Corona poling of printed piezoelectric films

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Research Experiences For Undergraduates

INTRODUCTION

WHAT IS PIEZOELECTRIC MATERIAL ?

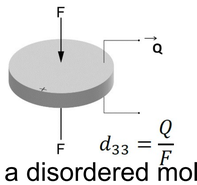
- Piezoelectric materials generate charge when squeezed or deformed and convert mechanical energy into electrical energy
- They are used in sensors, transducers, and actuators in various devices
- Examples include PVDF, PVDF-trFE, ceramics, and polymers

WHAT IS PVDF-trFE ?

- Polyvinylidene Fluoride-Trifluoroethylene (20 mol% trFE)
- It exhibits enhanced piezoelectric properties compared to PVDF alone

WHAT IS d_{33} ?

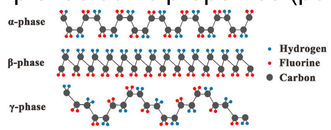
- Piezoelectric coefficient
- $d_{33} = \frac{\Delta Q}{\Delta F}$



$d_{33} = \frac{Q}{F}$

WHAT IS PVDF- trFE PHASE?

- Alpha phase is non-polar with a disordered molecular structure (as-printed material)
- Beta phase is polar, ordered, and demonstrates enhanced piezoelectric properties (poling is required)



α Poling β

BACKGROUND

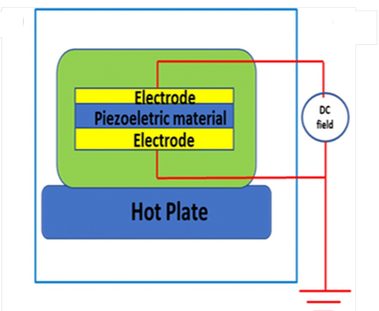
WHY CORONA POLING?

- Clean, non-contact technique suitable for delicate materials, minimizing contamination and damage risks.
- Achieves uniform polarization in thin films
- Prevents thin films from breakdown
- Suitable for large-size film production
- Needs shorter processing times.

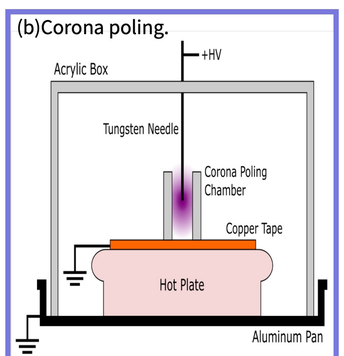
WHAT ARE THE CORONA POLING CHALLENGES?

- Voltage, duration, and temperature, Distance, field uniformity, and optimization of d33

(a) Direct poling.



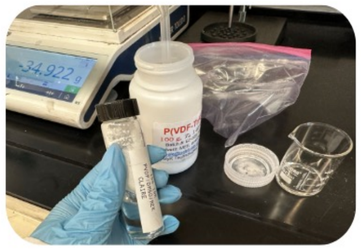
(b)Corona poling.



MATERIALS

A batch of 15%wt ink :
5.000g DMSO, 1.830g MEK, 1.205g PVDF-TrFE

METHODS



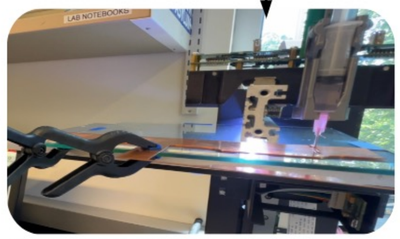
Measure 5.000g DMSO, 1.830g MEK, 1.205g PVDF-TrFE in order to make batch of 15%wt ink

Put DMSO, MEK, PVDF-TrFE together in a tuble.

Use Voltage mixer to mix until all mix together

Check full mix and have good viscosity

Put in to the Needle



Set the copper on the 3D printer

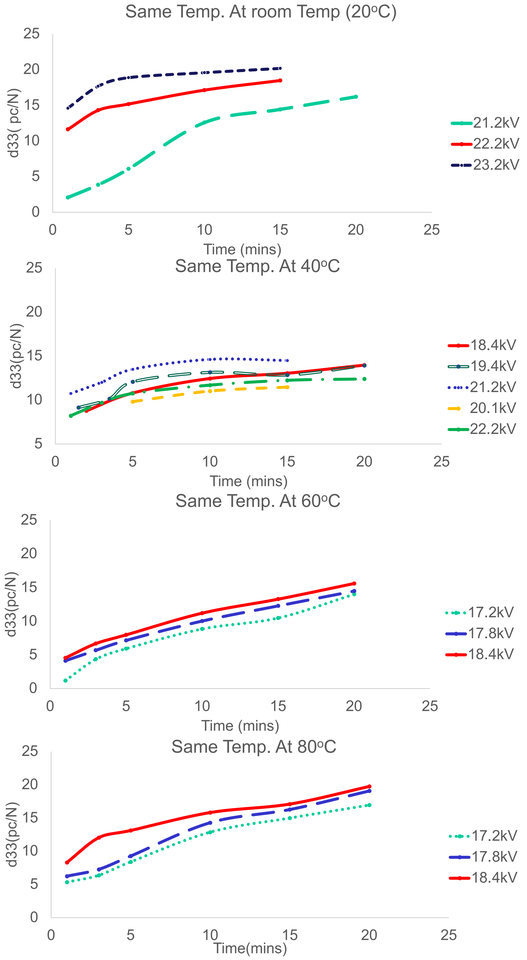
Open the 3D printer system and write the code to print 3 rectangle.

Transport sample to the oven, allow at least 15 minutes of cure time at the preset 90°C,then annealing at 130°C for 1 hours

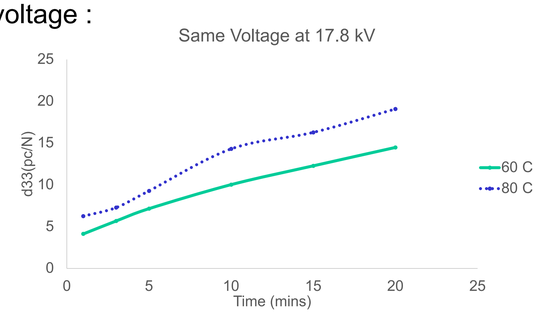
Use corona poling polarization the sample at 40°C,60°C and 80°C

RESULTS

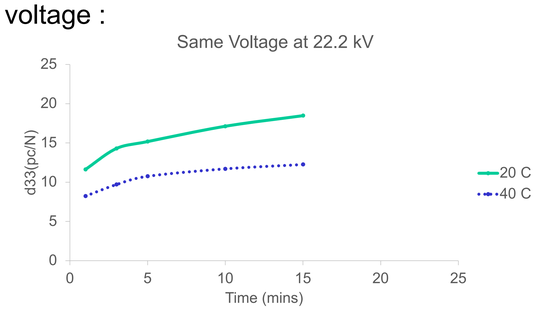
Compare the voltage at the same Temp:



Compare the 40 °C 60 °C, 80°C at the same voltage :



Compare the 20 °C, 40°C at the same voltage :



CONCLUSIONS

- At a constant voltage, increasing the temperature resulted in higher d_{33}
- A longer polarization at a given temperature leads to higher d_{33}
- The maximum d_{33} value achieved is 21.1 pC/N at a temperature of 20°C and a voltage of 23.2 kV, with a polarization duration of 15 minutes

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