

Ionic Polymer Metal Composites

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In the last decade a new breed of polymer has emerged which responds to external electrical stimulation by displaying a significant shape or size displacement. These materials, known as electro active polymers, or more commonly EAPs are now on the verge of many exciting applications.

EAPs have attracted much attention from engineers and scientists from diverse disciplines. In particular, researchers in the field of biomimetics (a field of study where robotic mechanisms are based on biologically-inspired models) find it foreseeable that these materials may be applied to mimic the movements of animals, insects and even human body parts

Generally, EAPs have the ability to induce strains that are as high as two orders of magnitude greater than the movements possible with rigid and fragile electro active ceramics (EACs), a current material displaying similar results. EAP materials have higher response speeds, lower densities and improved resilience when compared to present alternatives. Limiting factors to EAPs are low actuation forces, mechanical energy density and lack of robustness. However, there have been reported successful applications in catheter steering elements, miniature manipulators, dust-wipers, miniature robotic arms and grippers.

There are two major categories that EAPs depending on their mode of activation mechanism, these include, electronic and ionic categories. Ionic EAPs also know as IPMCs bend in response to an electrical activation as a result of the mobility of cations in the polymer network. Generally, two types of base polymers are employed to form IPMCs these are Nafion[®] (perfluorosulphonate manufactured by Du Pont) and Flemion[®] (perfluorocaboxylate manufactured by Asahi Glass, Japan). IPMC require relatively low voltages to stimulate a bending response (0.1-10 mV) with low frequencies below 1 Hz.

Strips of these composites can bend and flap dramatically when an electric current is applied. In this sense they are large-motion actuators—they can move and exert force. Conversely, when a strip is bent, voltage is produced across its thickness, allowing the strip to behave like a sensor that can determine a given level of force and motion. These two abilities—to move and to provide feedback are the reason researchers have put emphasis in someday designing bionic parts which will not only mimic the natural movements of the original, but will also send feedback response, something that is currently not seen in today's prosthetic applications.