discs, EAP braided artificial muscles, EAP braided regulators (e.g., artificial sphincter), EAP braided peristaltic pumps (e.g., artificial heart, esophagus and colon) and EAP braided locally controllable bladders. A plurality of discrete EAP structures can be configured to produce a complex EAP structure. Exemplary complex EAP structures include EAP animal toys having discrete EAP structures for limbs, torso and head, which can all be activated independently or in conjunction.

FIG. **2**A is a top view of one embodiment of an EAP structure. EAP braided structure **200** includes a plurality of EAP strands having a braided configuration. EAP braided structure **200** of FIG. **2**A has a "one-over, one-under" braided configuration. Those skilled in the art shall recognize that other braided configurations such as a "two-over, one-under, two-under, one-over" braided configuration can be used with EAP braided structure **200** without departing from the scope or spirit of EAP braided structure **200**. As shown in FIG. **2**A, EAP braided structure **200** includes EAP strands **210**, **220**, **230**, **240**, **250**, **260**, which are substantially similar to EAP strand **110** of FIG. **1**, and thus, are not described in detail hereinagain. EAP strand **210** includes EAP tiles **212**, **214**, **216**, first electrode **204**, second electrode **206** and insulator **292**, which are analogous to EAP tiles **112**, **114**, **116**, first electrode **104**, second electrode **106** and insulator **192** of EAP strand **110** of FIG. **1**. EAP strand **220** includes EAP tiles **222**, **224**, **226**; EAP strand **230** includes EAP tiles **232**, **234**, **236**; EAP strand **240** includes EAP tiles **242**, **244**, **246**; EAP strand **250** includes EAP tiles **252**, **254**, **256**; EAP strand **260** includes EAP tiles **262**, **264**, **266**. The braid angle between overlapping EAP strands (e.g., EAP strands **230**, **240**) is approximately equal to 90 degrees. A controller (not shown in FIG. **2**A) can be operatively 29 coupled to the first and second electrodes of EAP tiles **212**, **214**, **216**, **222**, **224**, **226**, **232**, **234**, **236**, **242**, **244**, **246**, **252**, **254**, **256**, **262**, **264**, **266** to individually control voltage potentials between these electrodes. Thus, EAP tiles of EAP braided structure **200** can be activated individually or in groups to selectively deform EAP braided structure **200**.

FIG. **2**B is a top view of one embodiment of an EAP structure. As shown in FIG. **2**B, EAP structure **200** includes frame **270**. Frame **270** is operatively coupled to ends of EAP strands **210**, **220**, **230**, **240**, **250**, **260**. Frame **270** can comprise rigid or elastic material. In one embodiment, frame **270** comprises a rigid material such as, for example, plastic, composite and metal. In one embodiment, frame **270** comprises an elastic frame such as, for example, rubber.

As shown in FIG. **2**B, EAP strands are braided so that EAP tiles overlap (e.g., EAP tile **254** overlaps EAP tile **224**). This braided configuration allows EAP tiles to operate in conjunction to provide desired deformations or motions. Exemplary operation of EAP braided structure **200** is now described. Activating EAP tiles in opposite directions provides a rigid area. For example, activating EAP tile **226** in the −Z direction (i.e., into FIG. **2**B) and activating EAP tile **264** in the +Z direction (i.e., away from FIG. **2**B) provides a rigid area where EAP tile **226** and EAP tile **264** overlap. Activating EAP tiles in the same direction provides a hump or dip. For example, activating EAP tiles **234**, **256** in the +Z direction forms a hump where EAP tiles **234**, **256** overlap. In another example, activating EAP tiles **222**, **244** in the −Z direction forms a dip where EAP tiles **222**, **244** overlap. EAP tiles form pliable areas, which can be deformed by external forces. Activation of individual tiles deforms the individual tiles and applies forces on neighboring tiles and external points of contact. Activating EAP tiles in a serial fashion can provide a waveform. For example, the following actions results in a waveform: activating EAP tiles **234**, **256** in the +Z direction; deactivating EAP tiles **234**, **256**; activating EAP tiles **254**, **224** in the +Z; and deactivating EAP tiles **254**, **224**. Activating groups of EAP tiles can provide raised formations. For example, activating EAP tiles **222**, **244**, **224**, **254**, **232**, **246**, **232**, **234**, **256** in the +Z direction results in a raised formation of EAP tiles. Those skilled in the art shall recognize that numerous other desired deformations and motions can be created using EAP tiles without departing from the scope or spirit of EAP braided structure **200**.

FIG. **3** is a perspective view of one embodiment of an EAP structure. The EAP biaxial braided structure of FIG. **3** has a configuration similar to a Chinese finger trap or a Chinese handcuff. As shown in FIG. **3**, EAP biaxial braided structure **300** includes a plurality of EAP strands **310** having a biaxial braided configuration, an outer frame **370** and an inner frame connector **372**. Outer frame **370** operatively couples the distal ends of the plurality of EAP strands **310** to each other. Inner frame connector **372** operatively couples rigid structure **380** and the proximal ends of the plurality of EAP strands **310** of EAP biaxial braided structure **300**. Outer frame **370** and inner frame connector **372** can comprise an elastic or rigid material. In the embodiment of FIG. **3**, outer frame **370** comprises a semi-elastic material. In one embodiment, the length (L) of each EAP strand **310** from proximal end to distal end is approximately equal and can be represented by the following Equation 1.

$$L=(0.5*C)/\cos(A) \qquad \text{(Equation 1)}$$

where

L=length of EAP strand

C=circumference of biaxial braided structure

A=braid angle

In one embodiment, EAP segments along each EAP strand **310** are distributed on a regular cycle so sinusoidal activations of any neighborhood of EAP segments will contribute to peak deflections anywhere on EAP biaxial braided structure **300**. Those skilled in the art shall recognize that EAP biaxial braided structure **300** can include variations in braid angle and tightness of the braid to provide different braid characteristics and different braid behaviors when used as an artificial muscle without departing from the scope and spirit of EAP biaxial braided structure **300**. Those skilled in the art shall recognize that EAP biaxial braided structure **300** can comprise other configurations without departing from the scope or spirit of the EAP biaxial braid structure **300**. For example, EAP biaxial braided structure **300** can be unattached to rigid structure **380**, which forms a snake-like structure.

FIGS. **4**A–**4**D are side views of one embodiment of an EAP structure depicting various desired deformations. FIG. **4**A is a side view of one embodiment of an EAP structure depicting a contracted deformation. EAP braided biaxial structure **400** of FIG. **4**A is substantially similar to EAP braided biaxial structure **300** of FIG. **3**, and thus, similar components are not described hereinagain. As shown in FIG. **4**A, EAP braided biaxial structure **400** retains its contracted biaxial structure because EAP segments are not activated. FIG. **4**B is a side view of one embodiment of an EAP structure depicting an elongated deformation. As shown in FIG. **4**B, EAP braided biaxial structure **400** has an elongated biaxial structure because all EAP segments are activated. FIG. **4**C is a side view of one embodiment of an EAP structure depicting a curled deformation. As shown in FIG.