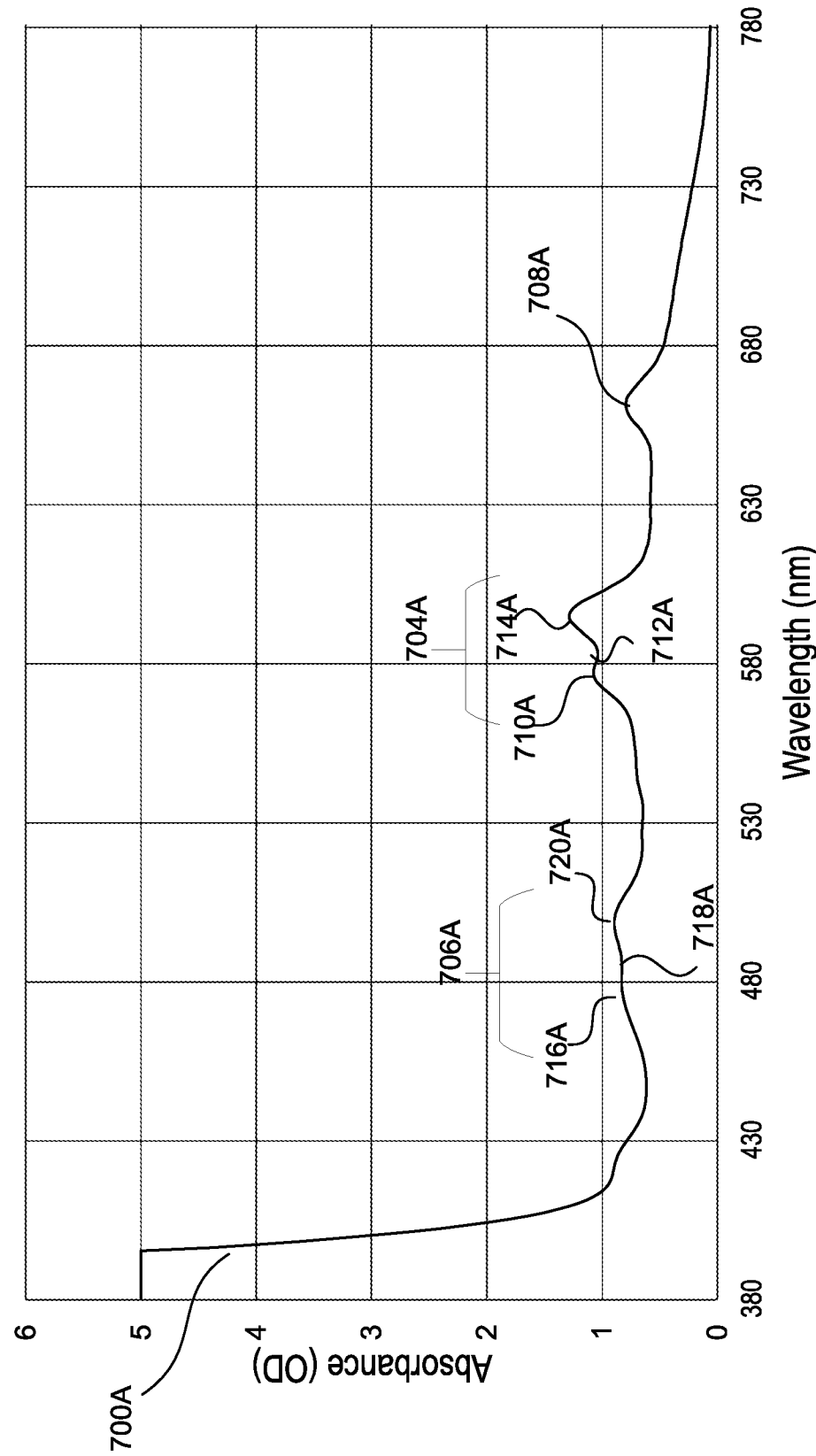


FIG. 7B

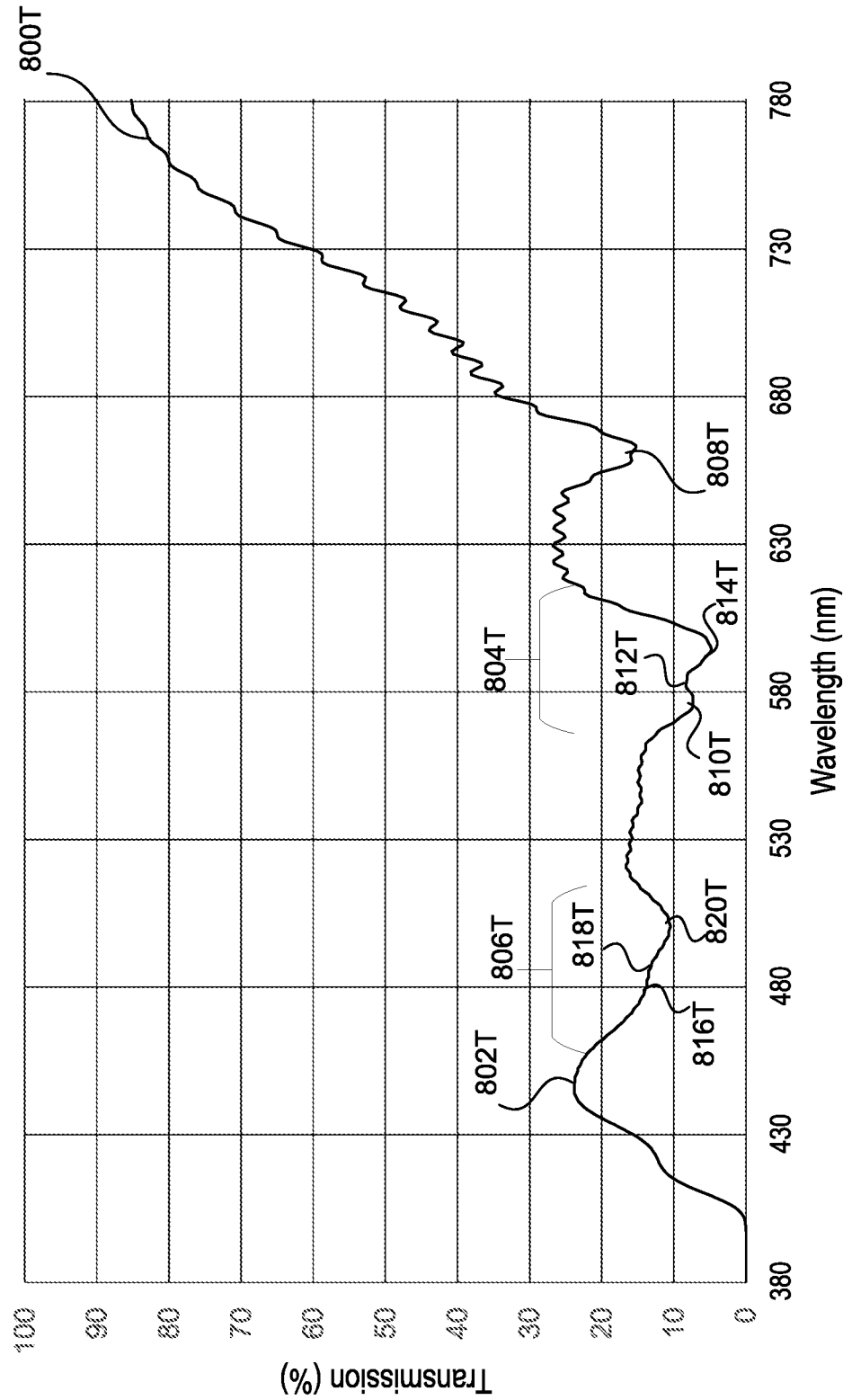


FIG. 8A

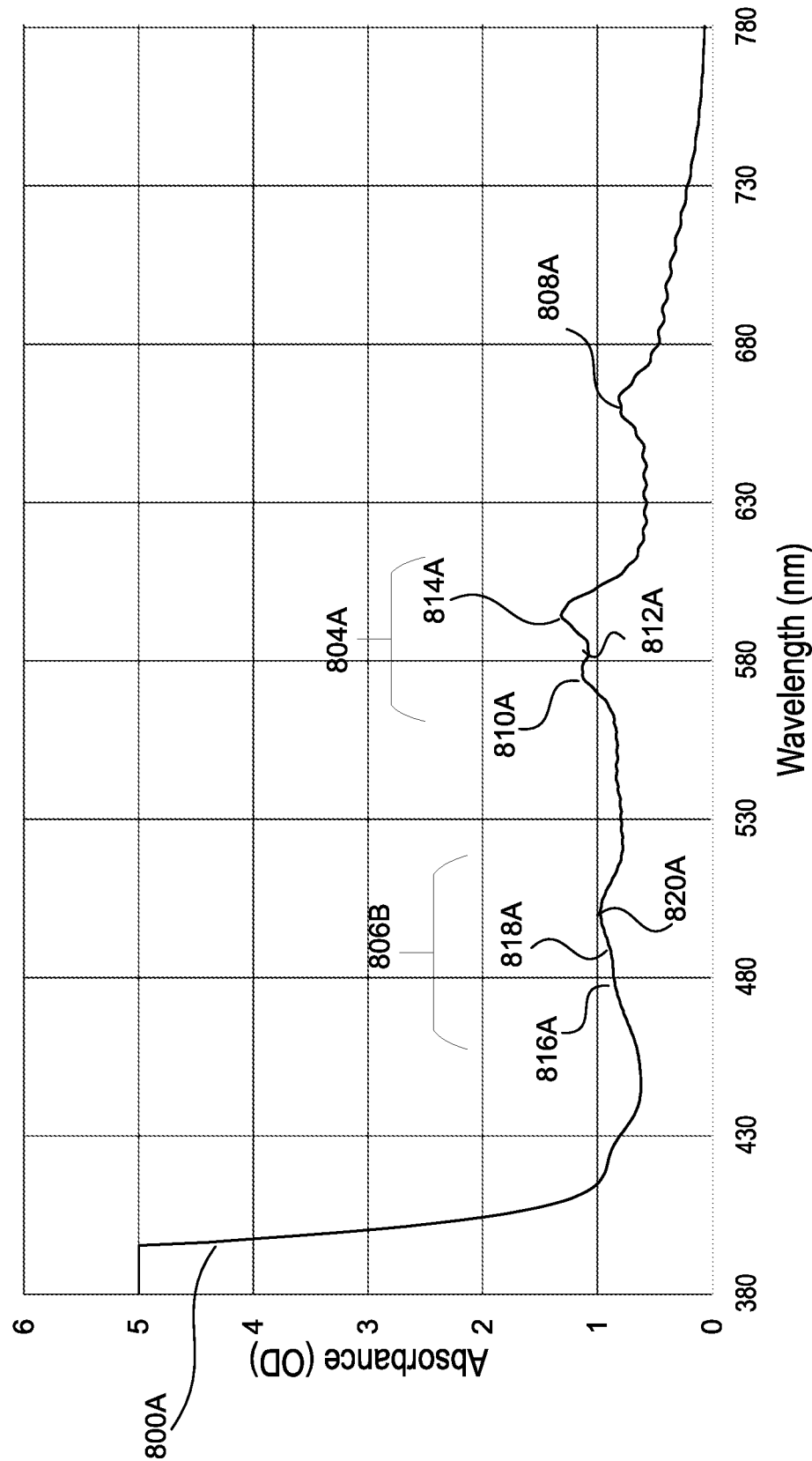


FIG. 8B

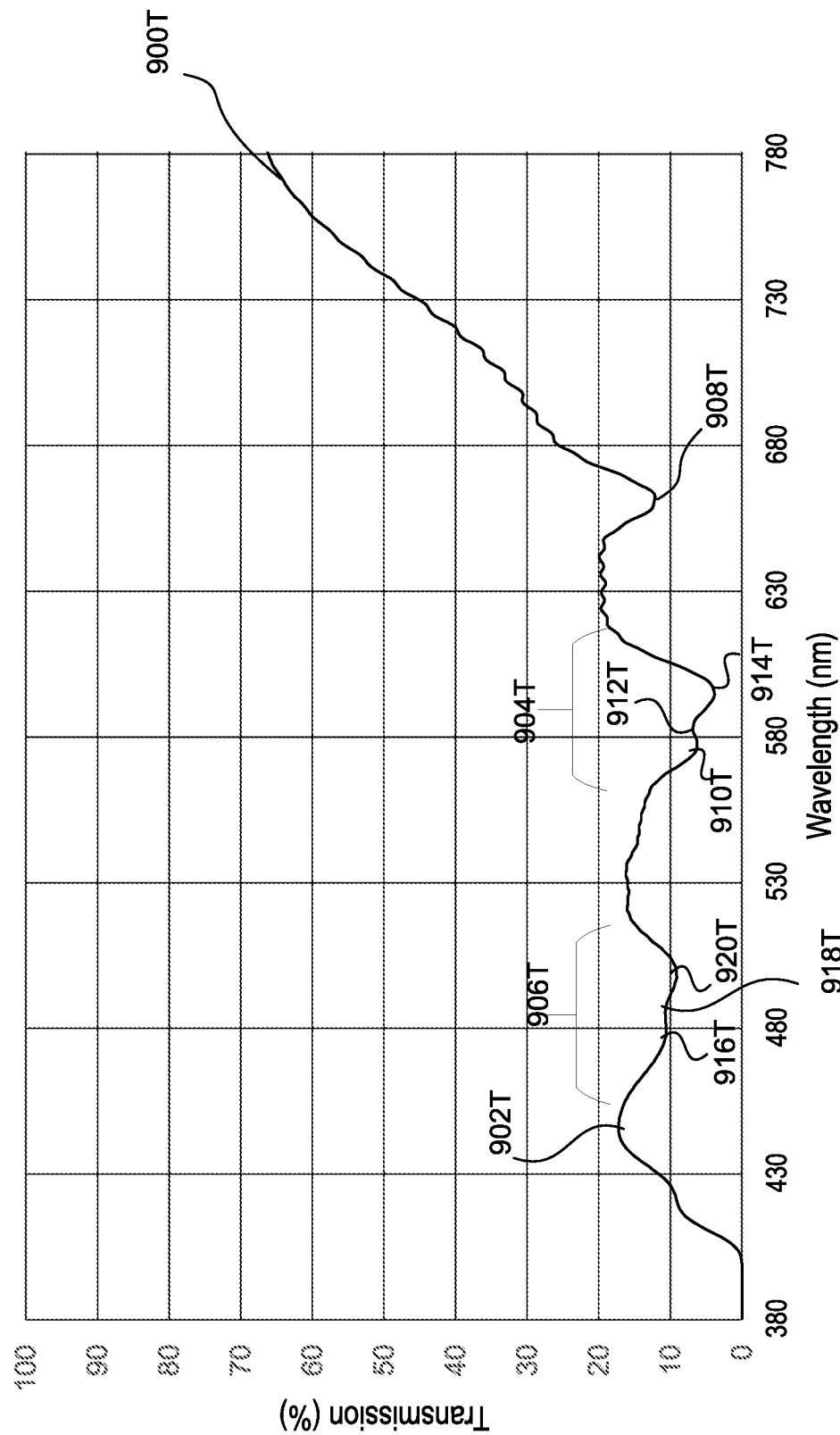


FIG. 9A

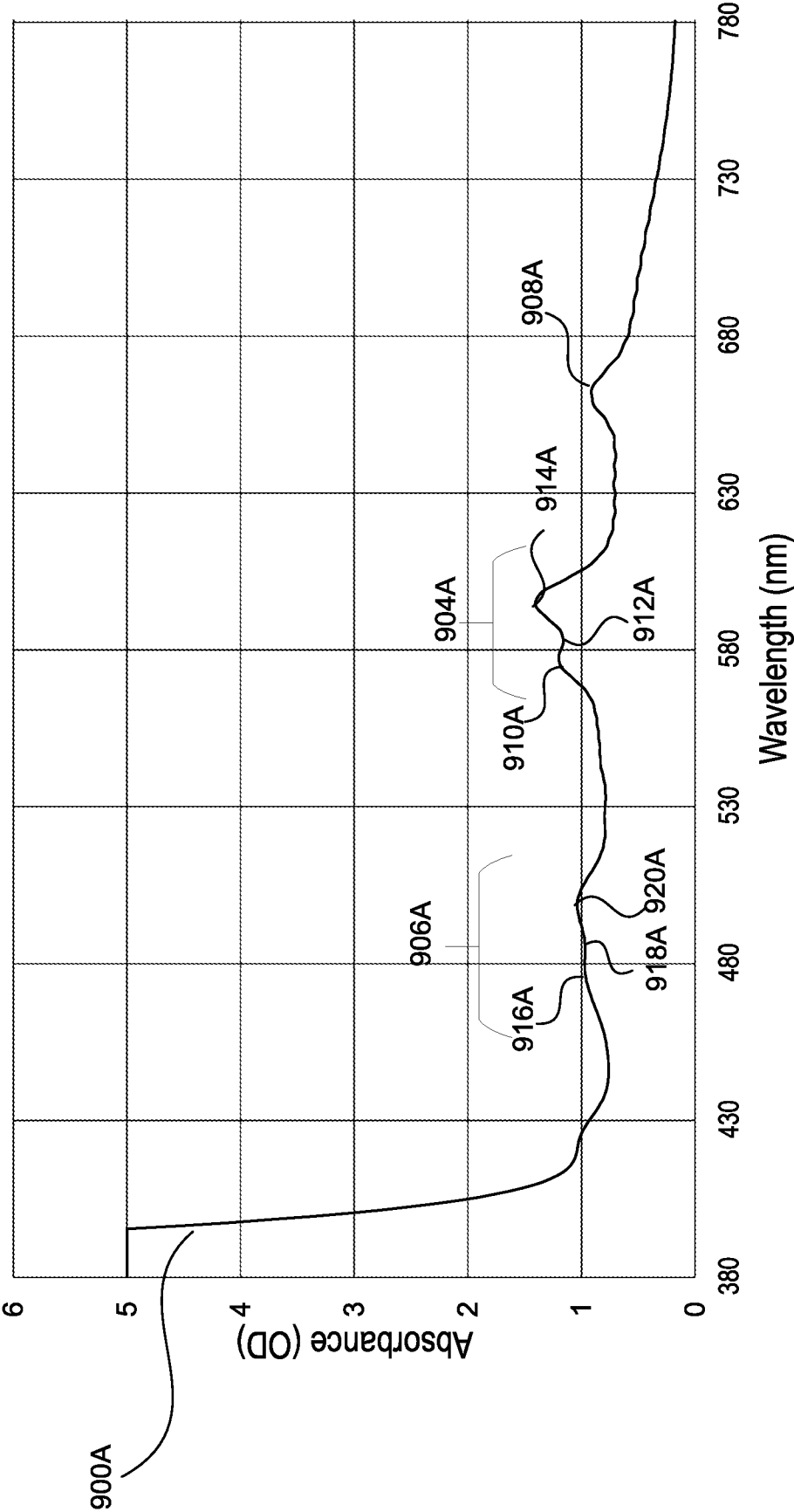


FIG. 9B

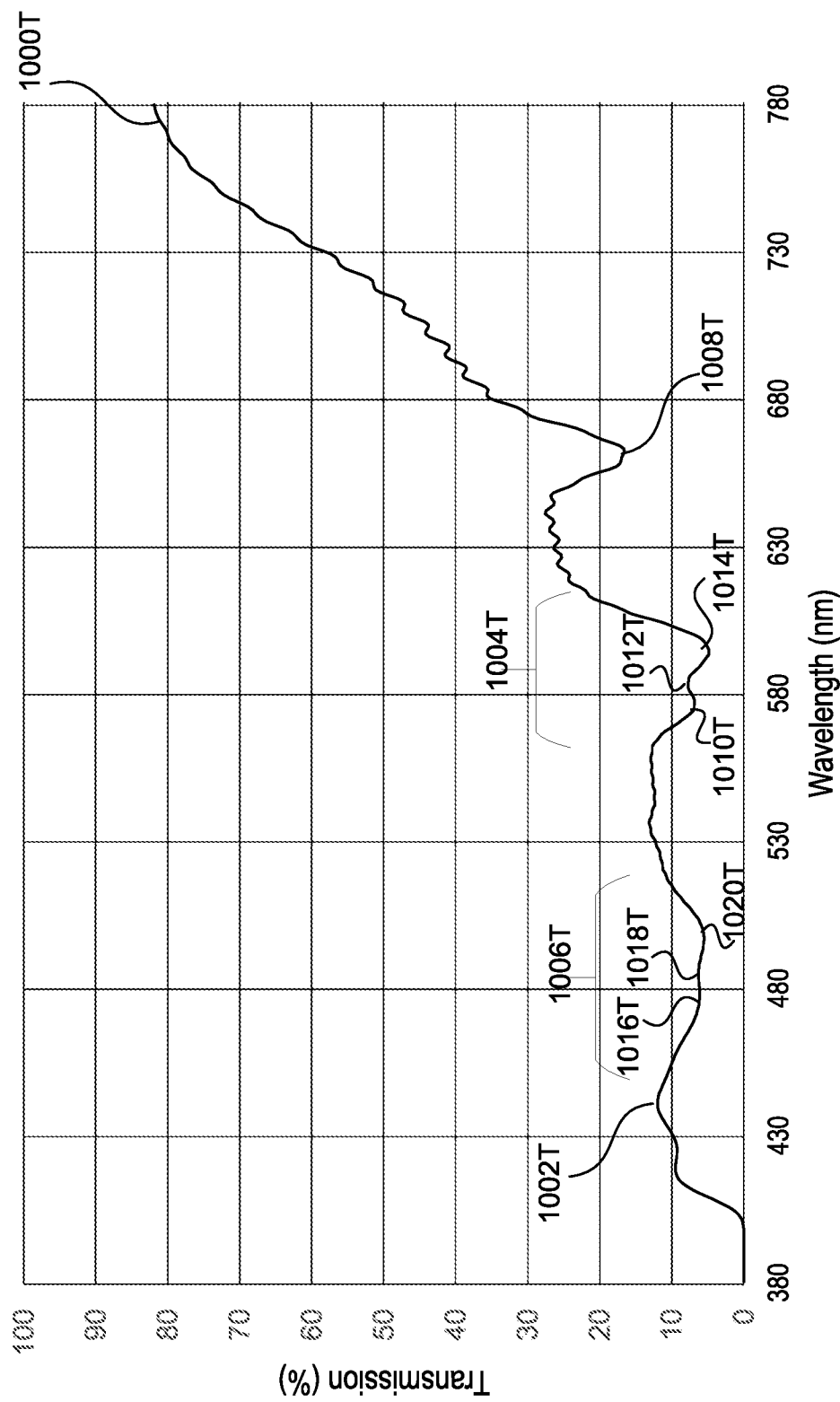


FIG. 10A

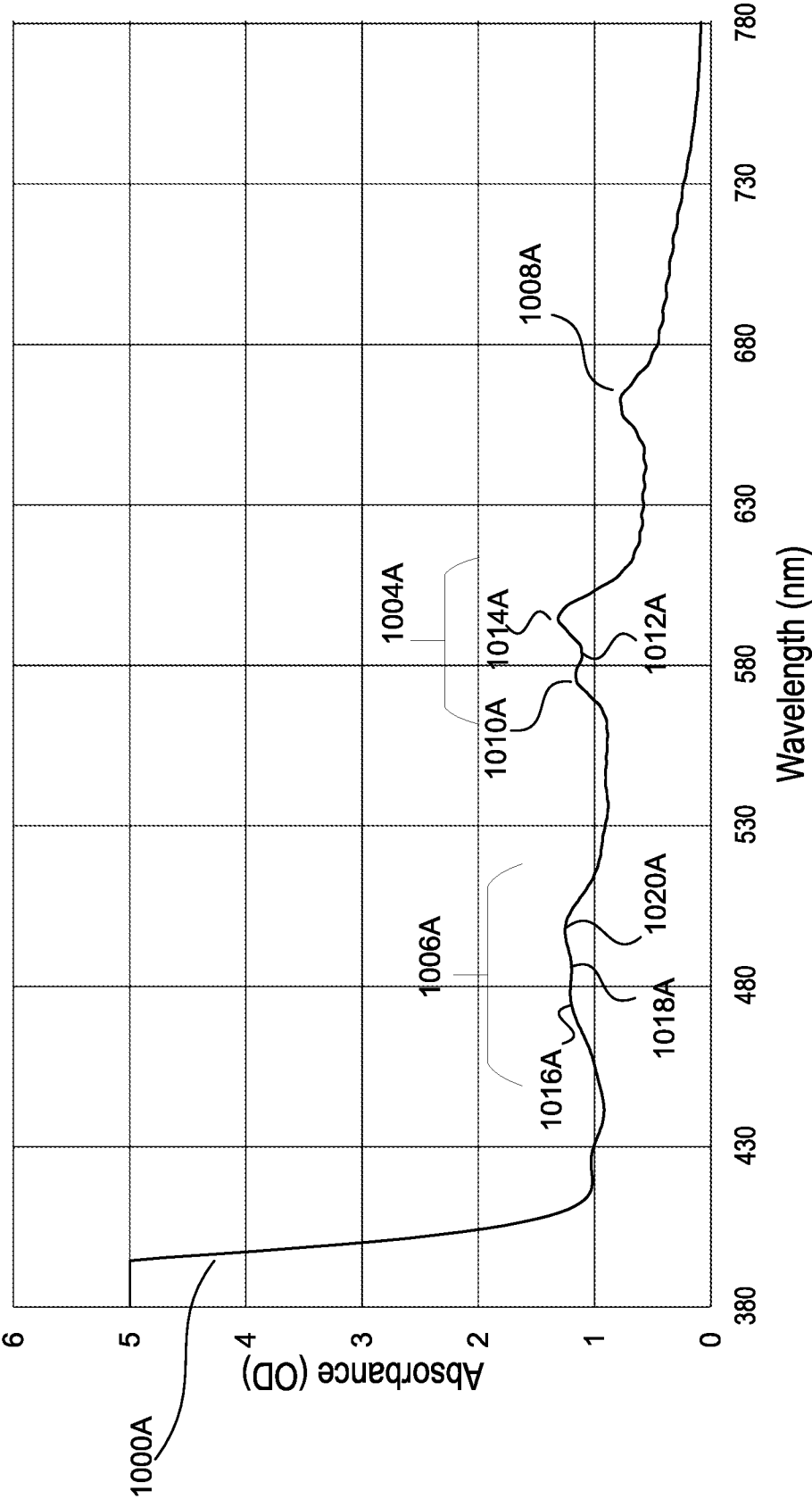


FIG. 10B

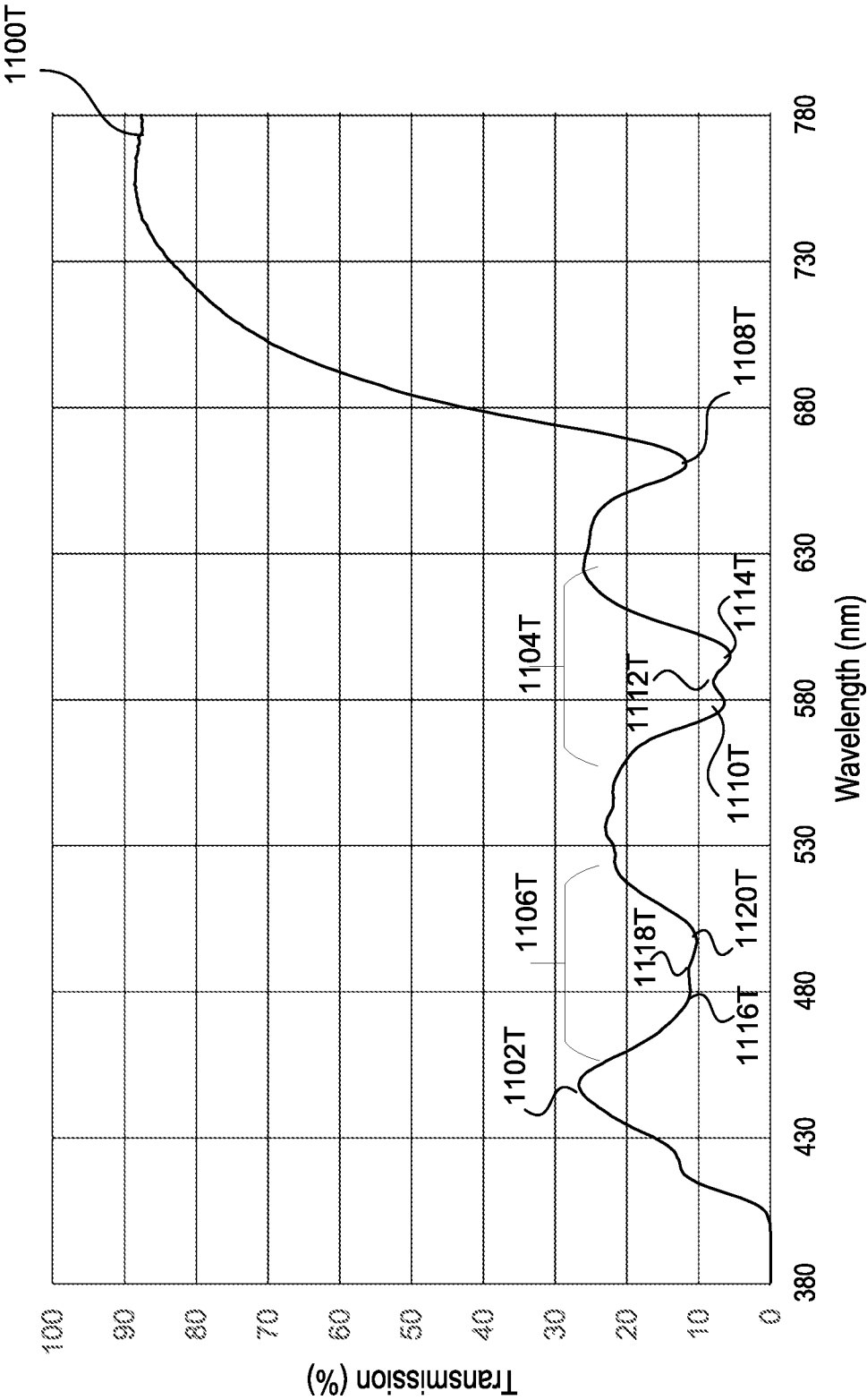


FIG. 11A

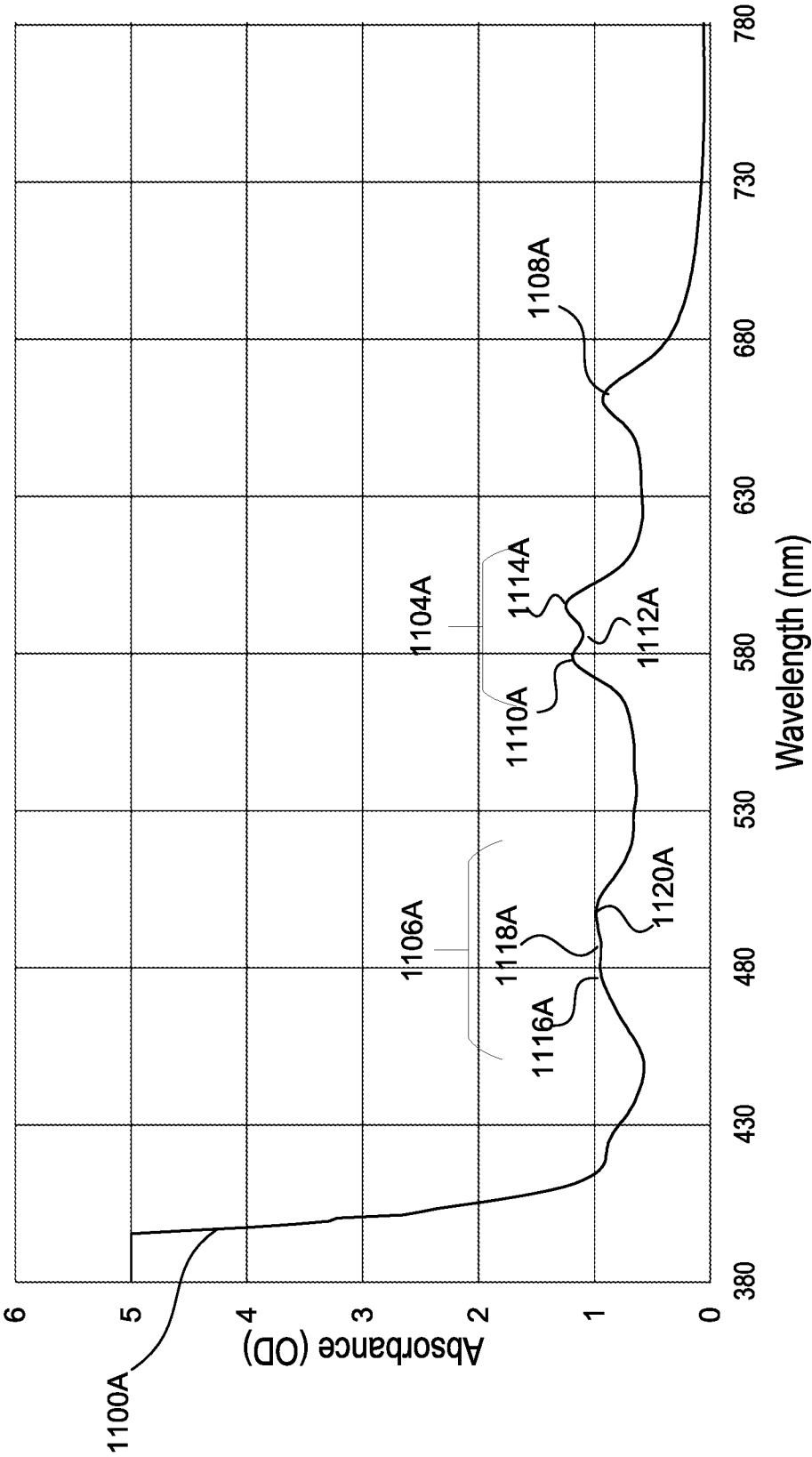


FIG. 11B

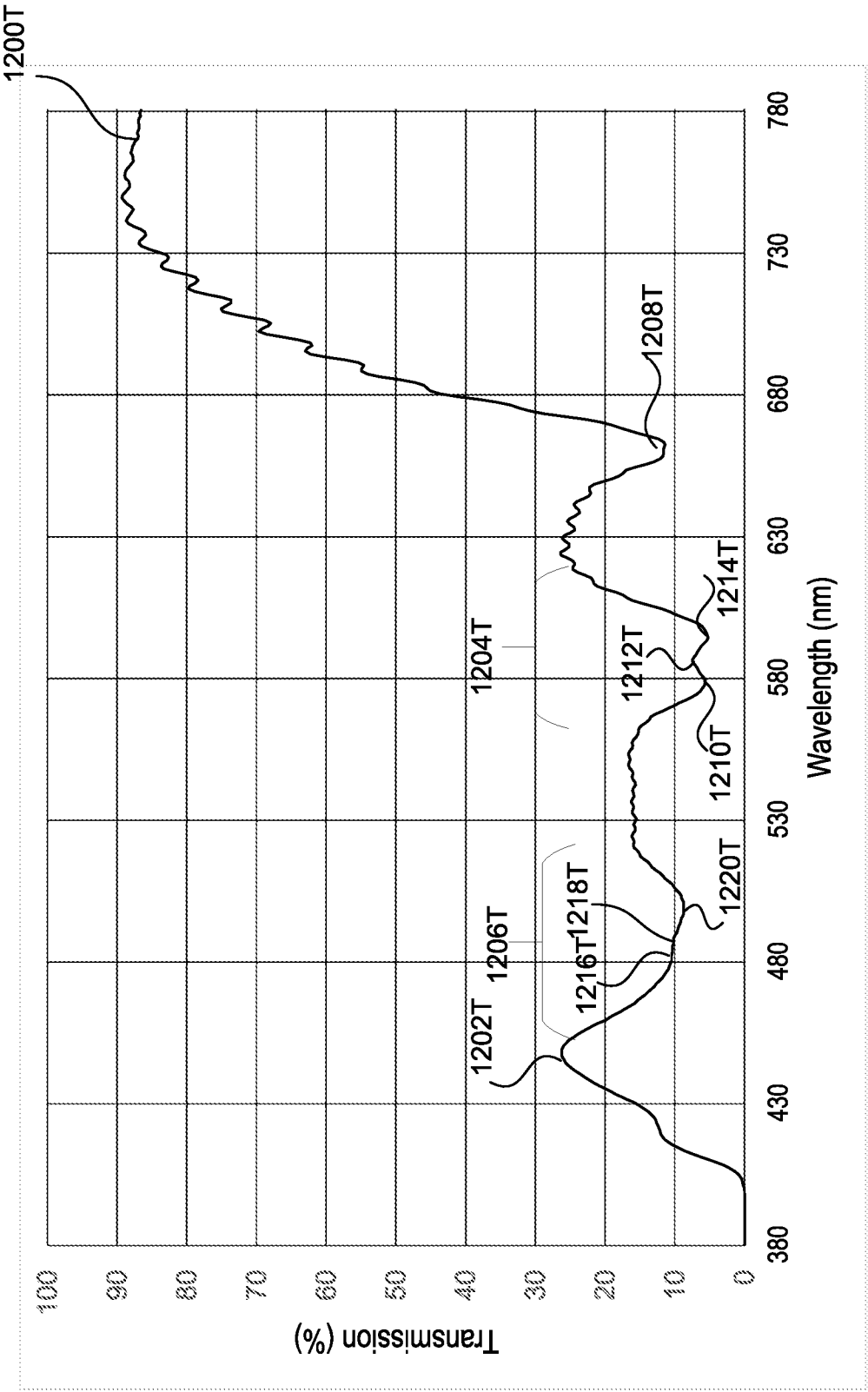


FIG. 12A

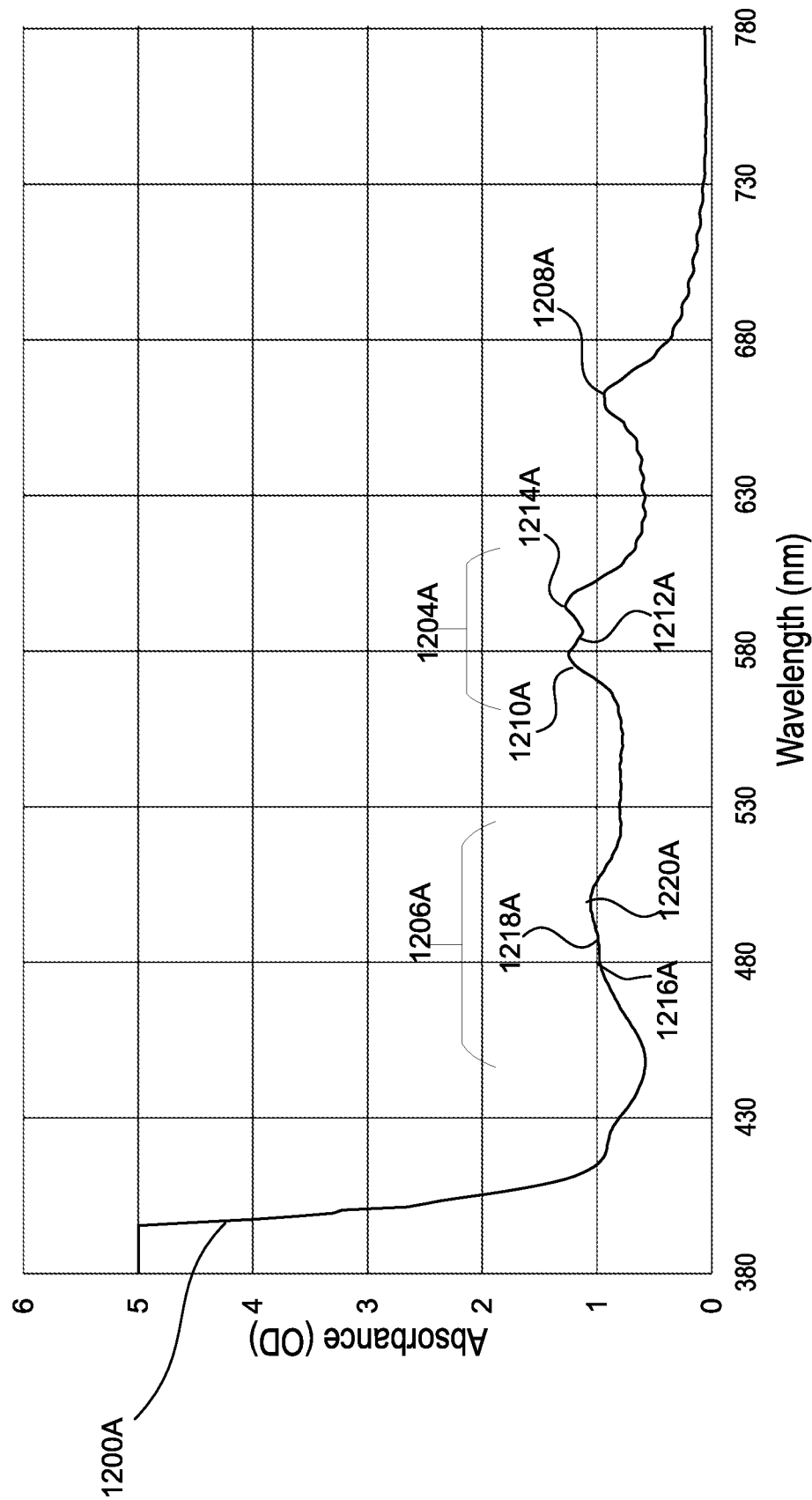


FIG. 12B

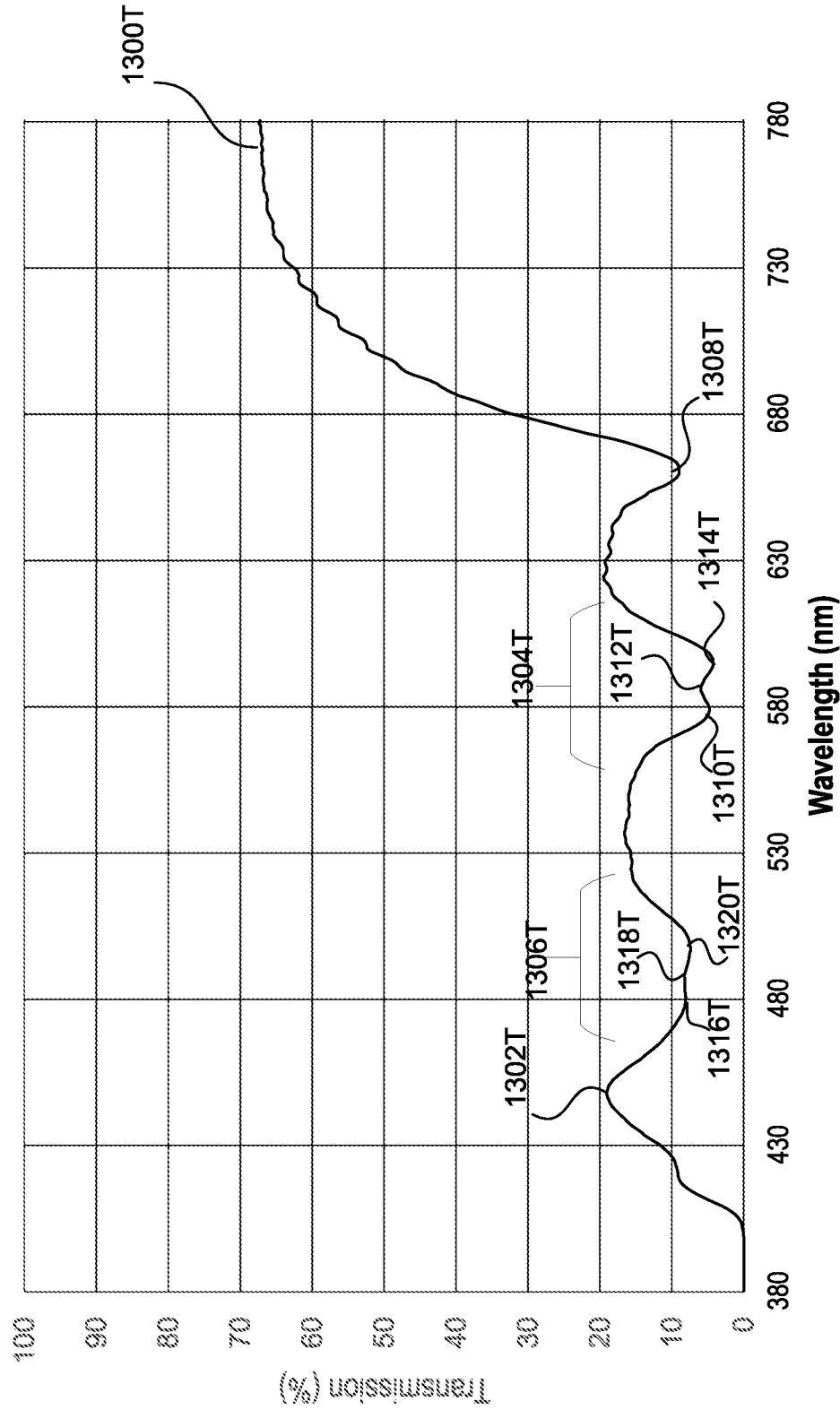


FIG. 13A

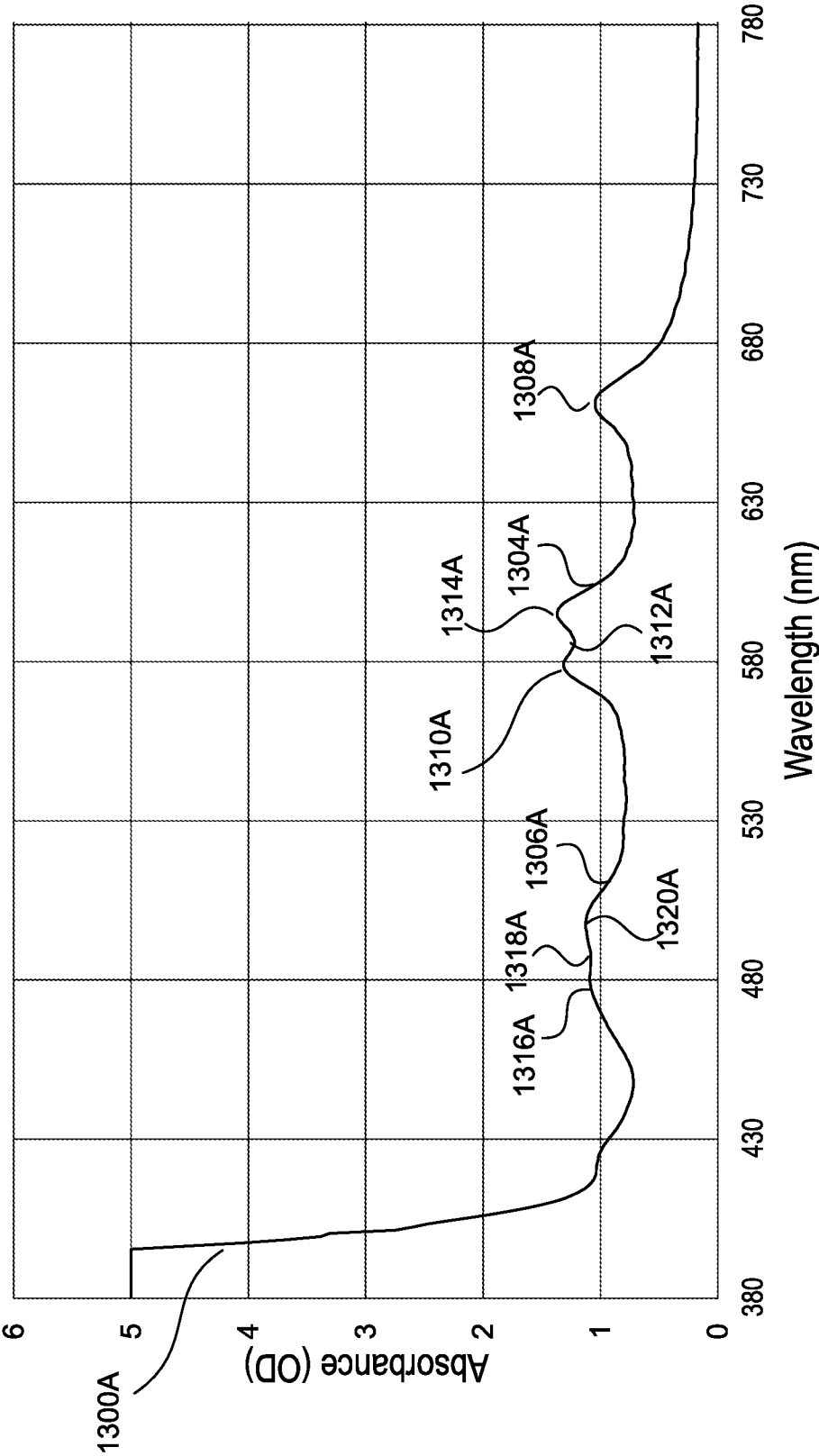


FIG. 13B

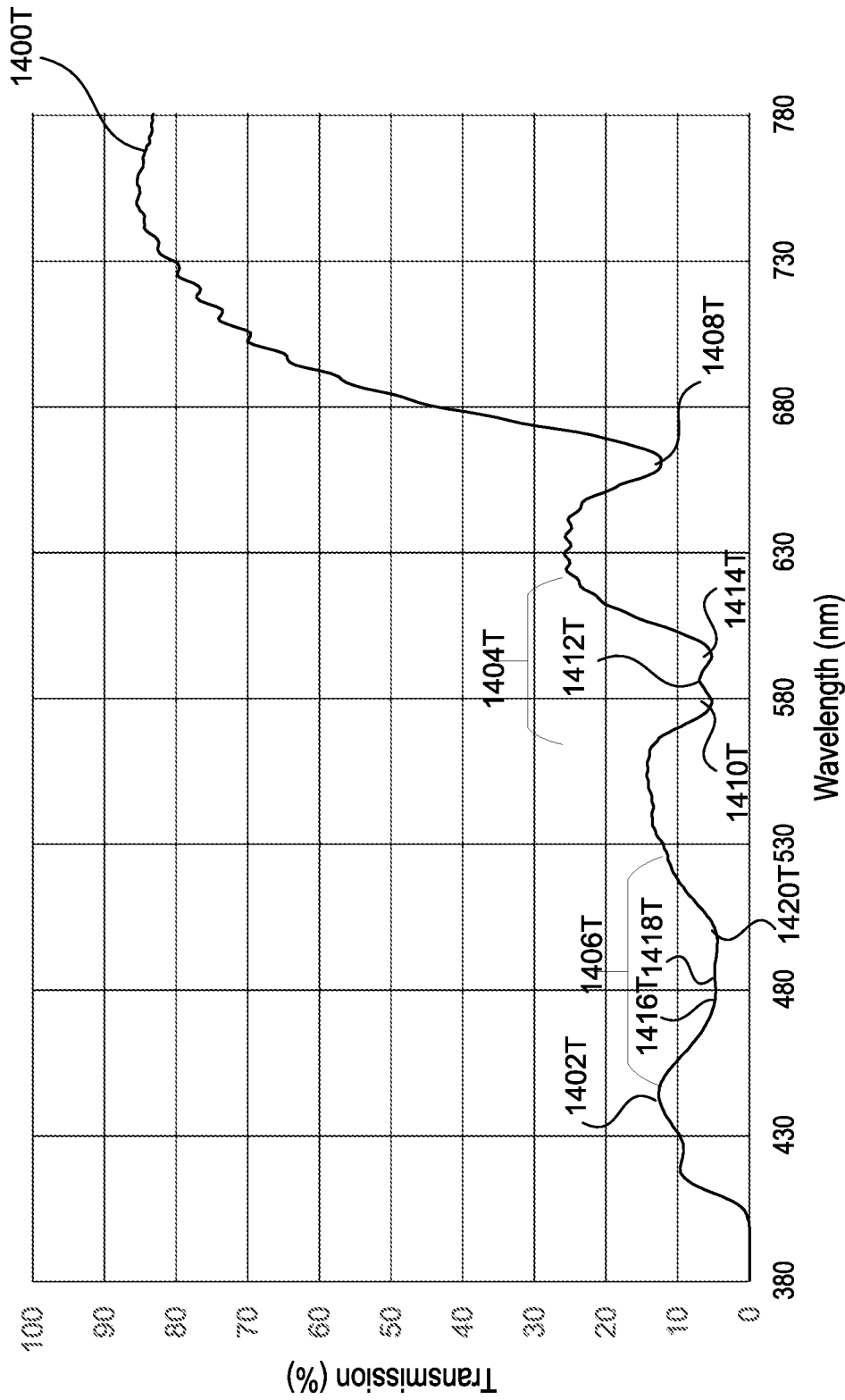


FIG. 14A

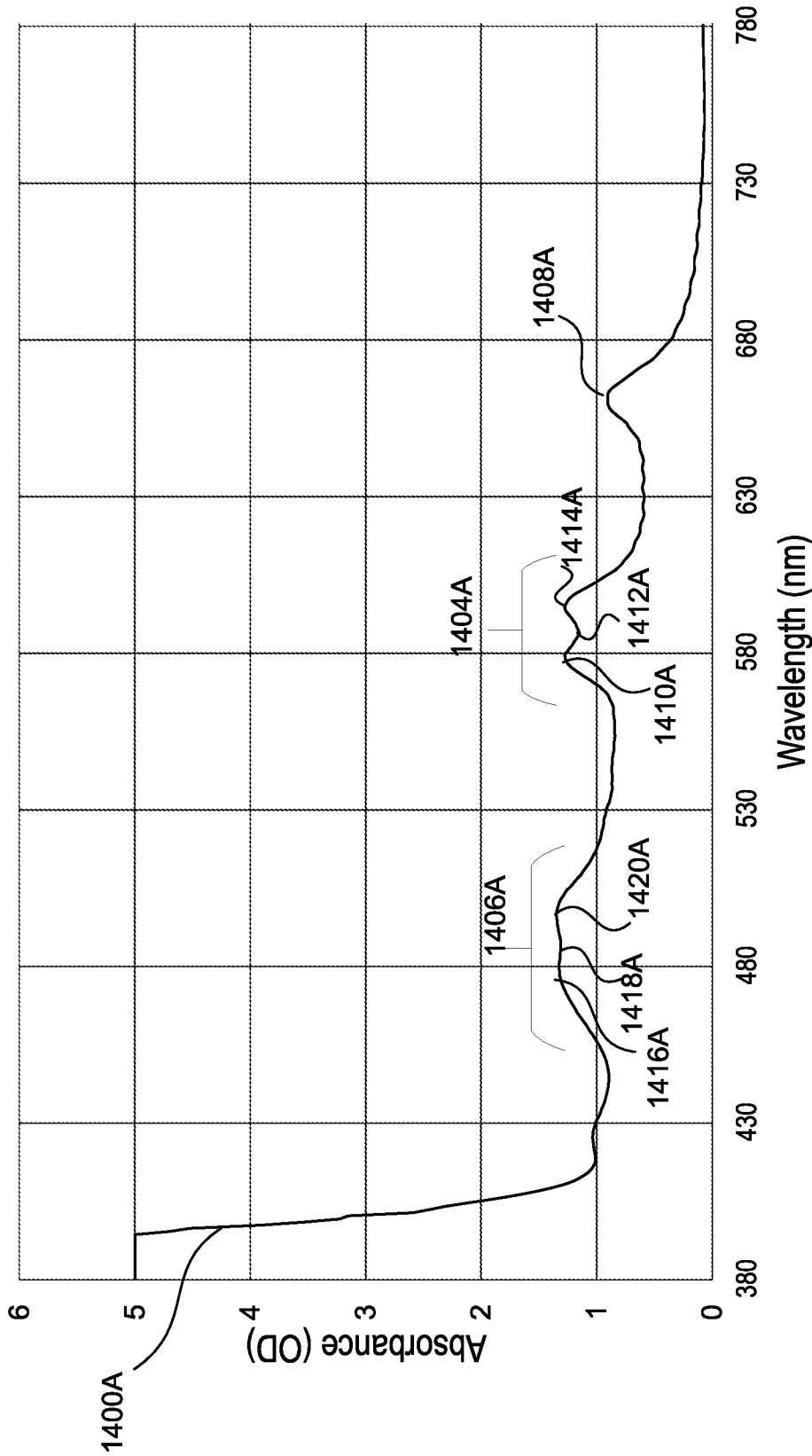


FIG. 14B

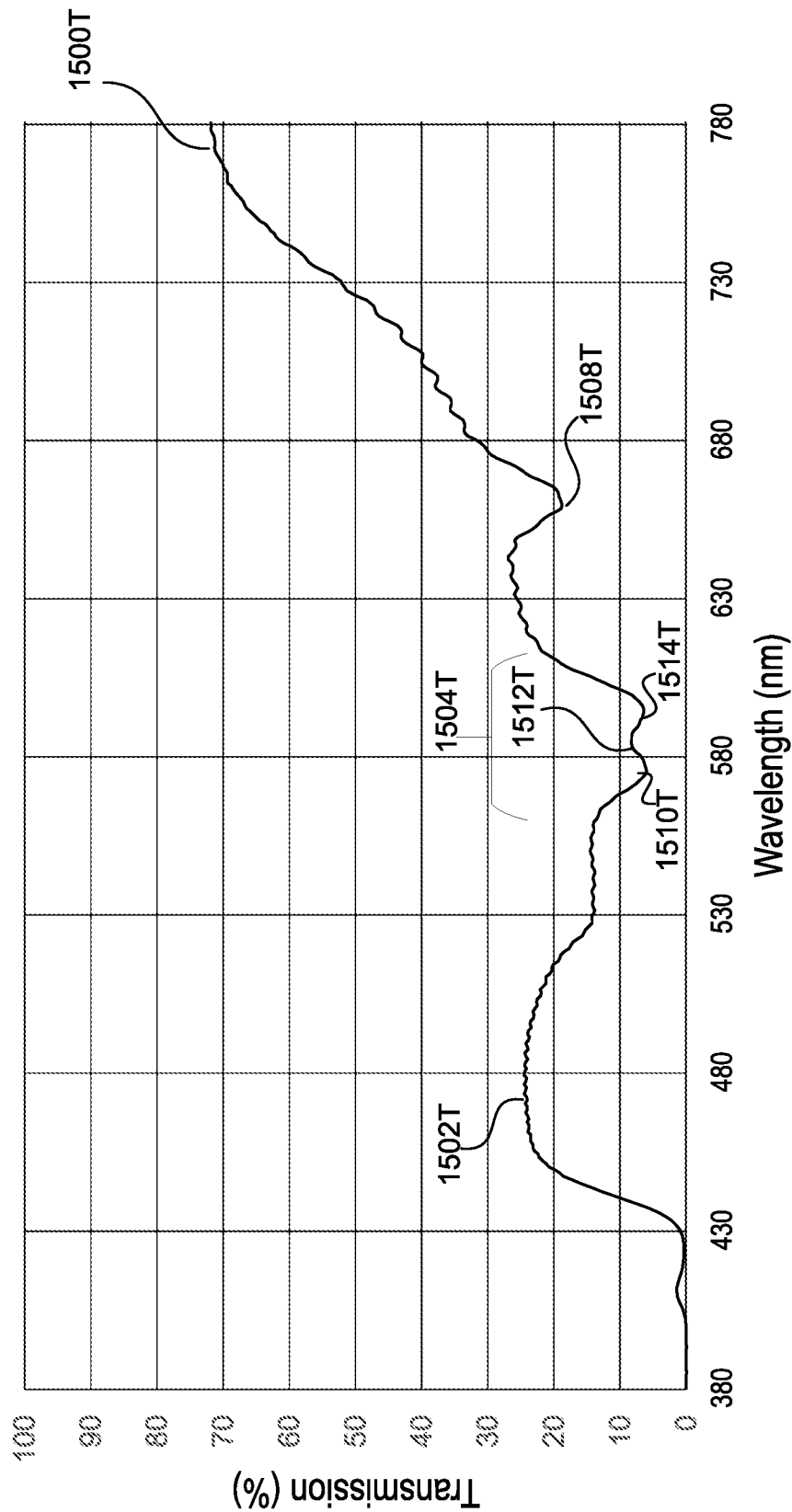


FIG. 15A

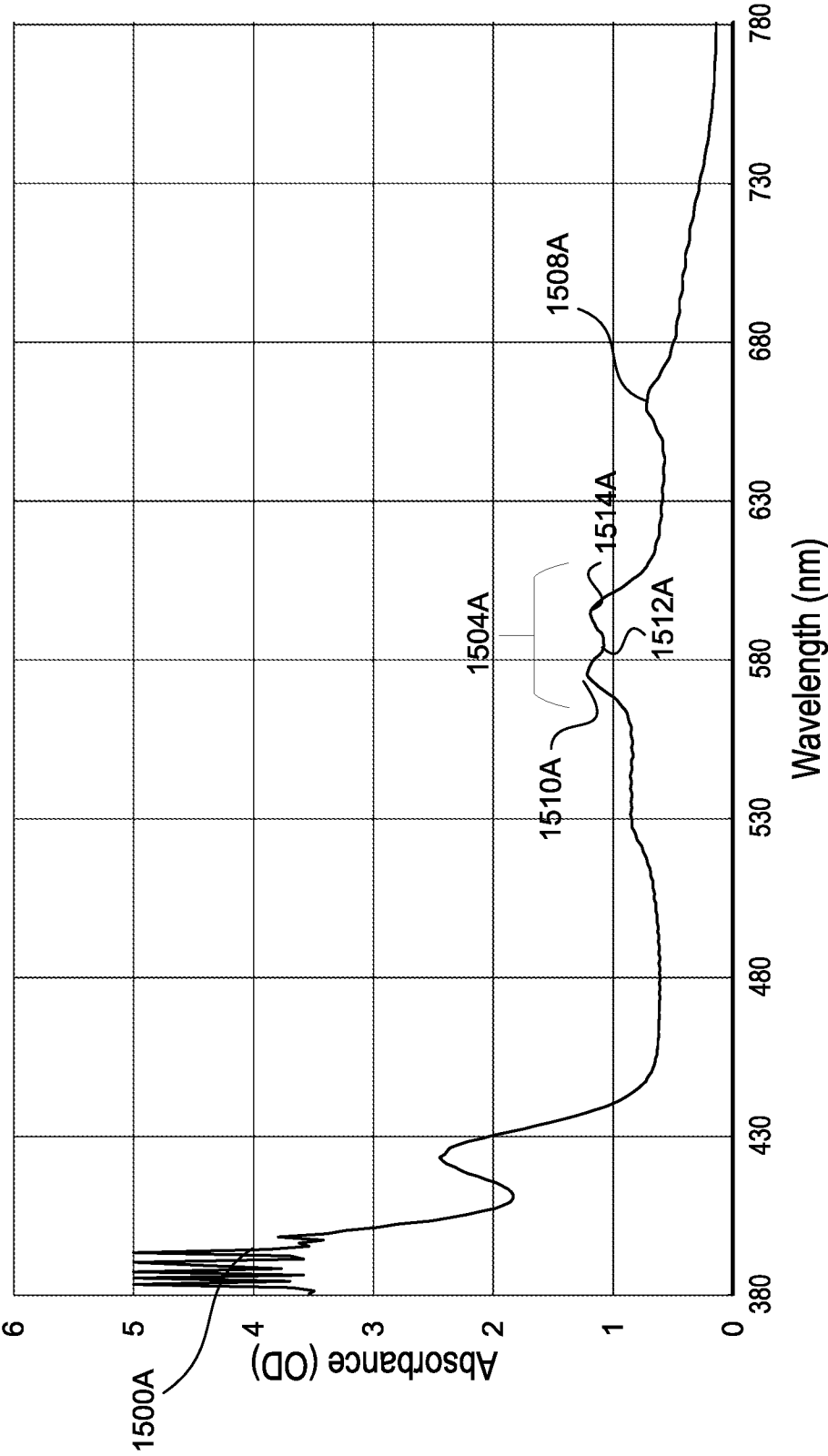


FIG. 15B

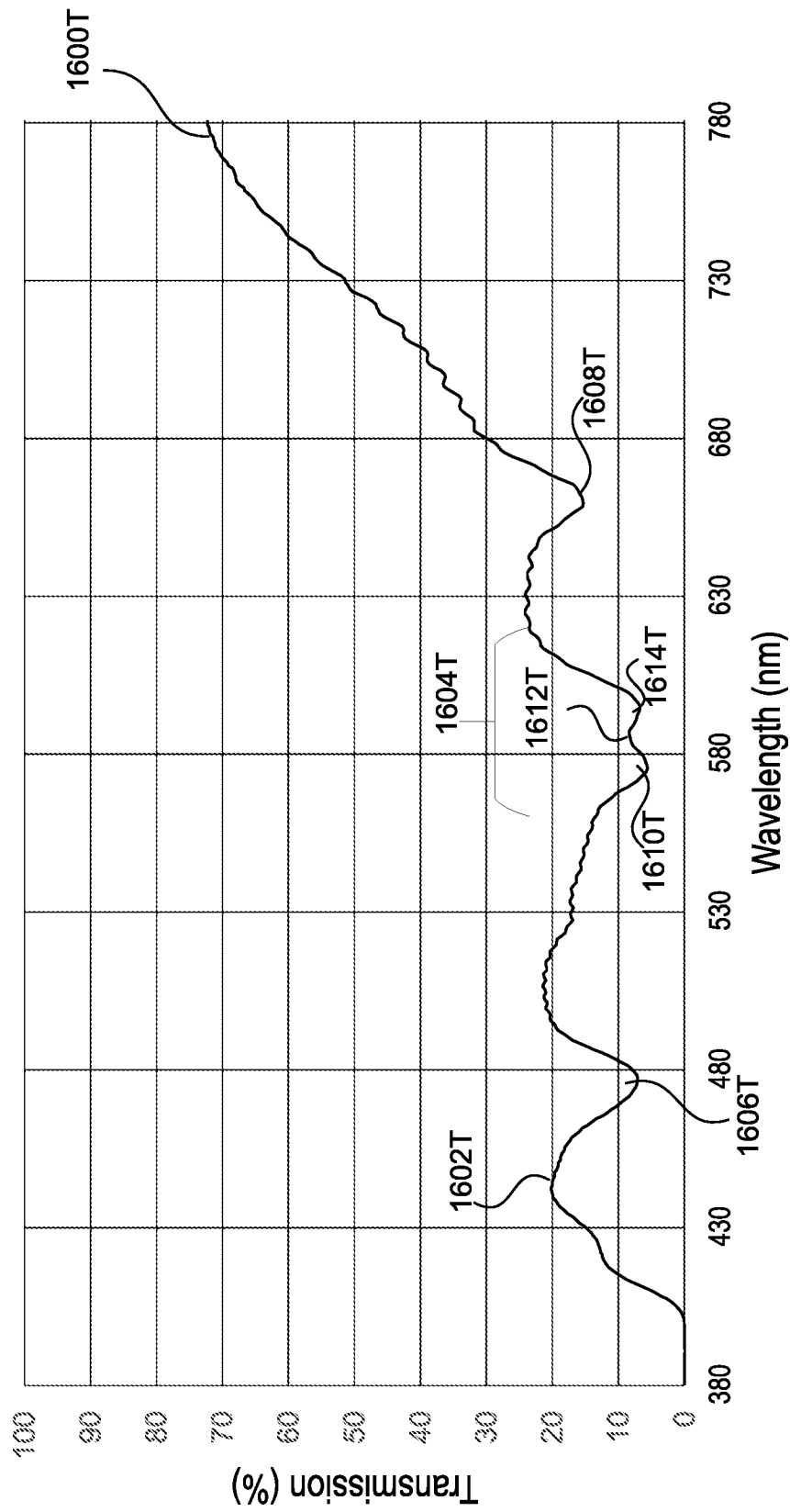


FIG. 16A

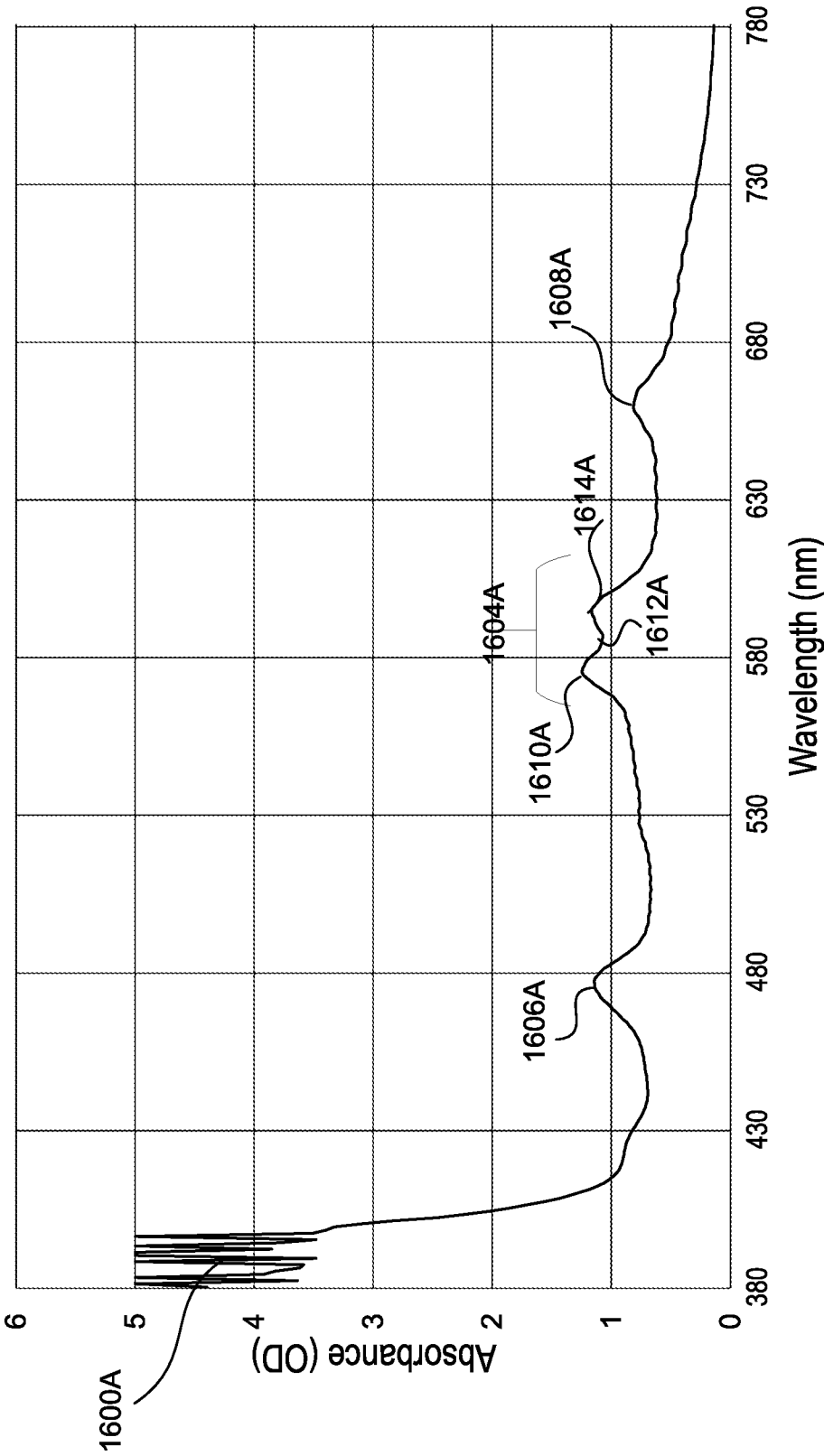


FIG. 16B

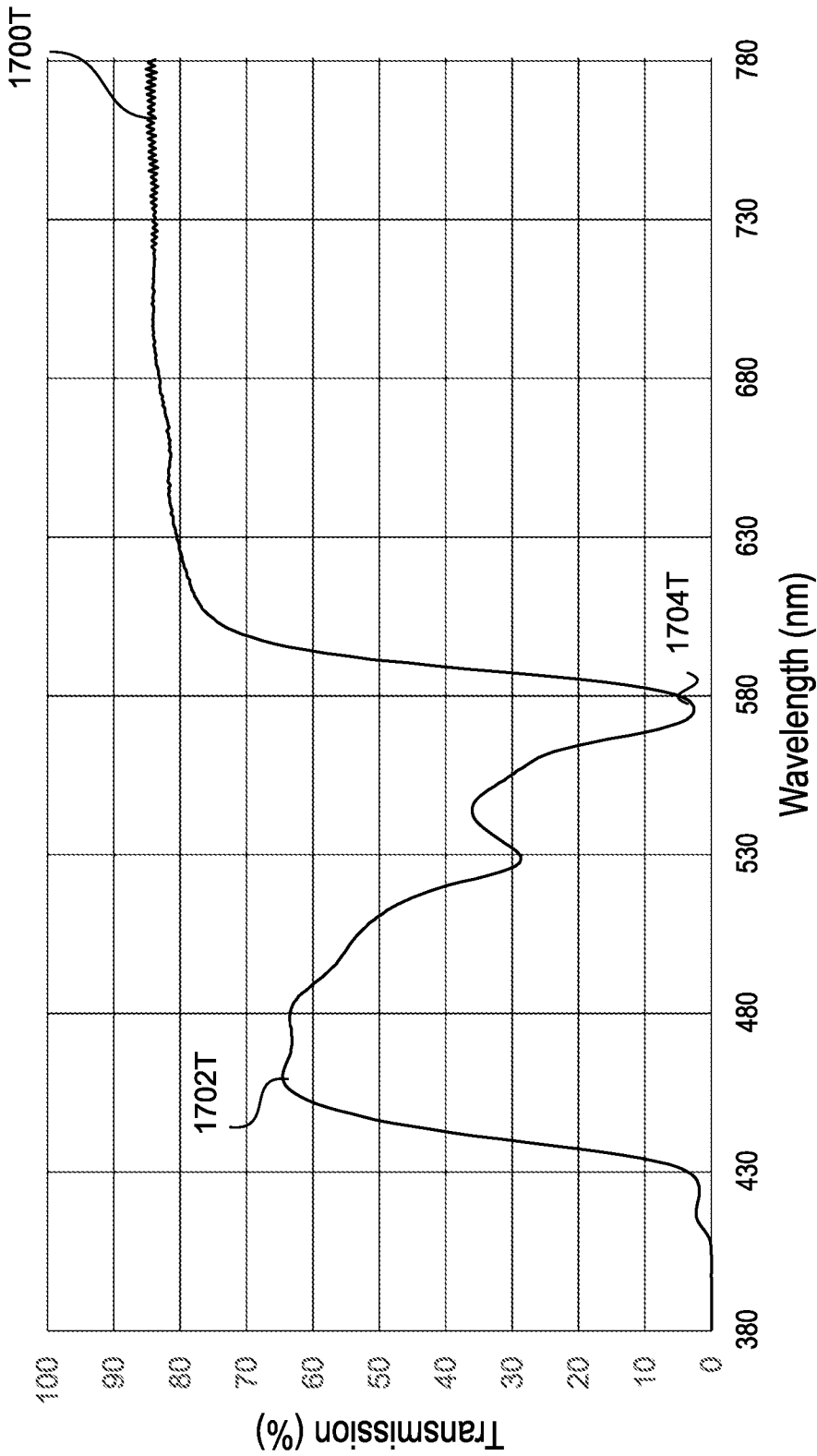


FIG. 17A

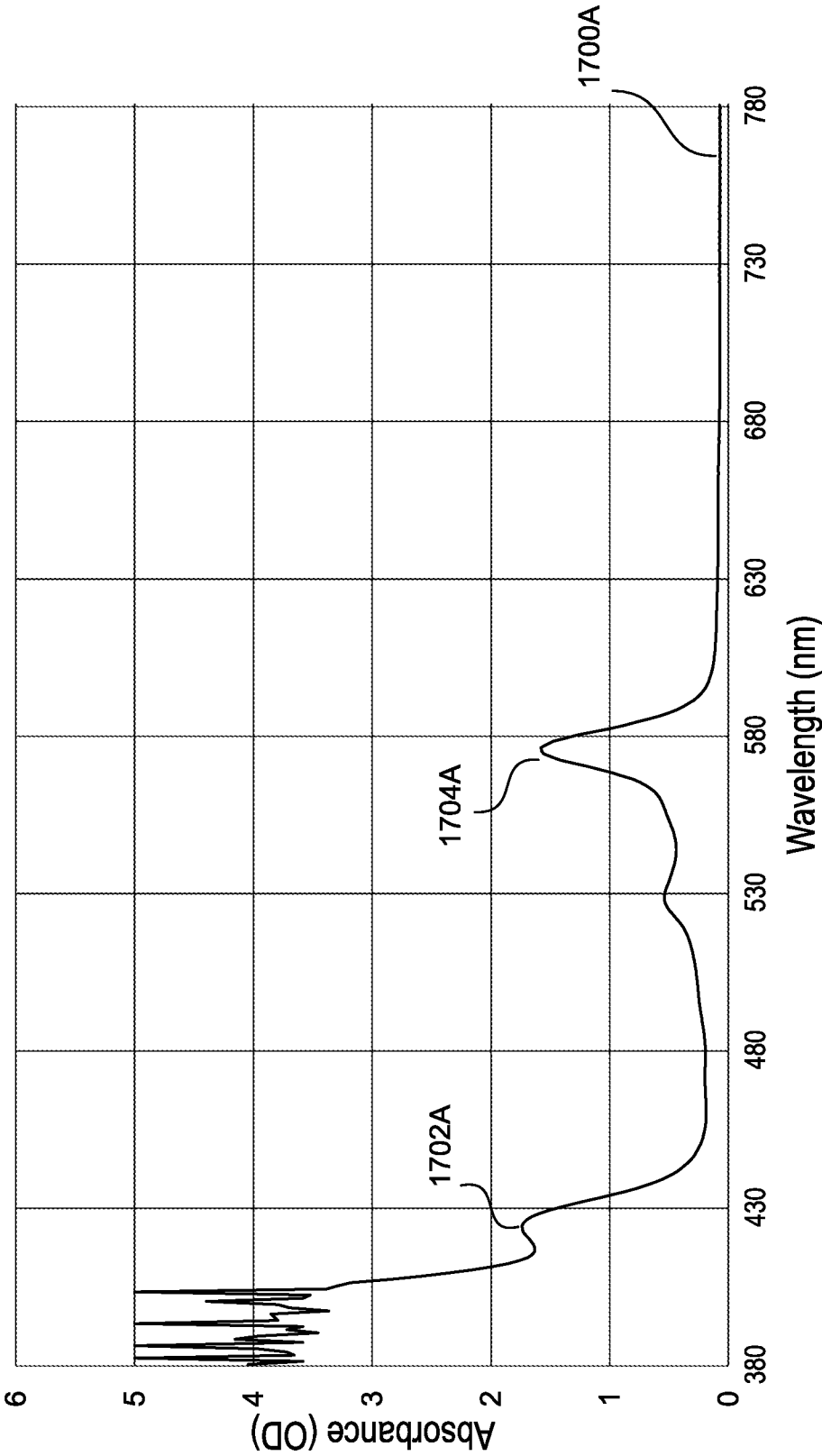


FIG. 17B

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
the subject matter listed in Rule 39 on which, under Article 17(2)(a)(i), an international search is not required to be carried out, including
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box for Details

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-49, 71

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2022/082166

A. CLASSIFICATION OF SUBJECT MATTER

G02C 7/10 (2006.01) G02B 5/22 (2006.01) G02B 5/23 (2006.01) G02B 5/28 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PATENW: IPC/CPC G02C7/10, G02B5/20, G02B5/223, G02B5/23, G02B5/28, G02C7/102 and Keywords(filter, transmit, valley, dip, saddle, 560-619 (range)) and like terms. Applicant/Inventor search

Google patents: glasses, spectacles, lenses, transmission, valley, minimum, saddleback, 570, 580, 590, 600 and like terms

Applicant/Inventor name searched in internal databases provided by IP Australia

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

☒ Further documents are listed in the continuation of Box C☒ See patent family annex

* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"D" document cited by the applicant in the international application	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
21 April 2023Date of mailing of the international search report
21 April 2023

Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE
PO BOX 200, WODEN ACT 2606, AUSTRALIA
Email address: pct@ipaustalia.gov.au

Authorised officer

Andrew Walker
AUSTRALIAN PATENT OFFICE
(ISO 9001 Quality Certified Service)
Telephone No. +61 2 6222 3676

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/US2022/082166
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2017/0075143 A1 (OAKLEY, INC.) 16 March 2017 Abstract; Figures 1, 32A and associated text	1-49, 71
X	EP 3825741 A1 (ESSILOR INTERNATIONAL) 26 May 2021 Abstract; Figure 2 (example 4)	1, 33, 71
X	US 2018/0098694 A1 (ENCHROMA, INC.) 12 April 2018 Abstract; Figure 6	1, 33, 71
X	US 8210678 B1 (FARWIG) 03 July 2012 Abstract; Figure 3	1, 33, 71
X	WO 2012/119158 A1 (ENCHROMA, INC.) 07 September 2012 Abstract; Figure 20B	1, 33, 71
X	WO 2016/077431 A2 (OAKLEY, INC.) 19 May 2016 Abstract; Figures 1A, 10F, 11F	1, 33, 71
X	WO 2016/148984 A1 (ENCHROMA, INC.) 22 September 2016 Abstract; Figure 18	1, 33, 71
X	WO 2018/045040 A1 (THE KALIDAS CORPORATION) 08 March 2018 Abstract; Figures 7, 9, 11, 13	1, 33, 71
X	WO 2019/113357 A1 (HUE.AI, LLC) 13 June 2019 Abstract; Figures 2, 13, 15	1, 33, 71
X	WO 2020/176444 A1 (HUE.AI, LLC) 03 September 2020 Abstract; Figures 3, 19	1, 33, 71

Supplemental Box

Continuation of: Box III

The specification does not comply with Section 40(4) because the claims do not relate to one invention only. I have found different inventions based on the following features that separate the claims into distinct groups:

- Claims 1-32, 71 are directed to a lens/eyewear. The feature of a saddleback transmission valley wherein a difference in transmittance between the first minimum transmittance and the local maximum transmittance is less than about 15% is specific to this group of claims.
- Claims 33-49 are directed to lens/eyewear. The feature of another transmittance valley, having a minimum transmittance positioned at a second wavelength from about 465 nm to about 505 nm wherein the minimum transmittance of the other transmittance valley is less than about 25% is specific to this group of claims.
- Claims 50-61 are directed to a lens/eyewear. The feature of a saddleback absorbance peak having an optical density at the first maximum absorbance of the saddleback peak at a first wavelength is from about 0.5 to about 1.5 and an average transmittance in a spectral range of about 480 nm to about 530 nm is greater than about 5% is specific to this group of claims.
- Claims 62-70 are directed to a lens. The feature of a visible light transmission of the lens is from about 35% to about 45% is specific to this group of claims.

Unity of invention is only fulfilled when there is at least one "special technical feature" present in the claims that both:

- provides a technical relationship among all the claims; and,
- makes a contribution over the prior art.

When there is no special technical feature common to all the claimed inventions there is no unity of invention.

In the above groups of claims, the identified distinguishing features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. The only feature common to all of the claimed inventions and which provides a technical relationship among them is:

a lens comprising a transmittance valley/absorbance peak, the peak/valley located in a spectral range of about 570 nm to about 600 nm.

However this feature does not make a contribution over the prior art because it is disclosed in:

US 2017/0075143 A1 (Oakley, Inc.) 16 March 2017 (e.g. Figs. 32A-B, 34A-B)

Therefore in the light of this document this common feature cannot be a special technical feature. Therefore there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied *a posteriori*.

Claim groups 1-32, 33-49, 50-61, 71 share the feature of a "saddle back transmission valley" (or saddle back absorbance peak) in the transmittance/absorbance profile. However this is also disclosed in the above documents in the figures referred to. For example Fig. 32A, between 560 nm and 620 nm, a transmission peak between two transmission valleys. The central peak ("local maximum transmittance") occurs at 590 nm which is within the wavelength range specified in these claims.

Hence this is not a special technical feature and does not unify these claim groups.

I have grouped the above inventions together as follows:

Search group 1: Claims 1-49, 71

Search group 2: Claims 50-70

Supplemental Box

INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/US2022/082166	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	Publication Date	Publication Number	Publication Date
US 2017/0075143 A1	16 March 2017	US 2017075143 A1	16 Mar 2017
		US 10871661 B2	22 Dec 2020
		EP 3218763 A2	20 Sep 2017
		US 2017315384 A1	02 Nov 2017
		US 10073282 B2	11 Sep 2018
		US 2019025611 A1	24 Jan 2019
		US 11048103 B2	29 Jun 2021
		US 2022057654 A1	24 Feb 2022
		WO 2015179538 A1	26 Nov 2015
		WO 2016077431 A2	19 May 2016
EP 3825741 A1	26 May 2021	EP 3825741 A1	26 May 2021
		AU 2020393381 A1	26 May 2022
		BR 112022008705 A2	26 Jul 2022
		CN 114730030 A	08 Jul 2022
		US 2023030555 A1	02 Feb 2023
		WO 2021105108 A1	03 Jun 2021
US 2018/0098694 A1	12 April 2018	US 2018098694 A1	12 Apr 2018
		US 10912457 B2	09 Feb 2021
		AU 2017340505 A1	02 May 2019
		BR 112019006852 A2	06 Aug 2019
		CA 3039185 A1	12 Apr 2018
		CN 109890342 A	14 Jun 2019
		EP 3523569 A1	14 Aug 2019
		EP 3523569 B1	14 Jul 2021
		IL 265839 A	30 Jun 2019
		KR 20190060824 A	03 Jun 2019
		KR 102425913 B1	26 Jul 2022
		WO 2018067741 A1	12 Apr 2018
US 8210678 B1	03 July 2012	US 8210678 B1	03 Jul 2012
WO 2012/119158 A1	07 September 2012	WO 2012119158 A1	07 Sep 2012
		AU 2012223124 A1	24 Oct 2013
		AU 2012223124 B2	05 Nov 2015
		AU 2016200695 A1	25 Feb 2016
		AU 2016200695 B2	15 Mar 2018
		AU 2018204160 A1	28 Jun 2018
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.			

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/US2022/082166	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	Publication Date	Publication Number	Publication Date
		AU 2018204160 B2	06 Feb 2020
		AU 2020202954 A1	21 May 2020
		AU 2020202954 B2	27 Jan 2022
		AU 2022202763 A1	19 May 2022
		CN 103688145 A	26 Mar 2014
		CN 103688145 B	17 Mar 2020
		CN 111289108 A	16 Jun 2020
		CN 111289108 B	09 Sep 2022
		EP 2681522 A1	08 Jan 2014
		EP 2781899 A2	24 Sep 2014
		EP 2781899 B1	11 Aug 2021
		EP 3929546 A1	29 Dec 2021
		JP 2014513315 A	29 May 2014
		JP 5996563 B2	21 Sep 2016
		JP 2020024442 A	13 Feb 2020
		JP 6820392 B2	27 Jan 2021
		JP 2016224457 A	28 Dec 2016
		JP 2021073494 A	13 May 2021
		US 2014233105 A1	21 Aug 2014
		US 10338286 B2	02 Jul 2019
		US 2018095202 A1	05 Apr 2018
		US 10852461 B2	01 Dec 2020
		US 2021141132 A1	13 May 2021
WO 2016/077431 A2	19 May 2016	WO 2016077431 A2	19 May 2016
		EP 3218763 A2	20 Sep 2017
		US 2017315384 A1	02 Nov 2017
		US 10073282 B2	11 Sep 2018
		US 2017075143 A1	16 Mar 2017
		US 10871661 B2	22 Dec 2020
		US 2019025611 A1	24 Jan 2019
		US 11048103 B2	29 Jun 2021
		US 2022057654 A1	24 Feb 2022
		WO 2015179538 A1	26 Nov 2015
WO 2016/148984 A1	22 September 2016	WO 2016148984 A1	22 Sep 2016
		AU 2016233731 A1	26 Oct 2017
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.			
Form PCT/ISA/210 (Family Annex)(July 2019)			

INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/US2022/082166	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	Publication Date	Publication Number	Publication Date
WO 2018/045040 A1	08 March 2018	AU 2016233731 B2	03 Jun 2021
		BR 112017019564 A2	03 Jul 2018
		CA 2979566 A1	22 Sep 2016
		CN 107533169 A	02 Jan 2018
		EP 3268778 A1	17 Jan 2018
		JP 2020126277 A	20 Aug 2020
		JP 7041712 B2	24 Mar 2022
		JP 2018509661 A	05 Apr 2018
		TW 201702639 A	16 Jan 2017
		TW I751967 B	11 Jan 2022
		US 2018164608 A1	14 Jun 2018
		US 10606100 B2	31 Mar 2020
		US 2018196284 A1	12 Jul 2018
		US 10606101 B2	31 Mar 2020
		US 2020292849 A1	17 Sep 2020
		US 11454827 B2	27 Sep 2022
		US 2023016452 A1	19 Jan 2023
		WO 2018045040 A1	08 Mar 2018
		AU 2017321591 A1	14 Mar 2019
		AU 2017321591 B2	02 Jun 2022
		AU 2022203045 A1	02 Jun 2022
		BR 112019004184 A2	28 May 2019
		CA 3035431 A1	08 Mar 2018
		CN 106199953 A	07 Dec 2016
		CN 106199953 B	18 Jan 2019
		CN 106199954 A	07 Dec 2016
		CN 106199954 B	22 Mar 2019
		CN 106249406 A	21 Dec 2016
		CN 106249406 B	14 May 2019
		CN 106326582 A	11 Jan 2017
		CN 109239918 A	18 Jan 2019
		CN 110234499 A	13 Sep 2019
		CN 110234499 B	12 Apr 2022
		CN 114647026 A	21 Jun 2022
		EP 3507087 A1	10 Jul 2019
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.			
Form PCT/ISA/210 (Family Annex)(July 2019)			

INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/US2022/082166	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	Publication Date	Publication Number	Publication Date
WO 2019/113357 A1	13 June 2019	JP 2019528484 A	10 Oct 2019
		JP 7164515 B2	01 Nov 2022
		JP 2022191435 A	27 Dec 2022
		KR 20190050799 A	13 May 2019
		KR 102388209 B1	18 Apr 2022
		SG 11201901721R A	28 Mar 2019
		US 2019258087 A1	22 Aug 2019
		US 10852567 B2	01 Dec 2020
		US 2021080754 A1	18 Mar 2021
		WO 2019113357 A1	13 Jun 2019
		BR 112020011492 A2	30 Mar 2021
		CA 3084609 A1	13 Jun 2019
		CN 111684322 A	18 Sep 2020
		EP 3721272 A1	14 Oct 2020
		GB 2582117 A	09 Sep 2020
WO 2020/176444 A1	03 September 2020	JP 2021505955 A	18 Feb 2021
		KR 20200095523 A	10 Aug 2020
		US 2019187489 A1	20 Jun 2019
		US 10935814 B2	02 Mar 2021
		US 2021157171 A1	27 May 2021
WO 2020176444 A1	03 Sep 2020		
		EP 3931261 A1	05 Jan 2022
		US 2022187628 A1	16 Jun 2022
End of Annex			