having sufficient stress induced by the electrostatic force to enable deflection upon application of voltages using the electrodes **156***a* and **156***b*.

[**0071**] Polymer surface features may be formed about the perimeter of top and bottom electrodes **154***a* and **154***b* during actuation of each active area **151***a*. The polymer surface features would include aggregated polymer **151** material that bulges vertically from the plane of polymer **151** on the top and bottom surfaces. When viewed from the top, the top polymer surface feature resembles a rectangle that borders the rectangular dimensions of top electrode **154***a*. When viewed from the bottom, the bottom polymer surface feature resembles a rectangle that borders the rectangular dimensions of bottom electrode **154***b*.

[**0072**] Electrode surface features may be formed corresponding to the shape and size of electrodes **154***a* and **154***b* during actuation of each active area **151***a*. In this case, the top and bottom electrode surface features resemble a rectangle with dimensions corresponding to the dimensions of electrodes **154***a* and **154***b* when actuated, respectively.

[**0073**] Active areas **152***a* and **152***b* permit independent control via their respective electrodes. Thus, in conjunction with suitable control electronics, active areas **152***a* and **152***b* may be actuated individually, simultaneously, intermittently, etc. to independently create polymer surface features and electrode surface features for each active area **151**.

[**0074**] So far, electrodes on opposite surfaces of an electroactive polymer described so far have been symmetrical in size, shape and location. Electrodes on opposite sides of a transducer of the present invention are not limited to symmetrical designs or layouts and may have different sizes, shapes, types, and/or locations on opposite surfaces of an electroactive polymer. Electrodes on a polymer may be patterned as desired. For example, one or more electrodes may be sprayed onto a surface of a polymer in the shape determined by a stencil. Different stencils may be used for each polymer surface Control of electrodes for each active area then allow each active area to be activated on the polymer surface individually, simultaneously, intermittently, etc. Further description and examples of customized surface features are described below.

[**0075**] **FIG. 1G** illustrates an electroactive polymer transducer **70** before deflection in accordance with a specific embodiment of the present invention. Transducer **70** comprises an electroactive polymer **72**, electrode **74** and electrode **76**. Polymer **72** is characterized by an undeflected thickness **22** before deflection for a surface region **80** of interest. Undeflected thickness **22** for either surface is measured from a surface opposite to the surface of polymer **72** being deformed, before deflection. Electrode **74** adheres to a bottom surface of polymer **72**, comprises a metal, and is thick and rigid. Electrode **76** adheres to a top surface of polymer **72**, comprises a compliant electrode and conforms in shape to polymer **72**. Electrode **76** also includes a different size, lateral location and shape than electrode **74**.

[**0076**] **FIG. 1H** illustrates transducer **70** after actuation using electrodes **74** and **76** and deflection of a portion of polymer **72**. Rigid electrode **76** prevents the bottom surface **72***b* of polymer **72** from deflecting. In this case, only a portion of polymer **72** deflects and expands in the plane where electrodes **74** and **76** laterally overlap, as shown. After deflection, a polymer surface feature **82** is created above the undeflected thickness **22** after deflection. In addition, only a left portion of compliant electrode **76** is below the undeflected thickness **22** and forms an electrode surface feature **85**. The remainder of compliant electrode **76** remains substantially at the same elevation relative to the undeflected thickness **22**. Thus, in some cases, it is possible for an electrode to include portions in an active area that contribute to an electrode surface feature and portions outside an active area or electrode surface feature that do not contribute.

[**0077**] In some cases, an electrode may elevate above the undeflected thickness, t. For example, if a second active area were patterned over polymer **72** at polymer surface feature **82**, it is possible for this electrode from a second active area to rise above the undeflected thickness **22** for deflection of another portion of the polymer. Thus, the polymer surface feature refers to polymer material above the undeflected thickness after the deflection regardless of whether an electrode has been pattered over the polymer surface feature.

[**0078**] In another embodiment, an electroactive polymer comprises a common electrode. A common electrode is an electrode that is capable of electrically communicating with more than one active area of an electroactive polymer. In many cases, a common electrode allows monolithic transducers to be implemented with less complexity (see **FIG. 3C**). For example, multiple electrodes may be patterned on one surface of a polymer while the entire second surface includes a common electrode. Alternatively, a common electrode may be used to sequentially actuate multiple active areas according to a propagation of the electrical charge through the common electrode.

3. PASSIVE LAYER

[**0079**] For some electroactive polymer transducers, in absolute terms, the change in polymer thickness during deflection or actuation may be small relative to the change in the planar area dimensions. For instance, for a thin polymer film, area changes may be of the order of square centimeters and changes in planar dimensions may be of the order of centimeters, while thickness changes may be of the order of microns (thousandths of a millimeter). However, although the absolute change in thickness for the polymer film in an electroactive polymer device in this instance is small, the percentage change is still significant (e.g., 50% or greater).

[**0080**] In one embodiment, transducers and devices of the present invention comprise a passive layer to amplify out-of-plane deformations and create more visible polymer and electrode surface features. **FIGS. 2A-2B** illustrate an electroactive polymer transducer **51** comprising a passive layer **50** in accordance with one embodiment of the present invention. **FIG. 2A** illustrates transducer **51** in an undeflected state without polymer deflection. As shown in **FIG. 2A**, polymer surfaces **52***a* and **52***b* and a passive layer surface **50***a* opposite to polymer **52** are all substantially flat before deflection of polymer **52**. **FIG. 2B** illustrates the transducer **51** in an actuated state. Compliant electrodes **54***a* and **54***b* are attached to a central portion **56** of polymer **52** on its top and bottom surfaces **52***a* and **52***b*, respectively. For actuation, an electric field with a voltage, V, is applied via electrodes **54** across polymer **52** to actuate a portion **56** of polymer **52**.