TABLE 1

[Table 1] Circular and linear strain test results

Material	Prestrain (x, y)(%)	Actuated relative area strain (%)	Actuated relative area strain (%)	Field strength (MV/m)	Effective compressive stress (MPa)	Estimated ½e (MJ/m^3)
			Circular strain			
HS3 silicone	(68, 68)	48	93	110	0.3	0.098
	(14, 14)	41	69	72	0.13	0.034
CF 19-2186 silicon	(45, 45)	39	64	350	3.0	0.75
	(15, 15)	25	33	160	0.6	0.091
VHB 4910 acrylic	(300, 300)	61	158	412	7.2	3.4
	(15, 15)	29	40	55	0.13	0.022
			Linear strain			
HS3	(280, 0)	54	117	128	0.4	0.16
CF 19-2186	(100, 0)	39	63	181	0.8	0.2
VHB 4910	(540, 75)	68	215	239	2.4	1.36

[0041] In order to increase the degree of strain of an electroactive polymer, a prestrain is applied. When a circular or linear prestrain is applied, the area of the electroactive polymer is increased. FIG. **2** illustrates an electroactive polymer before and after a voltage is applied to the electroactive polymer. When a circular prestrain is first applied and then a voltage is applied, the area of the electroactive polymer is increased and thus electrodes are extended. FIG. **3** illustrates a cross section of an electroactive polymer when a linear prestrain is first applied and then a voltage is applied. Referring to FIG. **3**, the cross sectional area of the electroactive polymer is increased from A to B, and from C to D.

[0042] The light reflecting unit **115**, which is disposed on the electroactive polymer layer **107**, is deformed when the electroactive polymer layer **107** is strained such that a distance between the reflecting cells **115***a* is changed. The reflecting cells **115** may be reflecting micro mirrors. When the second electrode **110** is disposed over the electroactive polymer layer **107**, the light reflecting unit **115** may be disposed on the second electrode **110**. Alternatively, when a support layer **113** is disposed on a second electrode **110**, the light reflecting layer **115** may be disposed on the support layer **113**. The support layer **113** may be formed of an electroactive polymer.

[0043] The light blocking unit **118** may include a plurality of blocking cells **118***a* corresponding to the reflecting cells **115***a* of the light reflecting unit **115**. The blocking cells **118***a* are arranged at predetermined intervals to be spaced apart from one another and face the reflecting cells **115***a* such that the blocking cells **118** can prevent external light from being reflected by the light reflecting unit **115** when no voltage is applied to the electroactive polymer layer **107**. The blocking cells **118***a* absorb light and prevent light from passing therethrough. The light blocking unit **118** may be spaced apart from the light reflecting unit **115**, and a space between the light reflecting unit **115** and the light blocking unit **118** may be filled with a low reflective medium **120**. The low reflective medium **120** may be formed of an index matching material.

[0044] The operation of the reflective unit according to the strain of the electroactive polymer layer **107** will now be explained.

[0045] FIG. **4**A illustrates the state where the reflecting cells **115***a* and the blocking cells **118***a* are aligned with each other when no voltage is applied to the electroactive polymer layer **107**. That is, the centrelines of the reflecting cells **115***a* and the blocking cells **118***a* coincide with each other. In this state, part of external light L is absorbed by the blocking cells **118***a*, and the remaining part of the external light L which passes between the blocking cells **118***a*, is reflected by the reflecting cells **115***a*, and then is absorbed by the blocking cells **118***a*, thereby displaying black. The blocking cells **118***a* may be formed of a material that can absorb light, and the reflecting cells **115***a* and the blocking cells **118***a* may have the same width.

[0046] FIG. **4**B illustrates the state where the electroactive polymer layer **107** strained and the reflecting cells **115***a* are accordingly extended when a first voltage V**1** is applied to the electroactive polymer layer **107**. Since the light reflecting unit **115** is deformed whereas the light blocking unit **118** is not deformed when the first voltage V**1** is applied to the electroactive polymer layer **107**, there is a positional difference between the light reflecting unit **115** and the light blocking unit **118**. Therefore, the centrelines of the light reflecting cells **115***a* and the blocking cells **118***a* no longer coincide with each other. In this state, part of the external light L which passes between the blocking cells **118***a*, is reflected by the reflecting cells **115***a*, and is reflected by the reflective unit.

[0047] When a distance between the reflecting cells **115***a* when no voltage is applied to the electroactive polymer layer **107** is do and a distance between the reflecting cells **115***a* when a voltage V is applied to the electroactive polymer layer **107** is d, the distance d between the reflecting cells **115***a* is defined by

$$d = \frac{d_0}{\sqrt{1 - \varepsilon\varepsilon_0 \frac{V^2}{Yt^2}}} \tag{1}$$

where $\in$ denotes the dielectric constant of the reflecting cells **115***a*, $\in_0$ denotes the dielectric constant of air, Y denotes a Youngs Modulus, and t denotes a distance between the first