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EAPap의 전극이 진동에너지 회수에 미치는 영향
Study on the Effects of Electrodes of EAPap into Vibration Energy Harvesting

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1. Introduction

Cellulose is environment friendly and one of the most easily available natural polymers on earth that can be obtained from various plants. Cellulose has been reported as smart material that can be used for biomimetic sensor and actuator devices and micro- electromechanical systems [1]. Also cellulose is environmentally friendly and biocompatible product [2]. In the recent times, cellulose-based Electro-Active Paper (EAPap) has been investigated to have electro-mechanical coupling and piezoelectric effects which are promising characteristics for a smart material [3]. The formation of cellulose composites with synthetic polymers and biopolymers also make it suitable as bio- sensors as well as actuators [4-5]. Moreover, piezoelectricity is one of the major characteristics for energy transducer from mechanical energy to electrical energy. In this paper, the effects of electrodes of EAPap are investigated for vibrational energy harvesting.

2. Effects of Electrodes of EAPap

2.1 Sample Preparation

Regenerated cellulose films were made from natural cotton cellulose (Buckeye technologies Co., USA) with degree of polymerization of 4,500. Raw cotton cellulose and LiCl (Junsei Chemical Co., Japan) were dried in heating oven at 100°C to remove inside remnant water. Then, dried cotton pulp was mixed with LiCl/anhydrous DMAc (N, N-dimethyl acetamide, Sigma Aldrich) with a proportion of cellulose pulp/LiCl/DMAc to 2/8/90. The cellulose was dissolved in the solvent by heating and finally a transparent cellulose solution was obtained at room temperature.

The transparent cellulose solution was poured on a glass plate and cast using a doctor blade to keep a uniform film thickness. The cast solution was cured in prepared solvent mixture for 10 min. After curing process, the cured film was rinsed twice in DI water for 10 min. The rinsed film was drawn in wet state by a mechanical stretching machine with 1.8 drawing ratios. Then the cellulose film was dried by infrared heater during stretching process. The dried cellulose film was cut into 5cm length and 1.2cm width. Gold, silver and aluminum electrodes were deposited on both sides of the cut cellulose film using a thermal evaporator.

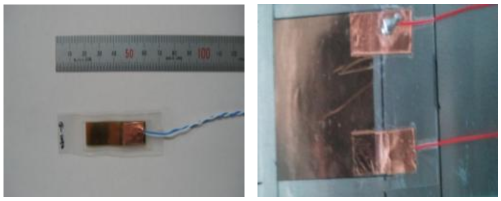

Fig. 1 Fabricated EAPap sample

2.2 Experimental Test Setup

In order to study the effects of electrodes of EAPap, a base-excitated cantilevered beam with surface bonded EAPap was investigated. The aluminum 6063-T5 was used with length of aluminum beam as 300 mm, width and thickness were 50 mm and 1 mm, respectively. The proof mass of 20 g was attached at the end of the beam. The shaker excited the base clamp of the beam with its natural frequency. To eliminate the surrounding noise effect, the EAPap was grounded as shown in Fig. 2.

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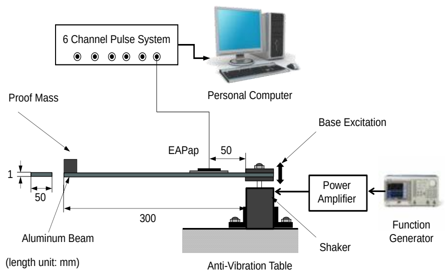

Fig. 2 Schematic diagram

2.2 Effects of EAPap Electrodes

It is noticed from the voltage output response of different types of EAPap electrodes as shown in Fig. 3-5, that gold electrode EAPap provided a 102 mV peak to peak voltage output without any sign of noise. Silver electrode EAPap presented 77.1 mV peak to peak voltage output. The peak to peak voltage output was decreased by 24 percent with the same excitation energy due to resistance of silver electrode. Aluminum electrode EAPap provided high noise because of large resistance. It is concluded that gold or silver electrode is suitable for the electrode of EAPap. If the thickness of aluminum electrode was increased, the resistance might be drop down, then it can be used as an EAPap electrode. So the thickness effect of electrode is needed to be investigated.

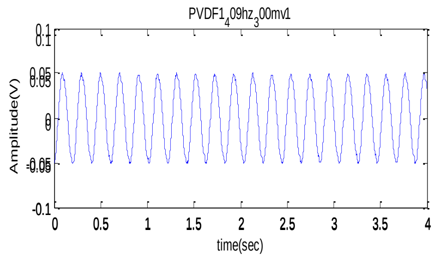

Fig. 3 Gold electrode EAPap

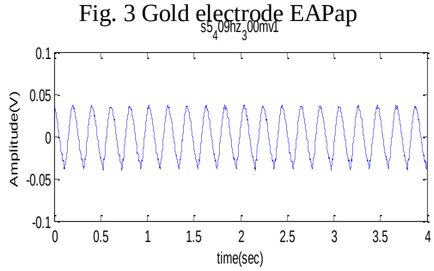

Fig. 4 Silver electrode EAPap

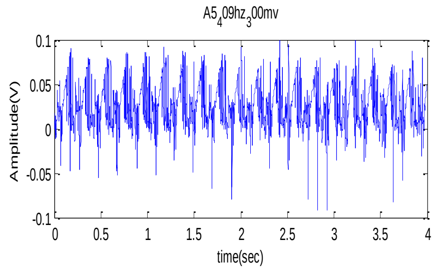

Fig. 5 Aluminum electrode EAPap

3. Conclusions

The forced response of EAPap was tested and the effects of electrodes were investigated. Gold and silver electrodes provided good energy transducer capability of EAPap but aluminum electrode showed high noise problem. This is because of high resistance of aluminum electrode..

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