The Design and Analysis of an Artificial Muscle Comprised of Ionic-Polymer Metal Composites

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Artificial muscles are identified by their ability to contract or expand in response to a given stimuli. Typically, artificial muscles are composed of carbon nanotubes, pneumatic bladders, materials like fishing line, or electroactive polymers. This project examines electroactive polymers specifically, focusing on ionic polymer metal composites (IPMC), and takes advantage of the contraction of IPMCs in response to an electric charge, which in turn produces another charge, allowing a flow of electricity and series of contractions. By layering pieces of IPMC and bonding them together, the project aims to design & analyze an artificial muscle which is capable of exerting a force, as evaluated according to a power criteria consisting of stress (force applied divided by the surface area of the muscle), energy conversion efficiency, strain (ratio of the contraction / expansion / deformation of the muscle), and the modulus of elasticity (relative flexibility of the muscle). Platinum composites are first chemically treated with a metal salt solution of Pt(NH3)4HCl, tested with various applied charges (mainly a charge of 6 volts); the IPMC muscle shows high potential for strain and stress, and, as a result, an overall low modulus of elasticity, which varies depending on the thickness of the muscle. It was found that between 5 and 7 layers of IPMC showed the optimum modulus of elasticity.