[0081] Passive layer **50** neighbors top surface **52***a* of polymer **52** and is configured to deflect with deflection of the electroactive polymer such that a surface **50***a* of passive layer **50** opposite to electroactive polymer **52** forms a set of passive layer surface features **57** that resembles the set of surface features **59** on top surface **52***a* of polymer **52**. Passive layer **50** is passive in that it conforms in cross sectional shape and dimensions to the forces applied onto it by polymer **52**. In another embodiment, passive layer **50** may also be considered passive relative to the electroactive polymer **52** in that it does not respond to the application of an electric field, with an area change and thickness change, like polymer **52**.

[0082] For transducer **51**, passive layer **50** couples directly to electroactive polymer **52** such that changes in polymer **52** surface area and thickness during actuation at least partially transfer to passive layer **50**. When passive layer **50** couples to electroactive polymer **52**, surface area and thickness changes in electroactive polymer **52** induce shearing forces in passive layer **50** that change the surface area and thickness of passive layer **50**. Since passive layer **50** is thicker than polymer **52**, or at least increases the combined thickness of passive layer **50** and polymer **52**, a change in surface area and thickness in passive layer **50** may be used to amplify, in absolute terms, a displacement produced by the change in thickness of polymer **52**.

[0083] In one embodiment, passive layer **50** contacts polymer **52** and coupling between passive layer **50** and polymer **52** may include direct attachment, an adhesive, or bonding of passive layer **50** onto polymer **52** (or portion thereof), etc. Alternatively, each passive layer **50** may be applied to electroactive polymer **52** as a surface coating. In another embodiment, passive layer **50** does not contact polymer **52** and one or more intermediate rigid structures are disposed between passive layer **50** and polymer **52**. The rigid structures, such as metal posts, attach to both passive layer **50** and polymer **52** and are configured to transfer forces from the electroactive polymer to passive layer **50**. The intermediate rigid structures then mechanically couple passive layer **50** and polymer **52** and transmit forces upon polymer **52** deflection.

[0084] In the cross section shown in **FIG. 2B**, elevated passive layer surface features **57***a* and **57***b* are created around the edges of top electrode **54***a* corresponding to the displaced top and elevated polymer surface features **59***a* and **59***b*, respectively, at the edges of top electrode **54***a*. Passive layer surface features **57***a* and **57***b* generally result in passive layer **50** from the fact that while the passive layer **50** increases in area over portion **56** corresponding to the shape of electrodes **54***a* and **54***b* and active area created by electrodes **54**, passive layer **50** typically (depending on design) decreases in area over the inactive regions **55** of polymer **52** outside the electrodes **45** and active area. Since passive layer **50** generally keeps a substantially constant total volume (with the exception when passive layer **50** includes a compressible foam), if its surface area decreases during actuation or polymer deflection in the inactive regions, then the passive layer **50** thickness typically increases and forms the surface features **57**. The location of thickness increase and surface features is typically predictable based on stress build up in the passive layer **50**. In many cases, the thickness increase is enhanced in regions of high strain, such as those immediately bordering the electrodes **54** and active area of transducer **51**.

[0085] In this manner, passive layer **50** forms a set of passive layer surface features **57** that resembles the set of surface features **59** on the top surface of polymer **52**. The set of surface features **59** on the top surface of polymer **52** includes both elevated polymer surface features and depressed electrode surface features. Thus, a set of passive layer surface features **57** may include both elevated and depressed portions relative to the original thickness of passive layer **50**. For transducer **51**, the set of passive layer surface features **57** includes elevated portions **57***a* and **57***b* corresponding to top polymer surface features **59***a* and **59***b* and a depressed potion **57***c* corresponding to thinning of polymer **52** in central portion **56**. It is understood that passive layer surface features **57** may not exactly mimic the spatial arrangement and size of polymer surface features and recessed electrode surface features on polymer **52** and may include spatial offsets, relative variations and minor quantitative differences. In general, however, the set of passive layer surface features **57** resembles the set of surface features **59** on the top surface of polymer **52** in approximate spatial configuration, relative size, etc. The number of surface features **57** for passive layer **50** will generally correspond to the number of surface features **59** on the top surface of polymer **52**, and each set may include from 1 to 200 surface features, or more, depending on the number, complexity and layout of electrodes on polymer **52**.

[0086] **FIG. 2C** illustrates a transducer **51** comprising an electroactive polymer **52** between two passive layers **50** and **58** in accordance with a specific embodiment of the present invention.

[0087] Actuation of polymer **52** in portion **56** via electrodes **54** causes polymer **52** in portion **56** to increase in planar area and reduce in thickness. Correspondingly, when portion **56** of polymer **52** is actuated, the passive layers **50** and **58** in this surface region both increase in area. Actuation of polymer **52** thus causes top and bottom passive layers **50** and **58** to reduce in thickness about portion **56** in the area where polymer **52** thickness has contracted. The reduction in thicknesses of the top passive layer **50** and the bottom layer **58** are distances, D1 and D4, respectively, as measured from their thickness. The change in thickness of polymer **52** at its contact with the top passive layer **50** and the bottom passive layer **58** are, D2 and D3, respectively. Top and bottom passive layers **50** and **58** are each thicker than polymer **52**. Hence, the change in thickness of top and bottom passive layers **50** and **58** is greater than the change in thickness of polymer **52** in portion **56**, i.e., D1>D2 and D4>D3. In this manner, each passive layer **50** and **58** amplifies the absolute displacement (change in thickness) as compared to an electroactive polymer transducer without passive layers.

[0088] The magnitude of forces generated by actuation of portion **56** in polymer **52** limits the thickness and stiffness of each passive layer **50**. As one of skill in the art will appreciate, the amount of forces generated by actuation of portion **56** is affected by the size of portion **56**, polymer **52** material, dielectric constant, and actuation voltage, for example. As the thickness or stiffness of each passive layer **50** increases, the required shear forces to displace it also increases. Thus, as the thickness for passive layer **50** increases, deflection of passive layer **50** decreases for a