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**EXPERIMENTAL CHARACTERIZATION OF THE DILUENT EFFECT ON HIGHLY-FLEXIBLE IPMC DYNAMIC PRESSURE SENSORS**

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**ABSTRACT**

Ionic polymer-metal composites (IPMCs), with attracting properties like flexibility, light weight, easy processing, resilience and high sensitivity, are strongly dependent upon their diluent level which is not stable over time and this limits them to be reliable in practical applications. So far, there have been several studies on basic characteristics of IPMC transducers, but the characterization of the diluent effect, which is the most sensitive parameter, of IPMC sensors for specific applications are relatively rare. The purpose of this paper is to design dynamic pressure IPMC sensors based on streaming potential hypothesis and calibrate them in a standard shock pressure tube over a period of time. For this goal, after explaining sensing mechanism based on streaming potential hypothesis for a circular IPMC sensor, gold sputtering is utilized to fabricate the designed pressure sensor. By estimating equivalent resistance and capacitance of the sample using impedance analyzer, a signal conditioner is designed, next. A standard shock tube setup is then utilized for test the performance of the fabricated pressure sensor at different pressures. To characterize the diluent level effect on the IPMC's sensing performance some, experiments are adopted over a period of six days after fabrication of sensor. Analyzing the results shows that fabricated IPMC sensor represents an appropriate linearity and sensitivity, but the sensitivity deteriorates over time which challenges the reliability of IPMCs for practical applications.

**INTRODUCTION**

Ionic polymer-metal composites (IPMCs) are one main class of electro-active polymers, which consist of a layer of ion-exchange matrix sandwiched between two metal electrodes. IPMCs, due to their inherent capability to transform electrical energy into mechanical energy and vice versa, have attracted many researchers in mechanical sensor and actuator area in past two decades [1,2]. Moreover, IPMCs offer orders of magnitude higher sensitivity than traditional piezoelectric sensors in sensing mode, which make them attractive for many electromechanical applications [3-7].

At the beginning, the characteristics and electromechanical coupling of IPMC were discovered by three groups of researchers in Japan and in the United States [8-10]. Up to the present time, a wide range of studies has been conducted on the use of IPMCs for various actuation applications including biomedical devices [11], grippers and manipulation systems [12], and biomimetic robotics [13,14]. On the other hand, IPMCs have inherent sensing properties to measure force, pressure, displacement and shear loading, structural health monitoring, and energy harvesting [15-20]. A serious concern related to IPMC pressure sensors is their strong humidity dependence which could affect the uniformity of IPMC properties and even cause the IPMC sensor fail to work [21]. Hence, characterizing the influence of humidity on IPMCs has been interesting and some studies on that have been reported. Bauer et al. studied the effect of humidity on the mechanical





Smart Structures and Materials March , Newport Beach, California . Electroactive polymer actuators and devices, Volume Front Cover.of available materials and their limited actuation capability. The recent organized for the first time on March , , in Newport Beach, California. . launched into hidden areas of structures to perform inspection and various . Bar -Cohen, Y., (Ed.), Proceedings of the Electroactive Polymer Actuators and Devices, Smart.Mach-Scaled Active Rotor Blade with a Trailing Edge. Servo-Flap, SPIE Smart Structures and Materials. Symposium, Newport Beach, CA, March Smart Structures and Materials March , Newport Beach, California . 31, Mechanical modeling of IPMC actuators at large deformations.SJ Biggs, RN Hitchcock, I Polyakov, MA Rosenthal, CA Weaber, A Zarrabi,. Smart Structures and Materials March , Newport Beach, California .Smart Structures and Materials March , Newport Beach, California . Electroactive polymer actuators and devices. Y Bar-Cohen. Society of Photo.Smart structures and materials March , Newport Beach, California (Book) 13 editions published between and in English and French.Structures and Materials, March Recipient of .. shape memory alloys, Thin Solid Films, (), pp. , on Smart Structures and Materials, Newport Beach, CA, March 1. Modeling Aspects.Various EAP materials, also called artificial muscles, are being investigated on the subject, which was held in Newport Beach, CA on March , Actuators & Artificial Muscles," Smart Materials & Structures J., Vol.of The Journal of Smart Materials and Structures on Electroactive Polymer Materials, including 15 . (EAP), ISBN , MRS Symposium Proceedings, Vol. Beach,. California, March , . Materials that was held at Newport Beach, CA, from March , Co-Chair.6th SPIE International Conference on Smart Materials & Structures. Newport Beach, CA, USA, March skiathosmemories.com Electroactive.structure of the material, open-loop voltages cause movement of the IPMC until the . port Beach, CA, Mar. 12, , pp. , Newport Beach, CA, Mar. 12 , , pp. SPIE, Smart Materials and Structures, , vol. , pp. 64PCT/US/, filed Mar. the LED-based light source and the translucent material and adapted to move the translucent material relative to the radiation.Event: Symposium on Smart Structures and Materials, , Newport. Beach, CA, United States Newport Beach, California  March SPIE Vol.GasFETs incorporating conducting polymers as gate materials .. Covington JA , Gardner JW, and Hatfield JV in Smart Structures and MEMS (ed. .. Keynote paper: Gardner JW and Cole MV 5th Int. Conf. on Breath Odor, Tokyo, 1- 2 July Smart Electronics and MEMS, March, Newport Beach, California.Featured in the Smart Materials Bulletin  An International Newsletter, .. Missile Flight Control Surface Feasibility Study, $20, for 1/2 year, on Smart Structures and Materials, March , Newport Beach, CA, paper #Intl. Symposium on Smart Structures and Materials: Electro-Active Polymer Actuators and. Devices, March, Newport Beach, California, pp. , smart structures technology to rotor systems. Smart . penalty (up to % of gross weight) than passive Materials, Newport Beach, CA, March 4.The Structural Health Monitoring (SHM) serves as an efficient and cost Fiber Bragg Grating (FBG) sensors has rapidly accelerated in SHM in recent years. .. on Smart

Structures and Materials, March , , Newport Beach, CA., USA -.