Full color reflective display based on high contrast gratings

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Reflective displays are widely used in e-book readers for their unique properties, such as printing-like looking and low power consumption. These properties also bring about a number of potential applications in signage, electronic shelf-labels and display for portable devices [1]. So far, several approaches have been reported and commercialized on reflective displays, i.e., electrophoretic display [2], electrowetting display [3, 4], and cholesteric liquid crystal display [5]. However, most approaches are still suffering from some common drawbacks, like low brightness, low color saturation and small gamut volume [1]. In addition, to fully utilize the ambient light, a three-layer architecture is required, in which red, green and blue tunable band reflectors are stacked (Figure 1). Such architecture prefers each layer to have square function transmission and reflection spectra, which cannot be realized using inks based on dyes or pigments. Subwavelength dielectric grating filter has the potential to fulfill the above requirements [6]. However, to our knowledge, no methods to tune the reflectance of resonant grating filters have been reported. Here we report a full color reflective display based on high contrast gratings in which the reflectance is tuned by driving liquid to/from the grating region.

Three different types of 2-dimentional subwavelength SiN_x gratings on glass substrates are designed to reflect blue (figure 2), green and red light respectively, in order to operate in a RGB trichromatic model. As shown in Figure 3a, the three resultant reflection spectra cover most parts of the visible spectrum, and a reasonable saturation of each color has also been obtained. The gamut of these filters is comparable with the traditional LCD display. There gratings are fabricated by nanoimprint lithography (NIL) with flexible molds. The mother molds for the NIL are fabricated using interference lithography with a 266 nm laser.

The reflection of a resonance grating is intimately related to the index contrast between the grating material and that of its environment. Hence, when the grating is emerged in some liquid, the reflectance is greatly reduced, and most of the light will be transmitted, achieving a dark state of the filter (Figure 3b). More details in design, fabrication and characterization will be presented.

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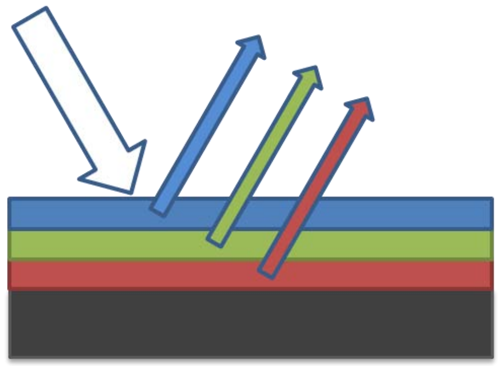

Figure 1 Three-layer architecture of a full color reflective display. Blue, green and red filters are stacked, reflecting blue, green and red light, respectively.

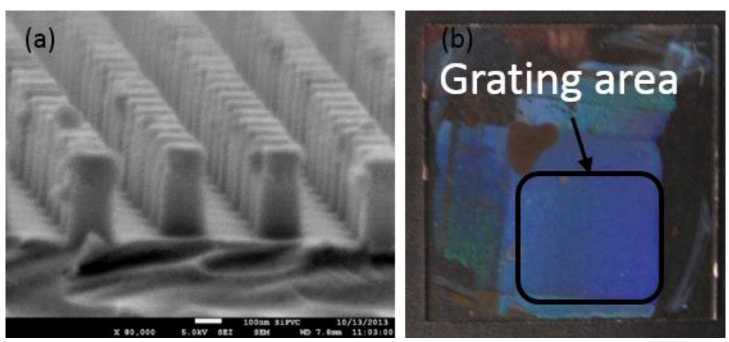

Figure 2 (a) SEM images of the 2D subwavelength grating reflecting blue light. (b) Photo of the blue reflector, the grating area is about 18 mm by 18 mm.

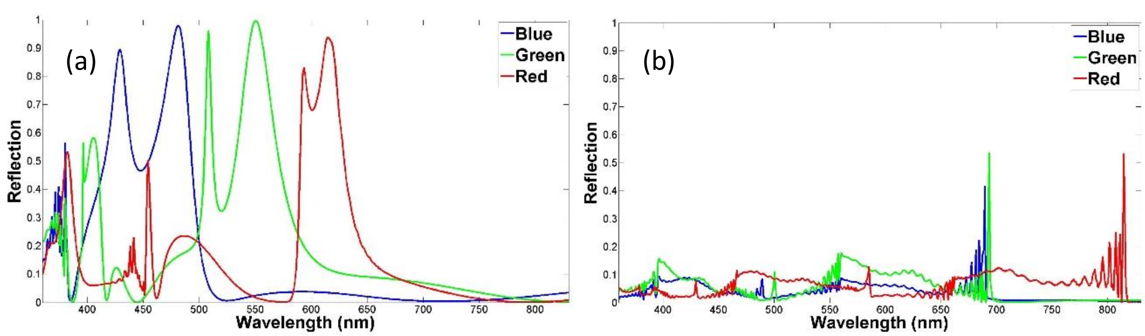

Figure 3 Simulation results of the reflection spectra of the three types of filters. (a) Reflection spectra with a background index of 1.0. (b) Reflection spectra with a background index of 1.8.