Preliminary research on electrical response comparison of Piezoceramic crystal attached to cantilever beam

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Introduction: The recent trends in electro-mechanical technology have created a demand for low power consuming and efficient technologies to cater the needs of Industries. Energy harvesting using piezoelectric devices is one of possible way to accomplish this short term goals. The application of Piezoceramic materials is unanimously increasing in areas of Energy harvesting as it has minimum weight and appealing efficiency. In this paper we are comparing Piezoceramic material as a Single crystal and Series of Piezoceramic crystals are crystal placed in a cantilever beam are tested under excitation in a Subsonic Wind tunnel. Cantilever beam when subjected to airflow vibrates in lateral axis along with Piezoceramic crystals which produces an electrical response. The electrical response are recorded in an Oscilloscope and plotted to compare their characteristics and evaluate the maximum voltage generated for a particular force of vibration. Piezoceramic material used for our research is Brass coated with Zinc which is used in electrical buzzers. Wind Tunnel which is used for exciting the crystals is a subsonic wind tunnel and maximum speed input is 1200 rpm. From this paper we can able to compare the efficiency of electrical response of Single and Series Piezoceramic crystals under excitation.

Aim: To extract the electrical response from cantilever action of a Piezo ceramic crystal using Subsonic Wind Tunnel

Method: In this paper we are testing the response of the Piezo ceramic material under excitation in an Open circuit Wind tunnel. For our experiment we have selected a conventional Piezo ceramic metal bonded in a circular brass metal as a base metal. The Piezo material is attached to Stainless steel scale (Conventional) near extreme end. The brass metal is connected to negative and ceramic is connected a positive terminal.The connected Piezoceramic material is installed in Test Section of an Open Circuit Wind tunnel with the help of clamps. A wind tunnel calibration has to be done before placing Piezo material in the test section. The type of flow used in the experiment is Blow down flow. The Piezo material is placed along axis of Wind tunnel so that the clamped end is facing towards blade and attached material facing the Honeycomb section. The test section is fixed rigidly by clamps and horizontal movement is arrested by applying China clay on the connecting point of rod and test section. The overview of setup is shown in Fig :1 and process is explained in flowchart Fig 2.The response from the material is recorded in Digital Signal Oscilloscope as .csv file and plotted using MATLAB (Fig 3.)

Fig 1. Piezoceramic Crystal in Cantilever beam (Placed in Test section of Wind Tunnel)

Conclusion: From the response and plots, we come to following conclusion (Ref Fig 3 &5)

1.Voltage variation is regular and exponentially increasing when Piezo crystal is placed in Series. Therefore crystal in series gives a good voltage response with minimum noise and mean voltage of 1.49 V comparing to single crystal where it gives 0.433 V mean voltage .

2.In Single crystal case ,voltage plot is decreasing non-linearly and gives a maximum voltage of 0.512 V (650 rpm) which is very low when compared to Crystal in series which gives maximum voltage of 2.46 V (1200 rpm)

3.Finally,we conclude the Piezo ceramic material give good voltage response placed in series(2.46V) when compared to Single Piezo ceramic crystal of same dimension.

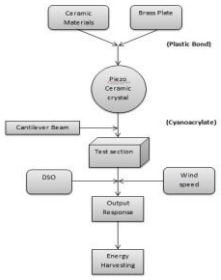

Fig 2.Process Layout

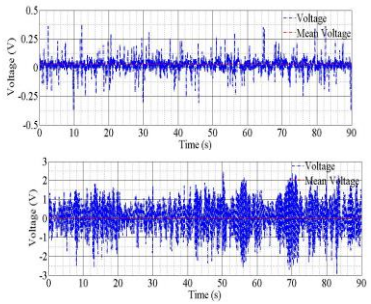

Fig 3 .Voltage Response (MATLAB plot)

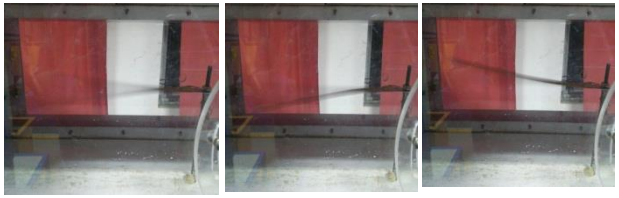

Fig 4 Vibration of Cantilever Beam (Modes)

Graph

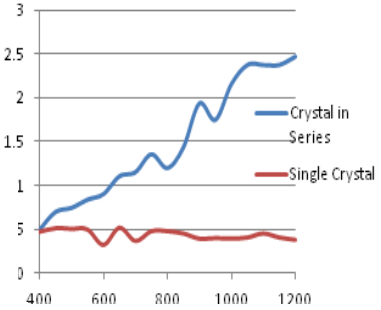

Fig 5. Comparison of Single vs Series Crystal Voltage response

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