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Fabrication and Evaluation Energy Harvesting based on Smart Triboelectric Material

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KEYWORDS

Energy Harvesting,
Triboelectric,
Microstructure,
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ABSTRACT

One of the ways to convert mechanical energy into electricity is the use of triboelectric generators. In this paper, it has tried to discuss the principles of these generators and improve their performance, as well as present new structures for their use. The most important researches on improving performance include improving materials, improving surface geometry, improving structures, and more. A solution is proposed to improve the surface geometry, which involves changing the angle of the double-corrected surface by sandpaper with different grit sizes. The output voltage was investigated for different angles of adjustment of the two modified tribo surface relative to each other, including a PVC surface and another surface of aluminum. It was found out that the produced voltage for the two-surface placement ratio with non-zero polishing angle in different grit sizes of sandpaper was significantly improved in comparison with zero-degree mentioned in previous studies.

1. Introduction

Energy has vivid role in the human life and civilization. People demand to energy is like as human requirements to be live. Historically, some of human activities are related to energy producing and usage of that. Chemical energy reached from nutrition was most important energy resource for many centuries because human muscles need that. Other types of energy were developed in various scales. Already, electrical energy is most vital type of energy due to using electrical devices in daily life [1]. In other words, by wide using of electrical devices, batteries of them require to recharge while they are low power. Thus, recharging generators are very interested. In addition, by developing the internet of things (IoT) and network of sensors, energy harvesting from environment in low scale is solution for this demand and focused by researchers.

Stability in power source is important because it grantees the performance of device in long term working. This is one reason of mechanical energy converting to electricity self-powered sensors [2]. The idea of self-powered were introduced by nano piezoelectric generators (PENGs) working by nano wires in 2006. After that, triboelectric nanogenerator (TENG) were unveiled in 2012. It works by electrostatic charge generated by contacting two various surfaces. Investigations in TENGs increased drastically because self-powered sensors can be used in IoT, environment monitoring, health monitoring, medicine science, and safety [3].

Mechanical motion can be found anywhere and in human daily life, and it is attractive target for energy harvesting as alternative source of energy beside the fuel particularly for the battery replacement. Up to recent decade, energy harvesting methods were limited to electromagnetic based techniques and piezoelectric effect [4]. History of TENG working by mechanical power is referred to Wimshurst machine and Van de Graaff generator were established in 1880 and 1929, respectively. They worked by rotating circular belt and metal brush. The charging and recharging occurred frequently between two electrodes [2].

The main concept of electricity generation in TENGs is based on the Maxwell's displacement current law. It is mentioned as:

$$J_D = \frac{\partial D}{\partial t} = \varepsilon_0 \frac{\partial E}{\partial t} + \frac{\partial P}{\partial t} \quad (1)$$

The second term of this equation, $\frac{\partial P}{\partial t}$, is belong to polarization, and triboelectric and piezoelectric are working by that. The first term of equation is belonging to electromagnetic effect [3]. So, triboelectric is created by contact and induction of positive and negative charged surfaces [5].

Current paper aims to present a localized triboelectric for energy harvesting and performance of that.

2. Methodology

In this paper, to develop a TENG by maximum power generation, the effect of angle between two polished surfaces is studied. Previous study [6] is focused in aligned surfaces, but various angles must be investigated in terms of performance of power generating. Thus, optimum angle between two polished surfaces is studied from 0 to 90 degree (0, 30, 60, and 90 degrees). It is shown in Figure 1. Two materials are selected as surfaces: aluminum and ploy vinyl chloride (PVC). They are polished by grinding paper number 100 and 400. Figure 2 illustrates this treatment on the surface. Treated surfaces are exposed to vibration by oscillation tools, and electrical voltage is recorded by oscilloscope.

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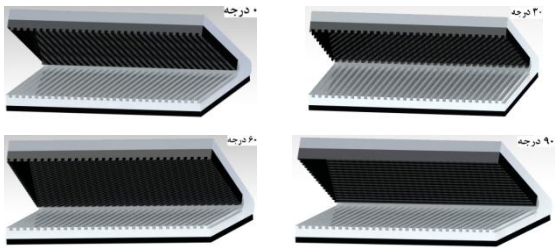

Figure 1. angle of two surfaces

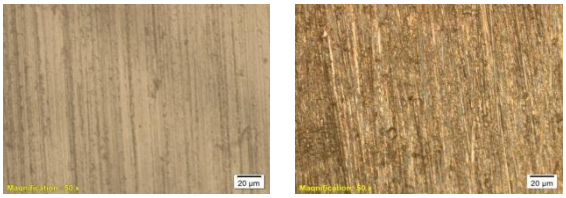

Figure 2. samples of treated PVC and Aluminum surface by grinding paper number 400

3. **Results and Discussion**

Obtained voltage of each test is recorded to identify the effect of surface angles on the power generation. By grinding paper number 100, the maximum voltage is produced with angle of 60 degree. This voltage is 272mV. Figure 3 reveals the output of TENGs by various angles between surfaces. By treated surfaces via grinding paper number 400, the maximum voltage is reached in angle 30 degree as 156mV. It is depicted in Figure 4.

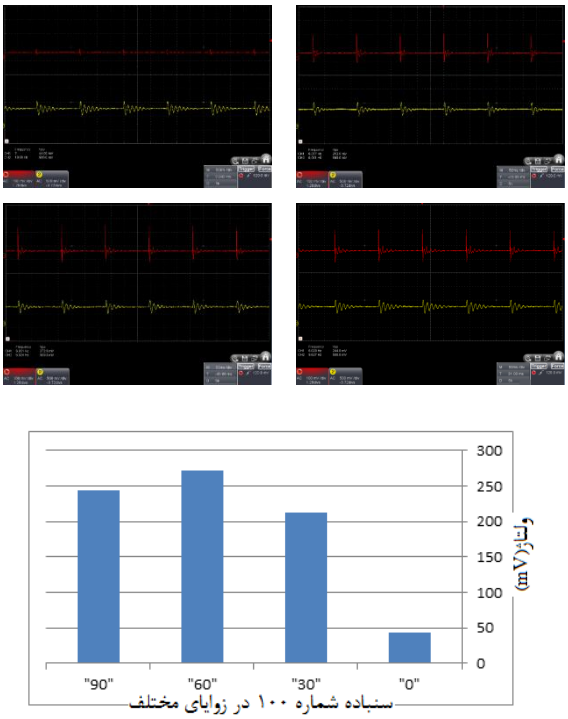

Figure 3. generated power sample by treated surface via grinding paper 100

4. **Conclusion**

As stated previously, fabrication of TENG is described in this paper. The effect of angles between surfaces in power generating is studied. The results show that angle of surfaces has influence to generated power. In addition, it was found out that the produced voltage for the two-surface placement ratio with non-zero polishing angle in different grit sizes of sandpaper was significantly improved in comparison with zero-degree mentioned in previous studies.

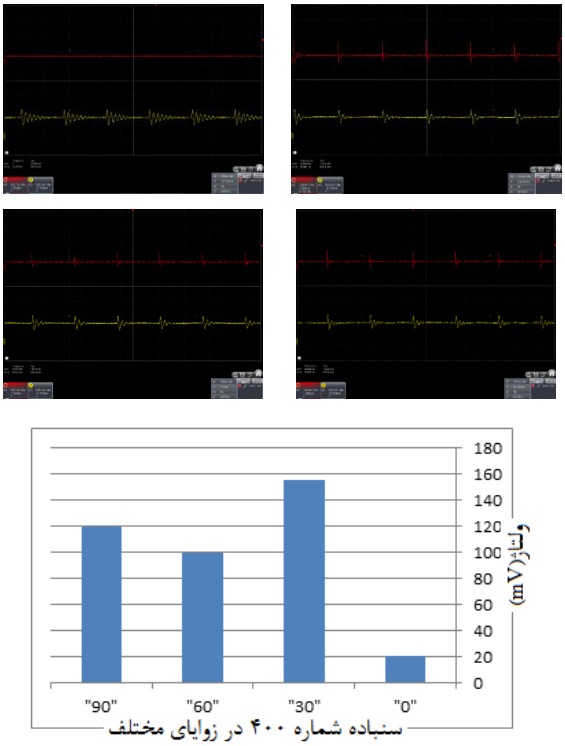

Figure 4. generated power sample by treated surface via grinding paper 400

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