Revisit hot plate poling method of P(VDF-TrFE) thick film in sensing applications

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ABSTRACT – This paper presents effect of hot plate polling method on the performance of the P(VDF-TrFE) thick film in sensing applications. Two different type top blocks (alumina and stainless steel) were applied on the P(VDF-TrFE) thick film during the polarization process to act pressure on the thick film for even heat distribution from the hot plate. The output voltage performance of P(VDF-TrFE) thick film was affected by surface-contact heat in between the P(VDF-TrFE) thick film and the hot plate. Therefore, using the stainless steel as top block instead of alumina block is the best solution to increase surface-contact heat transfer from the hot plate where the result of the experiment shows significantly improvement of piezoelectric performance for output voltage.

1. INTRODUCTION

Piezoelectric P(VDF-TrFE) thick film are widely used in energy harvesting applications such as wearable sensors and power microgenerators due to high sensitivity, flexibility, lightweight and mechanical strength [1-2]. Polarization method is factor of piezoelectric properties performance to align the dipoles of the P(VDF-TrFE) crystalline structure after the post-fabrication method. P(VDF-TrFE) piezoelectric thick film generate an electric charge proportional to stress known as direct piezoelectric effect. By the default, all dipoles are randomly oriented; therefore it is no significant electric charges generated because of the minimum piezoelectric effect. To overcome this problem, polling is performed to align all electric dipoles. The process can be performed on P(VDF-TrFE) thick film using hot plate polling method as shown in Figure 1, with high electric field (direct current) and at Curie temperature [3].

A. Hartono et al. 2016 reported heater polling of electric field 2G/v with temperature, 40°C in 20 mins for PVDF thin film for improvement piezoelectric properties without the details of effect heater polling [4]. Therefore, an experiment setup was carried out to find out the effect of the hot plate polling method which its affected the performance of piezoelectric P(VDF-TrFE) thick film.

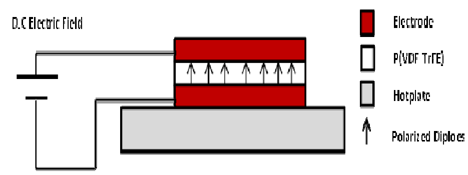

Figure 1 Hot plate polling method

2. EXPERIMENT SETUP

The fabrication steps of P(VDF-TrFE) piezoelectric thick film have been reported in previous work [5]. Figure 2 shown fabricated P(VDF-TrFE) thick film on the PET substrate before hot plate polling process.

Figure 2 Fabricated P(VDF-TrFE) thick film

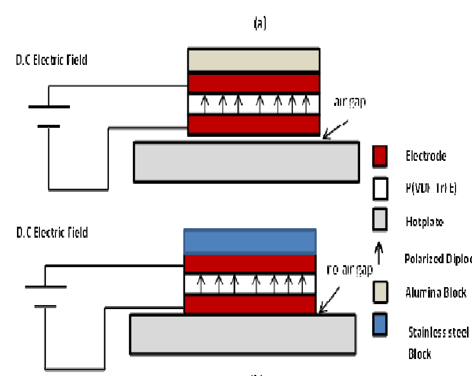

Figure 3 Hot plate polling method with (a) top-alumina block (b) top-stainless steel block

The experiment setup as shown in Figure 3 for hot plate polling method, and it is connected with D.C high electric field, 300V for 30 mins with temperature, 115°C which it is close to the curie temperature of P(VDF-TrFE) material. There are two different type top blocks (alumina block and stainless steel block) were used to act pressure on the P(VDF-TrFE) thick film for even heat distribution from the hot plate.

Further investigation air gap presence was performed using digital camera as shown in Figure 4 (a) where air gap presence using alumina block because the alumina block is not uniform surface contact whereas in Figure 4 (b) shown no air gap presence in between P(VDF-TrFE) thick film and the hot plate using stainless steel block. This is because the stainless steel block has uniform surface contact and good for heat distribution process.

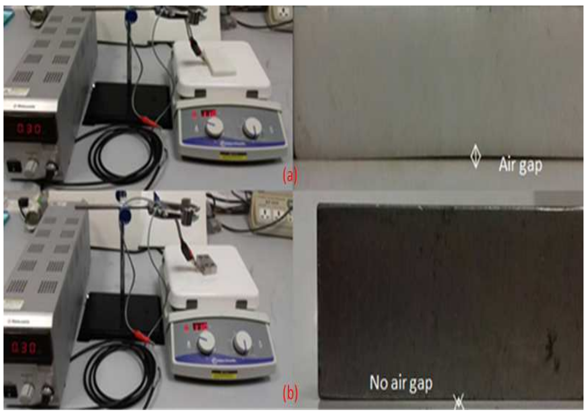

Figure 4 Gap in between the block and hot plate using: (a) Alumina block, (b) Stainless steel block

3. RESULTS AND DISCUSSION

To achieve a good polarization method during polling process, heat distribution in between the P(VDF-TrFE) thick film and hot plate is the main factor to align all dipoles of P(VDF-TrFE). If there is an air gap presence in between the P(VDF-TrFE) thick film and hot plate then the polling process is not perfect polling process because some parts of thick film are not heated in curie temperature for uneven heat distribution. As a result, some dipoles are not well align and it will be affected the performance of the piezoelectric.

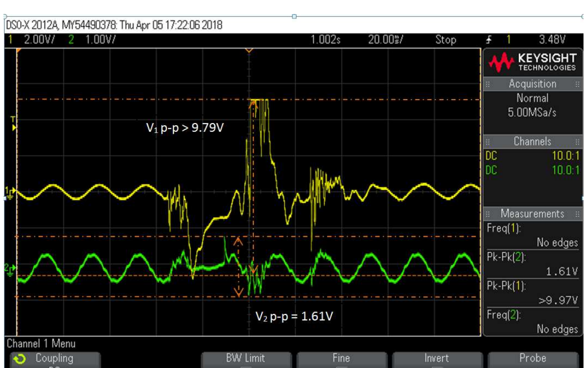

Figure 5 Output voltage using different blocks for hot plate polling

After the hot plate polling process, both samples are tested for output voltage performance under digital oscilloscope with gentle bending on the P(VDF-TrFE) thick film. In Figure 5 shown sample using stainless steel block generated higher voltage peak-to-peak about 9.97V than the sample using alumina block during hot plate polling where the voltage peak-to-peak is 1.61V in open circuit connection.

4. CONCLUSIONS

In this studies, the hot plate polling is the key factor performance of P(VDF-TrFE) thick film. The surface top block on the piezoelectric thick film must be uniformed in order to transfer direct heat contact from the hot plate else uneven surface of the top block give presence of air gap and reduce the polling effect for the piezoelectric thick film.

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