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MORPHOLOGICAL CHARACTERIZATION USING SMALL ANGLE X-RAY SCATTERING OF IONOMERIC POLYMER METAL COMPOSITES APPLIED ON THE DEVELOPMENT OF ARTIFICIAL MUSCLES

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Abstract - Some types of electroactive polymers (EAPs) allow the construction of low activating voltage actuators which execute smooth movements and have strategic characteristics such as lightness and malleability. This work presents a morphological study of a specific type of EAP: the ionomeric polymer-metal composites (IPMCs), by using small angle X-ray scattering (SAXS). These materials are composed of a proton exchange membrane (PEM) and electrodes plated on its both surfaces by an electroless process. Some PEMs, such as Nafion®, have hydrophilic domains which are organized in channels form with diameters of few nanometers. When a step voltage (1~3 volts) is applied on the electrodes of a hydrated Nafion® based IPMC sample, mobile cations and solvated water molecules migrate to cathode through these channels. As a result of the gradient of water concentration produced between the sample faces, the membrane bends toward the anode producing a smooth movement. In preliminary electromechanical experiments fast large bending displacements were observed in samples activated with voltages ranging from 1 to 4 volts. The generated force was measured with a load cell system showing results of few gram-force. In order to understand the relationship between these electromechanical properties and the structure of Nafion®, the morphology of the ionomeric channels was investigated using SAXS in sincrontron light radiation. We aim to understand the dynamic modifications of the channels structure when an electric field is applied. A discussion of the results and the prospect of using this material in building artificial muscles conclude the text.