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Abstract

Electronic versus Ionic Electroactive Polymers (EAPs) Strain Sensors for Wearable Electronics: A Comparative Study †

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Abstract: Electroactive polymer (EAP) strain sensors have gained appreciable attention as a potential candidate for their application in the area of soft electromechanical devices and have been widely used in soft robotics, healthcare, augmented reality, and wearable devices. In this research, a systematic comparison has been made by fabricating the electronic and ionic types of capacitive EAP strain sensors. To accomplish this, a combination of silicone rubber sandwiched between silver-coated stretchable fabric electrodes is used as an electronic type of EAP sensor, while a conducting and stretchable freestanding film consisting of Styrene-ethylene-butylene-styrene (SEBS) rubber and dedocyl benzene sulfonate acid (DBSA) doped polyaniline composite film sandwiched between carbon grease electrodes is chosen as an ionic type of EAP sensor. Mechanical characterization in terms of the uniaxial tensile testing was performed on both types of sensors using our custom-made tensile testing system, while capacitance under reversible stretching and relaxation under variable strains was measured using a computer-controlled XY-stage and an electrometer. Constitutive equations based on various existing mathematical models were used for analyzing stress–strain curves obtained from uniaxial tensile testing for predicting the mechanical behaviour of the sensor in multiaxial loading. The stress–strain curve for the electronic type of EAP sensor fit with Ogden's second term, while Yeoh's third term demonstrated a very good agreement for the ionic type of sensors. It was found that the observed capacitance was drastically enhanced for the ionic sensors, which was almost 1000 times higher compared to that observed for the electronic EAP based sensors. Conducting fabric used as stretchable top and bottom electrodes limit the elasticity of the sensor, while the ionic type of sensor can be stretchable up to >200% compared to the fabric-based sensor.

Keywords: electroactive polymers; strain sensors; wearable devices; soft robotics; healthcare

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