[0326] Alternatively, rather than changing temperature for each color (which may be time consuming) the short UV wavelength can be varied with filters so as to change the effective penetration length. In this method, each λ/4 sub-pixel is the same (since the temperature is fixed) while its effective thickness is varied by the UV wavelength. The step of the isotropic "seal" is the same in both methods.

[0327] Once the λ/4 portion is fabricated at the top 2 μm (and supported by alignment film of the top substrate) fabrication of the color filters themselves in the bulk of the layer below can start according to the process outlined before. However, in the presence of an isotropic portion at the top, the color filter alignment will have to rely only on the bottom substrate alignment portion.

[0328] There are contradictory demands on the mixture components: fabrication of the λ/4 portion requires a nematic polymer while the color filter below requires a cholesteric polymer. This can be resolved by using a nematic LC polymer doped with a chiral component. Since the fabrication of the λ/4 portion calls for UV exposure with a very large gradient inside the mixture, the chiral component is driven out from the top 2 μm by diffusion to recover there the nematic phase. The color filter fabrication is done with very long UV, which has uniform distribution throughout the sample and therefore will not drive a diffusion process.

[0329] The above two fabrication methods of the λ/4 portion can be also implemented with the current pitch-gradient process when the requirements for a nematic polymer are satisfied.

[0330] Instead of having two separate layers **102** and **104** on separate films, as shown in **FIG. 8**A, spectrally tuned CLC regions can be formed on one layer having the top portion polymerized with one bandwidth around one wavelength and the bottom portion of the layer polymerized with a second bandwidth around a second wavelength. Therefore two-color band reflection regions can be formed within the structure of one layer. Alternatively, two color-band reflection regions can also be formed by attaching two separate layers, each layer having one color. In either case, there is a top light reflecting portion reflecting one part of the spectrum, and a bottom light reflecting portion reflecting a different part of the spectrum to realize the spectral filter structure at hand.

[0331] In **FIG. 10**, an alternative embodiment of the spectral filter structure is provided, wherein a reflective-type "white or silver" matrix is realized by adding a stacked portion **135** having reflective blocking portions for the red-green color band in block **143** and for green-blue color band in block **142**, thus providing broad-band reflection over the intersubpixel regions defined thereby, as show in **FIG. 10**. Notably, the filter structure of **FIG. 10** has five portions stacked in its LC layer, in contrast to the filter structure of **FIG. 14** which has four portions stacked in its LC layer.

[0332] The single layer embodiments of **FIGS. 10 and 14** are useful since an entire device is all realized in a single LC layer. With this technique, no peeling, gluing, aligning, steps are needed to make the display device. With fewer layers, the LCD panel can be made thinner, lighter, and have fewer index of reflection problems between layers as there are fewer optical interfaces therewithin.

[0333] **FIG. 10** shows an embodiment of **FIG. 5**B1 in which both left handed CLC layers **40** and **50** are combined with right handed layers **45** and **55**. In this embodiment both polarized and/or unpolarized white light **201** which is composed of right handed and left handed circularly polarized light can be transmitted as red, green, or blue unpolarized light since layers **45** and **55** transmit the right handed portion of the blue, green, and red light and layers **40** and **50** transmit the left handed portion of the blue, green, and red light. Layers **40**, **45**, **50** and **55** can be placed in any order in the stack without effecting the transmitted light. Also as described herein the layers **40**, **45**, **50** and **55** of cholesteric liquid crystal material can be on one layer or two layers instead of on **4** layers of cholesteric liquid crystal material. Since this polarizer is insensitive to the incident polarization, it can also work with linear polarized light. In this case no quarter wave plate is required. Due to the symmetric arrangement between the left-handed layer pair (**40**, and **50**) and right-handed layer pair (**45**, and **55**), the optical rotation by the left- and right-handed CLC color filters are automatically cancelled provided that the two pairs have the same parameters, such as reflection wavelength, refractive index, birefringence, and film thickness. Therefore, when a linear light is incident on to the CLC color filter, the output light from different color pixel is still linearly polarized in the same polarization plane.

[0334] **FIG. 11** shows a second embodiment of the invention with two color sections per layer. In this embodiment reflective cholesteric liquid crystals having a broad band spanning two primary colors are used. Such reflective cholesteric liquid crystals are also made by the method as shown in the description of **FIG. 5**B1 with the cholesteric liquid crystals of copending patent application Ser. No. 08/739467. Using the CLC film fabrication method described above, the blue and green portion of the spectrum can be reflected by a first layer of broadband cholesteric liquid crystal film material. Using the CLC film fabrication method described above, the green and red portion of the spectrum can be reflected by a second layer of broadband cholesteric liquid crystal film material. Using these broadband cholesteric liquid crystals the reflective cholesteric liquid crystal color filters of **FIGS. 11, 13, 14, 39, 41**, and **15** through **26**D are made possible. In these embodiments, the top reflective portion and bottom reflective portion may be on one layer of material or on two layers as shown above.

[0335] Returning to the embodiment in **FIG. 11** when circularly polarized white light **120** is incident on layer **60** on the red (R) reflecting portion, red is reflected while green and blue are transmitted, in layer **70** the blue (B) component is reflected and Green (G) is transmitted. In the adjacent section G,R of layer **60** both green and red are reflected as shown in the broadband cholesteric liquid crystal material described above. This section uses the broadband Cholesteric Liquid Crystals of the patent application Ser. No. 08/739467 incorporated by reference above to obtain the broad band reflectivity needed. Since the green and red colors are reflected, blue is transmitted. The top layer in layer **70** does not have to reflect any colors. It is therefore made from the same material but in an isotropic state. Or it can be made to reflect light in the infrared or ultraviolet bands and transmit the visible light. Similarly in the red (R) transmitting section, layer **60** is clear and layer **70** reflects both green (G) and blue (B) transmitting red (R).

[0336] The spectral filter design shown in **FIG. 11** has an advantage of being able to make a white (broad-band)