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(54) HIGH-BRIGHTNESSS COLOR LIQUID CRYSTAL DISPLAY PANEL EMPLOYING LIGHT RECYCLING THEREIN

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(57) **ABSTRACT**

Reflective color filters using layers of cholesteric liquid crystals with two different center wavelengths and bandwidths per layer are stacked in two layers to provide colored light for displays. With a two layer stack circularly polarized light of one handedness can be provided. With a four layer stack unpolarized colored light can be provided. With a broadband polarizing filter overlapping other filters in the stack a black matrix can be provided by reflecting all colors and transmitting no light in the overlapping areas. When broadband reflective cholesteric liquid crystals are used two primary colors can be reflected in the same pixel of a display making reflective layers with two reflective portions per layer possible. Color displays having three linear sub-pixels with three primary colors or with four sub-pixels of white, blue, green, and red in a pixel with two colors in a top row and two colors on a bottom row can are made with two colors per layer in two layer stacks. The pixels in the display are arranged such that multiple adjacent sub-pixels in a layer, or row in a layer, with the same color makes the color filters easier to manufacture. Displays using these reflective color filters may have a reflective polarizer for viewing the display at wide angles without color distortion.

A method of producing cholesteric liquid crystal color filters by polymerizing different portions of cholesteric liquid crystal mixtures at different temperatures and radiations to obtain different central wavelengths and bandwidths of reflection. By masking parts of a layer several portions with different colors are polymerized in a single layer. Further, with radiation which is attenuated in the cholesteric liquid crystal material stacks of different portions reflecting different colors in the same layer are made. Further the cholesteric liquid crystals are polymerized to have other optical properties in the stack such as quarter wave plates and broad band polarizers such that entire optical devices can be made in one layer of cholesteric liquid crystal material making the devices smaller, lighter, more robust, reliable, and easier to make by eliminating gluing and alignment problems. With overlapping reflective cholesteric liquid crystal which together reflect all light stacks with automatic black matrixes built into the layer are made saving light from being blocked by conventional black matrix light absorbing layers in display devices.