[0053] A transparent substrate **230**, a quarter wave plate **232**, and a polarization film **235** are disposed on the liquid crystal layer **223**. The backlight unit **200** is disposed below the substrate **202**. Light emitted by the backlight unit **200** is not used by the reflective color unit RM, but used by the transmissive color unit TM. The backlight unit **200** may be a direct light type backlight unit or an edge light type backlight unit.

[0054] The transmissive color unit TM includes a color filter **225** transmitting light having a certain wavelength among light emitted by the backlight unit **200**. The liquid crystal layer **223** controls the transmittance of light L_{2i} emitted by the backlight unit **200** and transmits the light L_{21} according to an input signal. The color filter **225** transmits light having a certain wavelength among light transmitted through the liquid crystal layer **223**. The substrate **202**, and the TFT electrode **205** applying a voltage to the liquid crystal layer **223** are disposed between the liquid crystal layer **223** and the backlight unit **200**. The transparent substrate **230**, the quarter wave plate **232**, and the polarization film **235** are disposed on the color filter **225**.

[0055] The backlight unit **200** emitting light, and the substrate **202**, the TFT electrode **205**, the liquid crystal layer **223**, the transparent substrate **230**, the quarter wave plate **232**, and the polarization film **235** disposed on the backlight unit **200** are shared by the reflective color unit RM and the transmissive color unit TM. However, light emitted by the backlight unit **200** is used by only the transmissive color unit TM, and is not used by the reflective color unit RM. The electroactive polymer layer **213** and the diffraction grating **220**, which constitute parts of the reflective color unit RM only, are disposed in a part of the liquid crystal layer **223**, and the color filter **225** for only the transmissive color unit TM is disposed in the other part of the liquid crystal layer **223**. A black matrix **227** may be disposed at an upper part of the liquid crystal layer **223** between the reflective color unit RM and the transmissive color unit TM to block light emitted from an adjacent pixel.

[0056] In the reflective color unit RM, external light L_{1i} passes through the polarization film **235**, the quarter wave plate **232**, and the transparent substrate **230**, and is incident on the liquid crystal layer **223**. The liquid crystal layer **223** controls the transmittance of light according to a first voltage V**1** applied by the TFT electrode **205**. Light transmitted through the liquid crystal layer **223** is incident on the diffraction grating **220**. The pitch of the diffraction grating **220** changes according to a second voltage V**2** applied by the first and second electrodes **210** and **215** to the electroactive polymer layer **213**, and thus light having a certain wavelength is reflected as color light L_{1r} by the diffraction grating **220**.

[0057] In the transmissive color unit TM, light L_{2i} emitted by the backlight unit **200** passes through the substrate **202** and the TFT electrode **205**, and is incident on the liquid crystal layer **223**. The liquid crystal layer **223** controls the transmittance of light according to a first voltage V**1** applied thereto by the TFT electrode **202**. Light transmitted through the liquid crystal layer **223** is incident on the color filter **225**. Only light L_{2t} having a predetermined wavelength is transmitted through the color filter **225**, passes through the transparent substrate **230**, the quarter wave plate **232**, and the polarization film **235**, and is output to the outside of the color display apparatus.

[0058] Since the color display apparatus of FIG. **5** includes the reflective color unit RM, which creates a color image using external light, and the transmissive color unit TM, which creates a color image using light emitted by the backlight unit **200**, the external light or the light emitted by the backlight unit **200** can be selectively used. When external light is not sufficient to display an image, the backlight unit **200** can be turned on and the transmissive color unit TM can be used together with the reflective color unit RM.

[0059] As described above, the display pixel and the color display apparatus employing the display pixel emit color light using the electroactive polymer layer and the diffraction grating. Since the plurality of subpixels have the same structure and different color light can be emitted by controlling only voltages applied to the electroactive polymer layer, the color display apparatus can be easily manufactured in volume at low cost, unlike an existing color display apparatus using an expensive color filter. Since the existing color display apparatus using the color filter transmits only light having a predetermined wavelength and absorbs remaining light, light efficiency is low. However, since the color unit according to embodiments of the present invention is reflective, its light efficiency is improved.

[0060] Furthermore, since an image is formed using external light, the color display apparatus can be used at any location, thereby improving its portability. In addition, the color display apparatus can be applied to large-sized billboards installed outdoors or demonstration displays installed under bright illumination. Also, since a color image is formed using external light, energy consumption is low.

[0061] Moreover, since the color display apparatus employs both the reflective color unit using external light and the transmissive color unit using light emitted by the backlight unit, the external light or the backlight unit can be selectively used and thus user convenience can be improved.

[0062] While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

What is claimed is:

1. A display pixel comprising:

an electroactive polymer layer, of which shape and/or size is displaced when a voltage is applied thereto;

a diffraction grating, of which a pitch changes according to a displacement of the electroactive polymer layer; and

a liquid crystal layer which is disposed on the diffraction grating and controls gradation according to a voltage applied thereto by a thin film transistor (TFT) electrode.

2. The display pixel of claim **1**, wherein the diffraction grating is formed of a flexible conductive material.

3. The display pixel of claim **1**, wherein the diffraction grating is used as a top electrode of the TFT electrode.

4. The display pixel of claim **1**, further comprising a first and a second electrodes which each are formed of a flexible material and disposed on a bottom surface and on a top surface of the electroactive polymer layer, respectively, wherein the first and second electrodes apply a voltage to the electroactive polymer layer and undergo deformation according to the displacement of the electroactive polymer layer.

5. The display pixel of claim **1**, wherein the electroactive polymer layer and the diffraction grating are disposed in the liquid crystal layer.

6. The display pixel of claim **1**, wherein the electroactive polymer layer has a thickness ranging from 0.001 μm to 100 μm.