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(54) **Title:** CHOLESTERIC LIQUID CRYSTAL COLORING COMPOSITIONS AND ARTICLES PRODUCED THEREFROM

(57) **Abstract:** The invention relates to a composition which comprises an effective amount of cholesteric liquid crystal coloring agent, a directing agent, and a solvent system and to methods of conveying iridescent color to surfaces. The composition of the invention may be topically applied to a surface where it is desirable to provide a smooth application of a highly iridescent, long wearing, film-forming cosmetic product. Non-limiting examples of the topical applications include cosmetics, personal care products, nail polish, body art tattoos and industrial and decorative coatings as well as various forms of paint.

CHOLESTERIC LIQUID CRYSTAL COLORING COMPOSITIONS AND ARTICLES PRODUCED THEREFROM

FIELD OF THE INVENTION

[0001] The present invention generally relates to compositions suitable for use in conveying iridescent color to surfaces and in producing iridescent films, fibers and particles where the iridescent color may be goniochromatic and mechanochromic. The innovative composition may be a cosmetic, a paint, or a personal care product. More particularly, the composition is composed of a cholesteric liquid crystal coloring agent, a directing agent and a solvent system.

BACKGROUND OF THE INVENTION

[0002] Iridescent pigments (also described as pearlescent or nacreous) using mica or other thin platelet-like substrates coated with a metal oxide layer have hitherto been known and widely used in plastics, paints, inks, cosmetics, etc. Such iridescent pigments exhibit iridescent color by means of the interference effect of the reflected light from the surface of the metal oxide coating layer and the reflected light from the boundaries of the coating layer and the thin platelet-like substrates as disclosed in Japanese Patent No. B-43-25644 and Japanese Patent No. B-49-3824. The iridescent effect obtained by these traditional pearlescent pigments is generally very weak, resulting in a muted color.

[0003] Cholesteric liquid crystals have been utilized in the cosmetic industry to offer very bright iridescent color. However, the cosmetics are limited. For example, cosmetics consisting of a pure cholesteric liquid crystal are generally tacky due to the viscous nature of the liquid crystal material. Moreover, these pure cholesteric liquid crystal cosmetics impart color which is very short lived because the skin absorbs the liquid crystal. Also, contact by another surface results in the transfer or smearing of color. Another disadvantage of using a cholesteric liquid crystal is that cosmetic formulations typically include ingredients such as polymers, oils, solvents, and waxes (as known to practitioners of the cosmetic arts), which cause the cholesteric liquid crystal to lose it's iridescent color effect. Generally, it is believed that the disruption of the cholesteric liquid crystal phase by the ingredients common in cosmetic formulations causes the loss of iridescent color and has limited the use of liquid crystals in cosmetics to highly concentrated or pure cholesteric liquid crystal material.

[0004] Alternatively, cholesteric liquid crystals have been used to produce iridescent pigments which have been incorporated into cosmetics, personal care products and the like. Cholesteric liquid crystal monomers can be polymerized to provide iridescent plastics, also called LCPs for Liquid Crystal Polymers. These LCPs can be further processed into fine particles to provide iridescent pigments useful in cosmetic formulations such as the gels, emulsions and creams as described in U.S. Patent Publication No. 2003/0118622, U.S. Patent No. 6,159,454, U.S. Patent No. 6,346,237, and U.S. Patent No. 6,344,154. The synthesis and processing of these cholesteric liquid crystal polymer pigments are expensive and time consuming, hence simpler and more economical methods for producing iridescent cosmetics and the like are desired.

[0005] Therefore, there remains a need for simple compositions which convey lasting iridescent color to surfaces, for example, cosmetic coatings for keratinous surfaces, or paint for non-biological surfaces, which are economical to prepare and easy to use.

SUMMARY OF THE INVENTION

[0006] In accordance with the objectives and others detailed herein, embodiments of the invention overcome deficiencies associated with the prior art. It is an object of the invention to provide homogeneous cholesteric liquid crystal compositions generally composed of a cholesteric liquid crystal coloring agent, a directing agent and a solvent system which are suitable to convey iridescent color to surfaces or can be used to produce iridescent articles. The compositions of the invention are simple to formulate with inexpensive and often commercially available components.

[0007] One object of the invention is directed to the production of the inventive composition. It is an object of the invention to provide a cosmetic composition. The inventive composition may optionally include cosmetically, dermatologically, physiologically, and pharmaceutically acceptable additives and active ingredients.

[0008] Another object of the invention, is directed to a paint composition suitable for non-biological surfaces with good adhesion to wood, glass, metal ceramics, paper, plastics and the like.

[0009] An additional embodiment provides for highly iridescent films and fibers upon dissipating the solvent system of the inventive composition. These films and fibers of manufacture exhibit attractive color effect properties, for example, perceived color changes

according to the quality of the lighting, viewing angle (*i.e.*, goniochromatic), and sheer stress (*i.e.*, mechanochromatic).

[0010] Another object of the invention provides for the production of iridescent particles suitable for use as iridescent pigments in cosmetic, personal care, and paint formulations.

[0011]

DETAILED DESCRIPTION OF THE INVENTION

[0012] The present invention generally relates to a homogeneous composition having an effective amount of a cholesteric liquid crystal coloring agent, a directing agent, and a solvent system suitable for producing iridescent films or articles. More specifically, one embodiment of the inventive composition is directed to a paint or a cosmetic and their use in conveying iridescent color to surfaces. A further embodiment is directed to a method for producing the inventive composition. In another embodiment, the inventive composition may used to produce iridescent films and fibers which may be further processed to provide iridescent particles for use in conveying iridescent color to a broader range of formulations.

[0013] One embodiment of the inventive composition is directed to a cholesteric liquid crystal coloring agent that can reflect light in the visible region of the spectrum. The perceived color depends on the viewing angle as described in U.S. Patent No. 4,301,023 and U.S. Patent Publication No. 2006/0008433. One advantage of a cholesteric liquid crystal color coloring agent of the instant invention is that they provide iridescent color that is not compromised by the various components which are additionally included in the inventive compositions and products made therefrom.

[0014] The term "liquid crystal" is used herein to refer to material composed of molecules capable of aggregating into a liquid crystal phase (known in the art as "mesogens"). In general, the "cholesteric liquid crystal" is any liquid crystal composed of *chiral* molecules. The "cholesteric liquid crystal phase" (or the "chiral nematic phase") is understood to have particular and unique color properties. These properties are associated with the pitch of the helical domains that constitute the cholesteric liquid crystal phase. Specifically, when the helical domains are of the same order of magnitude as the wavelength of visible light, the cholesteric liquid crystal has the ability to selectively reflect light by constructive interference. The light reflected from the cholesteric liquid crystal is perceived to be iridescent (*i.e.*, goniochromatic). A cholesteric liquid crystal also exhibits a

mechanochromic effect whereby the reflected wavelength of light shifts in response to a stress, for example, deformation of the bulk material.

[0015] The "cholesteric liquid crystal coloring agent" of the inventive composition includes at least one colored cholesteric liquid crystal, *i.e.*, a cholesteric liquid crystal that reflects light in the visible region of the spectrum at the ambient temperature of use. Optionally, the cholesteric liquid crystal coloring agent may be a blend of liquid crystal varieties including, for example, but not limited to a cholesteryl oleyl carbonate, a cholesteryl chloride, a cholesterol nonanoate, a cholesteryl dichlorobenzoate, or mixtures thereof. In another embodiment the cholesteric liquid crystal coloring agent may optionally include a pigment, a color enhancer, a stabilizer, a preservative, and other active or inactive ingredients. Non-limiting examples of cholesteric liquid crystal coloring agents useful in the inventive composition may be commercially available as exemplified by the following blend, product LCB-OR30, composed of cholesteryl oleyl carbonate, cholesteryl nonanoate, cholesteryl chloride, silica (a brightening agent), butylated hydroxytoluene (BHT, a preservative), D&C red No. 30 aluminum lake (a pirment) and sold under the trade mark LIQUID CRYSTAL BRIGHTS (Presperse Inc.; NJ, USA). Similar formulations are also sold under the trademark LIPO CRYSTALS™ (Lipo Chemicals Inc.; NJ, USA).

[0016] In another embodiment, the cholesteric liquid crystal coloring agent of the invention may optionally include a cholesteric liquid crystal that reflects light in the ultraviolet region (*i.e.*, 1 nanometer to about 400 nanometers) as disclosed in U.S. Patent No. 6,159,454. In a further embodiment of the invention, the cholesteric liquid crystal coloring agent may include a temperature insensitive cholesteric liquid crystal. More specifically, a temperature insensitive cholesteric liquid crystal coloring agent is one that does not significantly change color in response to moderate fluctuations in temperature, for example in the range of about 20 °C from the average ambient temperature of use. A commercially available blend providing a temperature insensitive cholesteric liquid crystal is exemplified by the following blend, product ISP ColorFlow™ 104P, composed of cholesteryl oleyl carbonate, cholesteryl nonanoate, cholesteryl chloride, red 40 lake (a pigment) and butylated hydroxytoluene (BHT, a preservative) sold under the trade name COLORFLOW™ (ISP Inc., NJ, USA). A further embodiment of the inventive composition may have an effective amount of a cholesteric liquid crystal coloring agent ranging from about 5 to about 80 percent by weight, more typically from about to 8 to about 50 percent by weight and especially from about 12 to about 40 percent by weight. It is this cholesteric liquid crystal coloring agent in

combination with the other components of the composition that provides the unique color characteristics of the films (*i.e.*, coatings) and articles of the invention.

[0017] Another embodiment of the inventive composition relates to a directing agent. The "directing agent" of the invention generally forms a network structure through physical crosslinks which are attenuated upon dissolving the directing agent in an appropriate solvent. In so doing, the cholesteric liquid crystal coloring agent may be homogenously mixed with the directing agent. Care should be taken to select a directing agent such that the liquid crystal coloring agent is not soluble in the directing agent itself (without solvent) as this would inhibit the formation of the cholesteric liquid crystal phase. When colored cholesteric liquid crystal coloring agents are mixed with a directing agent and a solvent system, they lose their novel color effects. Although not wanting to be bound by theory, it is believed that as the solvent system dissipates, the physical crosslinks of the directing agent are reformed, thereby facilitating the assembly of the cholesteric liquid crystal phase. Upon reformation of the cholesteric liquid crystal phase, the novel color properties of the material reappear, resulting in a highly iridescent film or article. A further embodiment of the directing agent of the invention includes, for example, block co-polymers and cellulose derivatives, such as cellulose esters and cellulose ethers. A further embodiment of the directing agent of the invention includes blends of any of the directing agents mentioned herein or known in the art which have the desired properties.

[0018] In one embodiment, the directing agent of the invention is a block co-polymer. Block copolymers are members of a class of polymers that "microphase separate" to form periodic nano- or micro-structures, the dimensions of which are determined by the dimensions of the monomers chosen for the polymer formulation as described in *Block Copolymers* N. Hadjichristidis et al., John Wiley and Sons, Inc., New Jersey (2003). Generally, the block co-polymers used herein are film forming polymers of multiphase compositions where at least one phase has a material that is hard at room temperature and another phase has a material that is softer, more like rubber at room temperature as disclosed in U.S. Patent Publication No. 2007/0142521.

[0019] In a further embodiment, the directing agent of the invention may be any form of di-block, tri-block, and multi-block copolymers that are particularly useful as film formers. Classes of block copolymers are not limited to, but include A-B diblock copolymers, A-B-A triblock copolymers, A-B-C-triblock, $(A\text{-}B)_n$ multi-block copolymers, or mixtures thereof. For example, the block copolymer having a hard domain or block A (high Tg block) and a

soft, elastomer domain or block B (low Tg block) in the form of an A-B diblock copolymer, an A-B-A tri-block copolymer, and a multi-block copolymer structure $(A-B)_n$, as well as branched block copolymers having a structure of $(A-B)_nx$ (where x represents an *n* functional joint). More specifically, non-limiting block copolymers include polyurethane/elastomer block copolymers, polyester/elastomer block copolymers, polyamide/elastomer block copolymers, polyethrimide/polysiloxane block copolymers, styrene copolymers olefinics, melt-processable rubbers, and any combinations thereof. These block copolymers can provide elasticity to the product formulated from the inventive composition. The combination of the hard A block and the flexible B block allows for multiple applications where it is desirable to have a pliant yet durable material.

[0020] In particular embodiments of the invention, the directing agents relating to block copolymers include, but are not limited to styrene-ethylene-styrene block copolymer, styrene-isobutylene-styrene (SIBS) block copolymer, poly(ethylene glycol)-poly(propylene glycol)-poly(ethylene glycol) (PEG-PPG) block copolymer, or a combination thereof. Commercially available embodiments of the directing agent include Pluracare® L 44, a block copolymer of ethylene glycol and propylene glycol, and Pluracare® F 68 NF Prill, a block copolymer of ethylene oxide and propylene oxide. Both of these commercially available products are sold under the trade name PLURACARE® (BASF, NJ, USA). An effective amount of a block copolymer directing agent present in the inventive composition ranges from about 0.1 to about 20 percent by weight, ranging from about 1 to about 10 percent by weight, and ranging from about 2 to about 5 percent by weight based on the total weight of the inventive composition, which is particularly suitable for achieving the desired properties of the composition and products resulting therefrom.

[0021] A further embodiment of the invention the directing agent is a copolymer or a homopolymer from the class of acrylate copolymer, silicone acrylkate copolymer, polyurethane, etc In anothet embodiment the directing agent is a strucrturing agent such as polyamide.

[0022] A further embodiment of the directing agent of the invention includes any derivative of cellulose, a polysaccharide derived from beta-glucose which can further be described as an organic polymer of the formula $(C_6H_{10}O_5)_n$. The versatile chemistry of these cellulose derivatives (also known in the art as cellulosic plastics) permits variations in molecular weight and hydroxyl functionalities resulting in a broad range of solubility, compatibility and performance. Useful cellulose derivatives may be produced by the

chemical modification of cellulose, a naturally occurring polymer or a synthetic derivative, such as for example cellulose ethers and cellulose esters. The directing agent that is most useful is one which does not dissolve the cholesteric liquid crystal coloring agent in the absence of solvent.

[0023] One embodiment of the invention relates to a specific class of cellulose derivatives, namely a cellulose ester, useful as the directing agent of the invention. Non-limiting examples of cellulose esters are of the film-forming variety and include such materials as cellulose mono-, di-, and tri-acetates, nitrocellulose, cellulose propionate, cellulose butyrate, cellulose acetate propionate, cellulose acetate butyrate, and others as known by those of skill in the art. Nitrocellulose is particularly useful in cosmetic compositions and may be obtained in FDA approved formulations. Nitrocellulose dispersions are commercially available in a full line of transparent color concentrates. An effective amount of a cellulose ester directing agent present in the inventive composition ranges from about 0.1 to about 20 percent by weight, ranging from about 2 to about 15 percent by weight, and ranging from about 5 to about 10 percent by weight based on the total weight of the composition, which is particularly suitable for achieving the desired properties of the composition and products therefrom.

[0024] A further embodiment is directed to a cellulose ether as the directing agent of the invention. Non-limiting examples of cellulose ethers include ethyl cellulose, methyl cellulose, hydroxyethyl methyl cellulose, hydroxypropyl cellulose, carboxymethyl cellulose, and hydroxypropyl methyl cellulose, which can be used in the production of cellulose films. Another embodiment relates to a cellulose ether directing agent present in the inventive composition in an effective amount ranging from about 0.1 to about 20 percent by weight, ranging from about 0.5 to about 10 percent by weight, and ranging from about 1 to about 5 percent by weight based on the total weight of the composition, which is particularly suitable for achieving the desired properties of the composition and products therefrom. The cellulose derivatives of the invention are particularly useful in producing strong hard films or coatings that are also durable.

[0025] Another embodiment of the inventive composition, is directed to the solvent system. The "solvent system," "volatile solvent system," "volatile solvent" or "solvent," of the invention as used interchangeably herein, includes one or more volatile solvents that effectively dissolve the directing agent and the cholesteric liquid crystal coloring agent to provide a homogenous mixture of the inventive composition. The volatile solvent dissipates

from the homogenous mixture when the inventive composition is contacted to a surface to produce a film or article exhibiting superior iridescent color. The use of the concept "to dissipate" pertains to any circumstance which provides for the loss of solvent from the inventive composition and includes for example, to evaporate, to desiccate, to dry or to concentrate.

[0026] In one embodiment, the solvent system is volatile in that the solvent or mixture thereof evaporates or otherwise dissipates relatively quickly, *i.e.*, about 80% of the solvent has dissipated in roughly less than 30 minutes upon application of the composition to a surface or otherwise cast. The volatile solvent taken in isolation has a vapor pressure at room temperature and standard atmospheric pressure (760 mmHg), ranging from 10^{-3} to 300 mmHg. The volatile solvents of the solvent system generally have a boiling point below about 250 °C, preferably having a boiling point less than about 200 °C and less than about 175 °C but not lower than at standard atmospheric pressure. Non-limiting examples of volatile solvents useful in the inventive compositions described herein include aliphatic, olefinic and aromatic hydrocarbons which may be linear, cyclic or branched, chlorinated hydrocarbons, ketones, acetates, ethers, chloroform, alcohols, esters, as well as silicone or amide based organic solvents. Useful solvent systems are those that dissolve the cholesteric liquid crystal coloring agent and the directing agent of the inventive composition forming a homogenous mixture. These solvents are volatile in that they evaporate quickly upon application of the inventive composition to biological or non-biological surfaces.

[0027] In a further embodiment of the inventive composition, the effective amount of solvent, including solvent mixtures as set forth above, necessary to ensure an acceptable product viscosity (*i.e.*, ease of applying without running) depends on the nature of the solvent and the nature of and amounts of the other ingredients, such as, in particular the liquid crystal coloring agent, directing agent, film forming ingredients, plasticizers, thickeners, solids, tackifying resins and the like. The effective amount of volatile solvent may be readily determined by routine experimentation. In general, however, effective amounts of solvent in the solvent system suitable for the purpose of this invention range from about 1 to about 90 percent by weight, about 5 to about 80 percent by weight and about 10 to about 70 percent by weight based on the total weight of the composition.

[0028] Solubility parameters provide a numerical method of predicting the interaction between materials, such as liquids and polymers. They are useful in determining the suitability of polymers for particular applications and in formulating mixtures of solvents for

specific purposes. One of ordinary skill in the art can determine the solubility parameters and choose a solvent based on the directing agent chosen for the envisaged application. Solubility parameters and solvents useful in processing specific directing agents of the invention, for example, block co-polymers and cellulose derivatives, are typically included in specification sheets available from various manufacturers of block co-polymers and cellulose derivatives. Additional information about polymer solubility parameter concepts is presented in, for example, the *Encyclopedia of Polymer Science and Technology*, Vol. 3, Interscience, New York (1965) and the *Encyclopedia of Chemical Technology*, 2nd Ed., Interscience, New York (1971).

[0029] As will be understood by those of skill in the art, the solvent and solubility conditions may be altered in order to prepare a composition and film or article of manufacture which has the desired properties. As will be further appreciated by the skilled practitioner, the solubility parameters can be approximated by the formulas as known in the art depending on parameters, such as the properties of the cholesteric liquid crystal coloring agent, directing agent, selected volatile solvent system, and any additional ingredients.

[0030] In an another embodiment, the inventive composition is a cosmetic, a paint, a personal care product, or a pharmaceutical formulation comprising an effective amount of a cholesteric liquid crystal coloring agent, a directing agent, and a volatile solvent system which are mixed until homogeneous and then applied to a surface resulting in an iridescent film (*i.e.*, a coating). Preferably, the solvent system evaporates at a rate that allows the formation of an iridescent film. The skilled artisan can determine the effective amount and type of cholesteric liquid crystal coloring agent, directing agent, and solvent system. The desired properties of the resulting film, when applied to a surface depend on the application and desired degree of durability, flexibility, applicability, wearability, uniformity, sheen or gloss, adhesion, water and oil resistance, transfer resistance, and abrasion resistance, preferably in the absence of irritation when applied to the skin, for example. The type and effective amount of the various components of the inventive composition useful in a stable cosmetic or pharmaceutical product may be easily determined by the skilled artisan. Not only does the inventive composition have sufficient stability in its homogeneous state, but also as a resulting film to enable effective commercialization of the finished product, cosmetic, coating, or pharmaceutical.

[0031] In a further embodiment of the invention, the composition is a cosmetic formulation which imparts an iridescent color for making up the skin, hair, nails and the like,

or their synthetic counterparts, for example, but not limited to, the formulation of a mascara (Table 3 of the instant specification), a nail polish (Table 2 of the instant specification), a hair coloring, an eye shadow, an eye liner, a blush, a foundation, a lipstick, a lip-gloss, a decorative skin paint, and the like. In various embodiments, the present invention relates to cosmetic methods of applying the composition for creating an iridescent effect, making up and caring for the skin, mucous membranes and the integuments. One embodiment of the invention relates to cosmetic formulations which, in addition to the composition of the invention, include additional ingredients known to those of skill in the art to produce a makeup composition with the desired properties for a particular application, for example, such as thickening agents, emollients and the like, in an amount that also provides the desired properties of color and iridescence.

[0032] Another embodiment of the invention is a nail polish, which employs the composition of the invention and produces highly iridescent films and exhibits good adherence to keratin surfaces, such as finger and toe nails. The nail polish using the composition of the invention may also provide a bright and long lasting iridescent color.

[0033] Another embodiment of the invention is a mascara, which employs the composition of the invention and produces highly iridescent films and exhibits good adherence to keratin surfaces, such as eyelashes. Mascaras using the composition of the invention may also provide brighter iridescent color, and improved cosmetic properties.

[0034] Yet another embodiment of the invention is an eyeliner. Eyeliners employing the composition of the invention may provide brightly iridescent color of high stability and adherence to eyelid tissue.

[0035] Another embodiment is a make-up composition for the lips employing the composition of the invention which provides a homogeneous film that has a light texture and remains comfortable to wear throughout the day. The preferred lip make-up, such as for example, a lip stick or a lip gloss, which is not tacky or sticky, and provides a bright iridescent and mechanochromic sheen to the lip surface.

[0036] In yet another embodiment of the invention, the composition is an iridescent paint suitable for producing a film, (*i.e.*, a coating) which conveys iridescent color to surfaces. Preferably the paint composition of the invention is water insoluble and has good adhesion to wood, glass, metal ceramics, paper, plastics and the like. Non-limiting examples

of particular embodiments include an automotive paint, an industrial paint, a decorative paint and the like.

[0037] The packaging and application device for any embodiment of the invention is chosen and manufactured by persons skilled in the art on the basis of their general knowledge and adapted according to the nature of the composition to be packaged. Moreover, the type of device to be used may be in particular linked to the consistency of the composition, in particular to its viscosity; it may also depend on the nature of the constituents present in the composition, such as the presence of volatile compounds.

[0038] One embodiment is directed to a method of producing the inventive composition comprising mixing a cholesteric liquid crystal coloring agent, a directing agent and a suitable solvent system until a homogeneous mixture results. The order of addition of the components of the inventive composition is not a crucial aspect of the invention, the essential aspect is that a homogeneous mixture of the inventive composition is obtained. For example, in one embodiment, a directing agent is dissolved in a solvent system and mixed until homogeneous. A cholesteric liquid crystal coloring agent is added to the directing agent mixture and further mixed, resulting in a homogeneous composition suitable for conveying iridescent color to surfaces or for producing iridescent articles, for example, such as a transferable film, fibers and particles.

[0039] Another embodiment is directed to a method of producing an iridescent film, comprising mixing a cholesteric liquid crystal coloring agent, a directing agent and a suitable solvent system until a homogeneous composition is produced. The homogeneous mixture is then applied to a surface and the solvent is dissipated, thereby producing the iridescent film (*i.e.*, coating) of the invention.

[0040] A further embodiment provides a method of applying the inventive composition to a surface. Non-limiting examples of the application include application by pouring, brushing, dripping, spraying, painting, air brushing, spin coating, laminating, stamping, smearing, or rubbing and any other method of applying such that the inventive composition is deposited upon a surface. After a period of time sufficient for enabling the solvent to dissipate, the film produced has a bright colored iridescence. Moreover, the resultant film has the novel color effects of being highly iridescent and may be goniochromatic, and mechanochromic.

[0041] Another embodiment relates to an iridescent film of the invention, comprising an cholesteric liquid crystal coloring agent and a directing agent. Desired films produced by the inventive compositions are water insoluble, can be processed at room temperature, provide good adhesion to biological and non-biological surfaces, such as for example, the skin or nails, and are tack free. It is also desired that the inventive composition be compatible with the other ingredients in the composition and that the resulting film or coating is highly iridescent. I n one embodiment, the film is transferable from one surface, for example, the surface of manufacture, to another surface, for example skin, where the transferable film is in the form of a sticker, a temporary tattoo, a body art, a wound healing strip, a pharmaceutically or biologically active delivery strip, and the like. Further embodiments of the transferable film of the invention include an effective amount of a cholesteric liquid crystal coloring agent ranging from about 42 to about 90 percent by weight and comprising a directing agent ranging from about 10 to about 58 percent by weight. The properties of the film may be adjusted as necessary according to the particular application so long as the iridescent film is iridescently colored.

[0042] Another embodiment relates to iridescent fibers of the invention, comprising a cholesteric liquid crystal coloring agent and a directing agent produced by extruding the inventive composition to form iridescent fibers upon dissipation of the solvent. The iridescent fibers are suitable for use in mascara formulations as described in U.S. Patent Publication No. 2006/0128578, which enables the lengthening of the eyelashes and conveys iridescent color to the surface of the eye lashes.

[0043] A further embodiment provides a method for producing iridescent particles from an iridescent film or fiber of the invention by processing the iridescent film or fiber to produce iridescent particles suitable for use as pigments. Processing the iridescent film or fiber of the invention includes chopping, cutting, milling, pulverizing or otherwise reducing the film or fiber to small particles suitable for use as iridescent pigments in, for example cosmetics, personal care products, or paints. The particles may be utilized in many different mediums, including a topical liquid, a gel, a foam, a cream, a lotion, a semi-solid. The iridescent pigments may be used in products, such as but not limited to, sun care, skin care, hair care products (shampoos, conditioners, hairspray, mousses and dyes/colorants), personal care products, a pharmaceutical, a medicinal formulation or in color cosmetics such as a mascara, a nail enamel, a lip coloring product, a lip gloss, a foundation, an eye makeup and

the like. The iridescent particles may be particularly useful in powdered cosmetic products, such as but not limited to an eye shadow, a blush, a face powder, and an eyeliner.

[0044] Another embodiment of the invention is directed to useful properties of the colored iridescent films, coatings, or articles. The inventive compositions produce films, coatings, or articles that are water resistant, which is specifically useful in products where it is desirable to minimize the washing off of active or functional ingredients. Sweat- and water-resistant products are particularly useful in sun products and mascaras, particularly after exposure to treated swimming pool water, fresh water, and ocean water. The final product is smudge resistant and does not flake while maintaining a long lasting iridescent color. The final products may also provide a moisture barrier thereby retarding dehydration of the skin by forming an occlusive film and providing for the absorption of some of the cholesteric liquid crystal coloring agent useful in treating dryness and scaling of the skin, although not in amounts sufficient to change the iridescent quality of the film coating or article.

[0045] Other non-limiting properties include a final product that is oil resistant, abrasion or rub resistant, transfer resistant, flexible, non-tacky, glossy, durable, and adhesive. The film, coating, or article final product is also capable of binding and/or delivering one or more active components, such as, but not limited to, a colorant, a dye, an ultraviolet absorber, a moisturizer, a biologically active agent, an insecticide/pesticide, and an organic or inorganic active agent.

[0046] In one embodiment, the inventive compositions may produce a film barrier between the skin and the environment, where the film is iridescent and mechanochromic and changes color with response to any stress on the film or on the skin to which the film is adhered. The film may contain the active and/or functional ingredients, such as for example, ingredients to promote the healing of wounds or for topical treatment of dermatological conditions. In general, liquid crystal compositions are known in the art to be excellent delivery agents as described in U.S. Patent No. 5,891,845, and in this regard, the iridescent film formed by the inventive composition can enhance the delivery of active or functional ingredients.

[0047] A further embodiment of the inventive composition is applied to the skin forming a film includes lotions such as suntan lotion or sunblock. Qualities such as the SPF and UV light protection may be enhanced by the use of cholesteric liquid crystals which

reflect light in the UV region of the spectrum in the inventive composition. Lotions employing the composition of the invention may provide additional protection due to the selective reflection of light in the UVa and UVb regions of the spectrum. Other formulations that provide UV light protection, such as but not limited to, powders, gels, mousses, forms and creams, are also envisioned.

[0048] In yet another embodiment, the composition of the invention may include any additional coloring agents. Coloring agents that may be used in the practice of the invention may include pigments, lakes, and dyes which are well known in the art and are disclosed in the *Cosmetic Ingredient Handbook*, First Edition, J. M. Nikitakis, et al., Cosmetic, Toiletry, and Fragrance Association, Washington DC, 1988. These additional coloring agents are useful in enhancing the resultant iridescent color, or merely to expand the range of available colors.

[0049] A pigment is understood to mean inorganic or organic, white or colored particles. Non-limiting examples of useful organic pigments include FD&C dyes, D&C dyes, including D&C Red, Nos. 2, 5, 6, 7, 10, 11, 12, 13, 30 and 34, D&C Yellow No. 5, Blue No. 1, Violet No. 2. Exemplary inorganic pigments include, but are not limited to, metal oxides and metal hydroxides, such as magnesium oxide, magnesium hydroxide, calcium oxide, calcium hydroxides, aluminum oxide, aluminum hydroxide, iron oxides (Fe_2O_3, Fe_3O_4, FeO), red iron oxide, yellow iron oxide, black iron oxide, iron hydroxides, titanium dioxide, titanium lower oxides, zirconium oxides, chromium oxides, chromium hydroxides, manganese oxides, cobalt oxides, cerium oxides, nickel oxides and zinc oxides and composite oxides and composite hydroxides such as iron titanate, cobalt titanate and cobalt aluminate. Other suitable coloring agents include carmine, ultramarine blue (*i.e.*, sodium aluminum silicate containing sulfur), ultramarine green, ultramarine pink, ultramarine red, ultramarine violet, Prussian blue, manganese violet, bismuth oxychloride, kaolin, talc, carbon black, mica, sericite, magnesium carbonate, calcium carbonate, magnesium silicate, aluminum magnesium silicate, silica, titanated mica, iron oxide titanated mica, and any other pigment or treated pigment known in the cosmetic arts. The various embodiments of the inventive composition may optionally comprise a cosmetically acceptable pigment treated with lecithin which are smooth, spread well, have a good moisturizing effect, good water repellency and are especially compatible with the skin.

[0050] In yet another embodiment, the composition of the invention may additionally include any additive usually employed in the field envisaged such as antioxidants, perfumes,

essential oils, stabilizers, cosmetic active substances, moisturizers, vitamins, essential fatty acids, lipophilic sunscreens, liposoluble polymers, and especially hydrocarbon polymers such as polyalkylenes and polyacrylates for improving smoothness or spreadability, water and oil resistance, transfer resistance, or other cosmetic or pharmaceutical properties desired by one of skill in the art. Non-limiting examples of optionally added ingredients include: thickening agents, for example, clays, or organoclays, silicas, waxes, preservatives, surfactants, hectorites, gums and in particular xanthan gum, spreading agents, dispersants, antifoaming agents, wetting agents; ultraviolet-screening agents, cosmetic or pharmaceutical active agents, and other similar ingredients disclosed in the *International Cosmetic Dictionary and Handbook* Vols. 1 and 2. Eds. Wenninger, J. A. and G. N. McEwen, Cosmetic, Toiletry, and Fragrance Association, Washington DC, 2000. If the softness and elasticity of the composition are to be increased still further, it is also possible to add a plasticizer which is commonly added for cosmetic materials. Suitable materials may include both low-molecular weight and also high-molecular weight plasticizers which are optionally used, dissolved in a volatile co-solvent. The properties of the resulting film, coating, or article produced by the inventive composition should not be compromised by the addition of these ingredients. These additives are generally added for the purpose of comfort to the wearer in for example cosmetic formulations.

[0051] The contents of all patents, patent applications, published PCT applications and articles, books, references, reference manuals and abstracts cited herein are hereby incorporated by reference in their entirety to more fully describe the state of the art to which the invention pertains.

[0052] As various changes can be made in the above-described subject matter without departing from the scope and spirit of the present invention, it is intended that all subject matter contained in the above description, or defined in the appended claims, be interpreted as descriptive and illustrative of the present invention. Many modifications and variations of the present invention are possible in light of the above teachings.

EXAMPLE 1

[0053] The following example describes specific aspects of the invention to further illustrate the invention and provide a description of the present methods for those skilled in the art. The example should not be construed as limiting the invention, as the example

merely provides specific methodology useful in the understanding and practice of the invention and its various aspects.

[0054] All formulations presented in the following three tables, with the exception of the control samples as indicated in Table 1, were prepared according to the following procedure. The directing agent was dissolved in the solvent system and mixed at room temperature until homogenous, roughly 40 mins. The cholesteric liquid crystal coloring agent was added to the mixture and again mixed thoroughly until homogenous 30 mins. A film was cast by applying the final mixture across a surface. The film was set aside enabling the solvent to dissipate resulting in a brightly iridescent film. The time period for the solvent to dissipate depends on the solvent system used. The positive control listed in Table 1 is a pure liquid crystal coloring agent alone. The film was cast as described above. The negative control was prepared by mixing a non-directing copolymer and a solvent while heating at 90 °C until the mixture was homogenous 40 mins. The film was cast as described above resulting in a non-iridescent film.

Table 1. Thin Films Formulations

	A	B	C	Positive control	Negative control
Cholesteric Liquid Crystal Coloring Agent	15%	15%	15%	100%	15%
Directing Agent					
Block Copolymer X	8%	0	0	0	0
Block Copolymer Y	0	8%	0	0	0
Block Copolymer Z	0	0	5%	0	0
Non Directing Agent					
Copolymer	0	0	0	0	8%
Solvent system	77%	77%	80%	0	77%
Results					
Iridescent	Yes	Yes	Yes	Yes	No
Mechanochromic color change white background	Orange-pink to green	No color change	No color change	Orange to yellow-orange	No color
Mechanochromic color change black background	Green to blue	Pink to green	Orange to green	Red-orange to green	No color

* All amounts shown are percent by weight of the formulation.

Table 2. Iridescent Nail Enamel Topcoat Formulations

	D	E	F	G
Cholesteric Liquid Crystal Coloring Agent	15%	15%	10%	15%
Directing Agent				
Cellulose Ester X	15%	10%	0	0
Cellulose Ester Y	0	3%	3%	0
Block copolymer Z	0	0	0	2%
Solvent System	70%	72%	87%	83%
Results				
Goniochromatic color change White background	Orange to yellow	Orange to yellow	Orange to yellow	Orange to yellow
Mechanochromic color change Black background	Yellow to orange	Yellow to orange	Yellow to orange	Yellow to orange

* All amounts shown are percent by weight of the formulation.

Table 3. Iridescent Mascara Formulations

	H	I	J
Cholesteric Liquid Crystal Coloring Agent	15%	15%	15%
Additional Pigments	1%	1%	1%
Directing Agent			
Block Copolymer M	9%	9%	9%
Solvent System	75%	75%	75%
Results			
Mechanochromic color change White background	Black to green	Orange (no change)	Orange (no change)
Mechanochromic color change Black background	Green (no change)	Orange to green	Yellow to orange

* All amounts shown are percent by weight of the formulation.

WHAT IS CLAIMED IS:

1. A composition, comprising an effective amount of:
   (a) a cholesteric liquid crystal coloring agent;
   (b) a directing agent; and
   (c) a volatile solvent system;
   wherein the composition is homogeneous.

2. The composition for claim 1, wherein the ratio of cholesteric liquid crystal coloring agent to the directing agent is equal to or greater than 1.

3. The composition of claim 1, wherein the cholesteric liquid crystal coloring agent comprises a cholesteryl oleyl carbonate, a cholesteryl chloride, a cholesterol nonanoate, a cholesteryl dichlorobenzoate, or a combinationsthereof.

4. The composition of claim 1, wherein the cholesteric liquid crystal coloring agent reflects visible light.

5. The composition of claim 1, wherein the cholesteric liquid crystal coloring agent reflects ultraviolet light.

6. The composition of claim 1, wherein the cholesteric liquid crystal coloring agent is temperature insensitive.

7. The composition of claim 1, wherein the cholesteric liquid crystal coloring agent further comprises a pigment, a color enhancing agent, a preservative, a stabilizer, or a combination thereof.

8. The composition of claim 1, wherein an effective amount of the cholesteric liquid crystal coloring agent ranges from about 5 - 80 percent by weight.

9. The composition of claim 1, wherein an effective amount of the cholesteric liquid crystal coloring agent ranges from about 8 - 50 percent by weight.

10. The composition of claim 1, wherein an effective amount of the cholesteric liquid crystal coloring agent ranges from about 12 - 40 percent by weight.

11. The composition of claim 1, wherein the directing agent is a block co-polymer, random copolymer, a cellulose ester, a cellulose ether, or a combination thereof.

12. The composition of claim 10, wherein the block co-polymer is an A-B diblock copolymer, an A-B-A triblock copolymer, an A-B-C triblock, an $(A-B)_n$ multi-block copolymer, or a combination thereof.

13. The composition of claim 11, wherein the block co-polymer is a styrene-ethylene-styrene (SES) block copolymer, a styrene-isobutylene-styrene (SIBS) block copolymer, a poly(ethylene glycol)-poly(propylene glycol)-poly(ethylene glycol) (PEG-PPG) block copolymer, or a combination thereof.

14. The composition of claim 10, wherein the cellulose ester is a cellulose mono-, di-, or tri-acetate, a nitrocellulose, a cellulose propionate, a cellulose butyrate, a cellulose acetate propionate, a cellulose acetate butyrate, or a combination thereof.

15. The composition of claim 10, wherein the cellulose ether is an ethyl cellulose, a methyl cellulose, a hydroxyethyl methyl cellulose, a hydroxypropyl cellulose, a carboxymethyl cellulose, a hydroxypropyl methyl cellulose, or a combination thereof.

16. The composition of claim 10, wherein the directing agent ranges from about 0.5 - 30 weight percent.

17. The composition of claim 10, wherein the directing agent ranges from about 1 - 20 weight percent.

18. The composition of claim 10, wherein the directing agent ranges from about 5 - 15 weight percent.

19. The composition of claim 1, wherein the volatile solvent system comprises one or more volatile solvents.

20. The composition of claim 1, wherein the composition is a paint or a cosmetic.

21. The composition of claim 19, wherein the cosmetic is a mascara, a nail polish, a blush, a foundation, an eyeliner, an eye shadow, a lip gloss, a hair colorant, a body paint or a cosmetic suitable for conveying iridescent color to skin, hair, nails or lips.

22. The composition of claim 19, wherein the paint is a decorative paint, an automotive paint, or an industrial paint.

23. The composition of claim 1, wherein an iridescent film or an iridescent article is formed upon dissipation of the solvent.

24. A method for producing a composition, comprising:
    (a) mixing a directing agent, a cholesteric liquid crystal coloring agent and a suitable solvent system until a homogenous mixture is formed; and
    (b) producing a composition suitable for conveying iridescent color to surfaces.

25. A method for producing a composition, comprising:
    (a) mixing a cholesteric liquid crystal coloring agent with a dissolved directing agent until a homogenous mixture is formed; and
    (b) producing the composition suitable for conveying iridescent color to surfaces.

26. A method for producing a composition, comprising:
    (a) dissolving a directing agent in a suitable solvent system;
    (b) mixing a cholesteric liquid crystal coloring agent with the dissolved directing agent until a homogenous mixture is formed; and
    (c) producing the composition suitable for conveying iridescent color to surfaces.

27. The method of claim 23, further comprising:
    (a) applying the homogenous mixture to a surface;
    (b) dissipating the solvent system; and
    (c) producing an iridescent film.

28. The method of claim 26, wherein the homogeneous mixture is applied by pouring, brushing, dripping, spraying, painting, air brushing, spin coating, laminating, stamping, smearing, rubbing or any other method of applying such that the inventive composition is deposited upon a surface.

29. The method of claim 26, further comprising:
    (a) processing the iridescent film into iridescent particles; and
    (b) producing the iridescent particles suitable for use as iridescent pigments.

30. The method of claim 26, further comprising:
    (a) extruding the homogeneous mixture;
    (b) dissipating the solvent; and
    (c) producing iridescent fibers.

31. The method of claim 29, further comprising:
    (a) processing the iridescent fibers into iridescent particles; and
    (b) producing the iridescent particles suitable for use as iridescent pigments.

32. A composition, comprising an effective amount of iridescent fibers or iridescent particles wherein the composition is a cosmetic, a personal care product, or a paint.

33. The composition of claim 31, wherein the cosmetic is a mascara or a nail polish.

34. An iridescent film, comprising an effective amount of:
    (a) a cholesteric liquid crystal coloring agent; and
    (b) a directing agent.

35. The iridescent film of claim 33, wherein the iridescent film is transferable.

36. The iridescent film of claim 34, wherein the iridescent film is a wound healing strip, a decorative sticker, a temporary tattoo or a body art sticker.

37. The iridescent film of claim 33, wherein the effective amount of the cholesteric liquid crystal coloring agent ranges from about 42 - 90 percent by weight.

38. The iridescent film of claim 33, wherein the effective amount of the directing agent ranges from about 10 - 58 percent by weight.

39. A cosmetic composition, comprising an effective amount of:
    (a) a cholesteric liquid crystal coloring agent;
    (b) a directing agent; and
    (c) a volatile solvent system.

40. The cosmetic composition of claim 38, wherein the cosmetic is a mascara, a nail polish, a blush, a foundation, an eyeliner, an eye shadow, a lip gloss, a hair colorant, a body paint or any cosmetic suitable for conveying iridescent color to skin, hair, nails or lips.

41. A paint composition, comprising:

(a) a cholesteric liquid crystal coloring agent;

(b) a directing agent; and

(c) a volatile solvent system.

42. The paint composition of claim 40, wherein the paint is a decorative paint, an automotive paint, or an industrial paint.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/087132

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61K 8/00 (2009.01)
USPC - 424/401
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)
IPC(8) - A61K 8/00, 8/30 (2009.01)
USPC - 424/401,61, 63, 64

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)
USPTO EAST System (US, USPG-PUB, EPO, DERWENT), MicroPatent, IP.com, DialogPro

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,346,237 B2 (LEMANN et al) 12 February 2002 (12.02.2002) entire document	32
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Y		1-31, 33-42
Y	US 5,851,604 A (MULLER-REES et al) 22 December 1998 (22.12.1998) entire document	1-31, 33-42
Y	US 4,022,706 A (DAVIS) 10 May 1977 (10.05.1977) entire document	3
Y	US 7,201,794 B2 (ITO et al) 10 April 2007 (10.04.2007) entire document	11-18
Y	WO 1995/025642 A1 (PAULEY) 28 September 1995 (28.09.1995) entire document	35-36

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 January 2009	13 FEB 2009

Name and mailing address of the ISA/US	Authorized officer:
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774