210 is capable of initiating a haptic effect independent of other haptic cells **210** in touch panel **206**. In another embodiment, each of haptic cells **210** of touch panel **206** is capable of generating a unique haptic effect in response to a specific input. A unique haptic effect initiates a specific haptic sensation to a user's input. It should be noted that each cell **210** can be further divided into multiple sub cells wherein each sub cell can generate its own haptic effect.

[0031] FIG. **3**(*a*) illustrates a haptic cell **210** using piezoelectric materials to generate haptic effects in accordance with one embodiment of the present invention. Cell **210** includes an electrical insulated layer **302**, a piezoelectric material **304**, and wires **306**. Electrical insulated layer **302** has a top surface and a bottom surface, wherein the top surface is configured to receive inputs. A grid or an array of piezoelectric materials **304**, in one embodiment, is constructed to form a piezoelectric or haptic layer, which also has a top and a bottom surface. The top surface of the piezoelectric layer is situated adjacent to the bottom surface of electrical insulated layer **302**. Each cell **210** includes at least one piezoelectric material **304** wherein piezoelectric material **304** is used to generate haptic effects independent of other piezoelectric cells **210** in piezoelectric layer. In one embodiment, multiple adjacent or neighboring cells **210** are capable of generating multiple haptic effects in response to multiple substantially simultaneous touches. In another embodiment, each of cells **210** has a unique piezoelectric material thereby it is capable of initiating a unique haptic sensation.

[0032] It should be noted that a tactile touch panel, which includes an electrical insulated layer **302** and a piezoelectric layer, in some embodiments further includes a display. This display may be coupled to the bottom surface of the piezoelectric layer and is capable of projecting images that are viewable from the top surface of electrical insulated layer **302**. It should be noted that the display can be a flat panel display or a flexible display. Piezoelectric materials **304**, in one embodiment, are substantially transparent and small. The dimension of a cell **210** having piezoelectric material can be configured to be less than 5 millimeters by 5 millimeters. The shape of piezoelectric material **304**, for example, deforms in response to electrical potentials applied via electrical wires **306**.

[0033] During a manufacturing process, a piezoelectric film is printed to include an array or a grid of piezoelectric cells **210**. In one embodiment, a film of cells **210** containing piezoelectric materials is printed on a sheet in a cell grid arrangement. The film further includes wirings for directly addressing every cell **210** in the device using electrical control signals. Cells **210**, for example, can be stimulated using edge or back mounted electronics. Piezoelectric materials may include crystals and/or ceramics such as quartz (SiO_2)

[0034] FIG. **3**(*b*) illustrates a haptic cell **210** generating haptic effects in accordance with an embodiment of the present invention. During operation, when a voltage potential applies to piezoelectric material **305** via wires **306**, piezoelectric material **305** deforms from its original shape of piezoelectric material **304**, as shown in FIG. **3**(*a*), to expanded shape of piezoelectric material **305**. Deformation of piezoelectric material **305** causes electrical insulated layer **303** to deform or strain from its original state of layer **302**, as shown in FIG. **3**(*a*). In an alternative embodiment, piezoelectric materials **305** return to its original state as soon as the voltage potential is removed. It should be noted that the underlying concept of the present invention does not change if additional blocks (circuits or mechanical devices) are added to the device illustrated in FIG. **3**(*a-b*). If the piezoelectric material is replaced with other materials such as shape memory alloys ("SMAs'), such material may be capable of maintaining its deformed shape for a period of time after the voltage potential is removed. It should be noted that the underlying concept of the embodiments of the present invention does not change if different materials other than piezoelectric actuators are employed.

[0035] FIG. **4**(*a*) is a diagram **400** illustrating another embodiment of a haptic cell **210** using Micro-Electro-Mechanical Systems ("MEMS") device **402** to generate haptic effects in accordance with one embodiment of the present invention. Diagram **400** depicts a block **410**, which shows a top view of cell **210**. Cell **210** includes a MEMS device **402**. In one embodiment, MEMS device **402** is substantially transparent thereby the image projection from a display, not shown in FIG. **4**(*a*), can be viewed through block **410**. It should be noted that each of haptic cells **210** is coupled to at least one wire to facilitate and generate haptic effects.

[0036] MEMS can be considered as an integration of mechanical devices, sensors, and electronics on a silicon or organic semiconductor substrate, which can be manufactured through conventional microfabrication process. For example, the electronic devices may be manufactured using semiconductor fabrication process and micromechanical devices may be fabricated using compatible microfabrication process. In one embodiment, a grid or an array of MEMS devices **402** are made of multiple cantilever-springs. A grid of cantilever-springs can be etched using MEMS manufacturing techniques. Also, electrical wirings for stimulating or driving cantilever-springs can also be directly etched onto the surface of the MEMS device **402** thereby every single MEMS device can be correctly addressed. MEMS cantilevers can be stimulated using a resonant drive (for vibrotactile) or direct actuation (kinesthetic). In another embodiment, the MEMS are stimulated in response to the energy generated by the display. For example, radio frequency energy, light, or heat generated by the pixels of a plasma display could provide an excitation source or activation signal for a MEMS haptic cell.

[0037] FIG. **4**(*b*) illustrates a side view of MEMS device **402**, wherein MEMS device **412** can be stimulated or deformed from its original state of MEMS device **402** to deformed state of MEMS device **414** when a voltage potential across MEMS device is applied. Displacement **404** between the original state and the deformed state depends on the composition of materials used and the size of MEMS device **402**. Although smaller MEMS devices **402** are easier to fabricate, they offer smaller displacement **404**. In one embodiment, cantilever-springs can be made of piezo materials. It should be noted that the actuation of piezo material is generally vibrotactile sensation. It should be further noted that piezo material can be used as a sensor for sensing fingertip positions and depressions.

[0038] MEMS device **402**, in another embodiment, uses shape memory alloy ("SMA") in place of cantilever-spring as mentioned above. The actuation generated by MEMS device **402** using SMA provides kinesthetic actuation. SMA, also known as memory metal, could be made of copper-zinc-aluminum, copper-aluminum-nickel, nickel-titanium alloys, or a combination of copper-zinc-aluminum, copper-aluminum-nickel, and/or nickel-titanium alloys. Upon deforming from SMA's original shape, SMA regains its original shape in accordance with an ambient temperature and/or surrounding