Harvesting Vibrational Energy Due to Intermodal Transport Systems Via Nano Coated Enhanced Piezo Electric Devices

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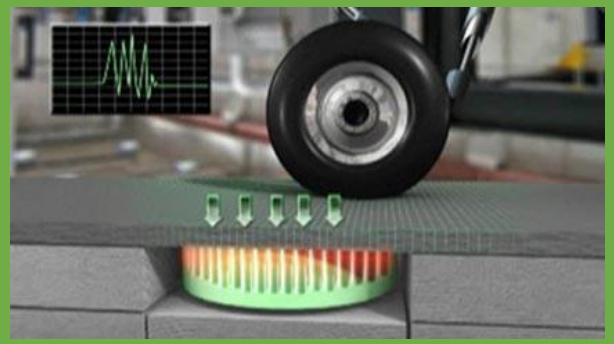

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1.Graduate students supported by this grant:

- **Doctoral student - Dinesh R. Palikhel**

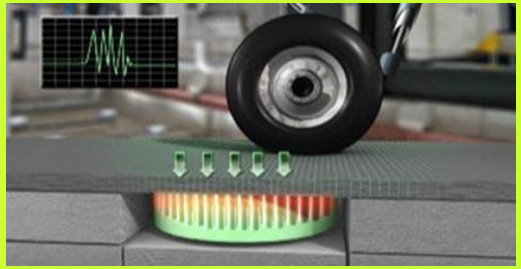
2. There is one master's student - Abhay Sharma

[Supported by Department]

Introduction

Examples of Alternate Energy Sources

- Solar Energy
- Wind Energy
- Thermal Energy
- Vibrational Energy
  - -Piezo Electric Materials



APPLICATION: TRAFFIC IN TUNNEL AND ON BRIDGES

TRAIN MOVING OUT FROM TUNNEL AND IN CITIES

APPLICATION: PLANE LANDING & TAKEOFF FROM RUNWAY

GOALS OF THE PROJECT

I. Design and construction of the special nano-coated piezo electric energy harvester. [To enhance Piezo properties]

II. Test the newly designed and constructed system in the laboratory and compare it with that of the traditional PZT system

III Implement the energy harvesting system to power a lighting system in the laboratory

Coating Materials

- **Coating Constituents**

–Zinc Oxide Nanoparticles

–Ferrofluid containing Ferrous nanoparticles

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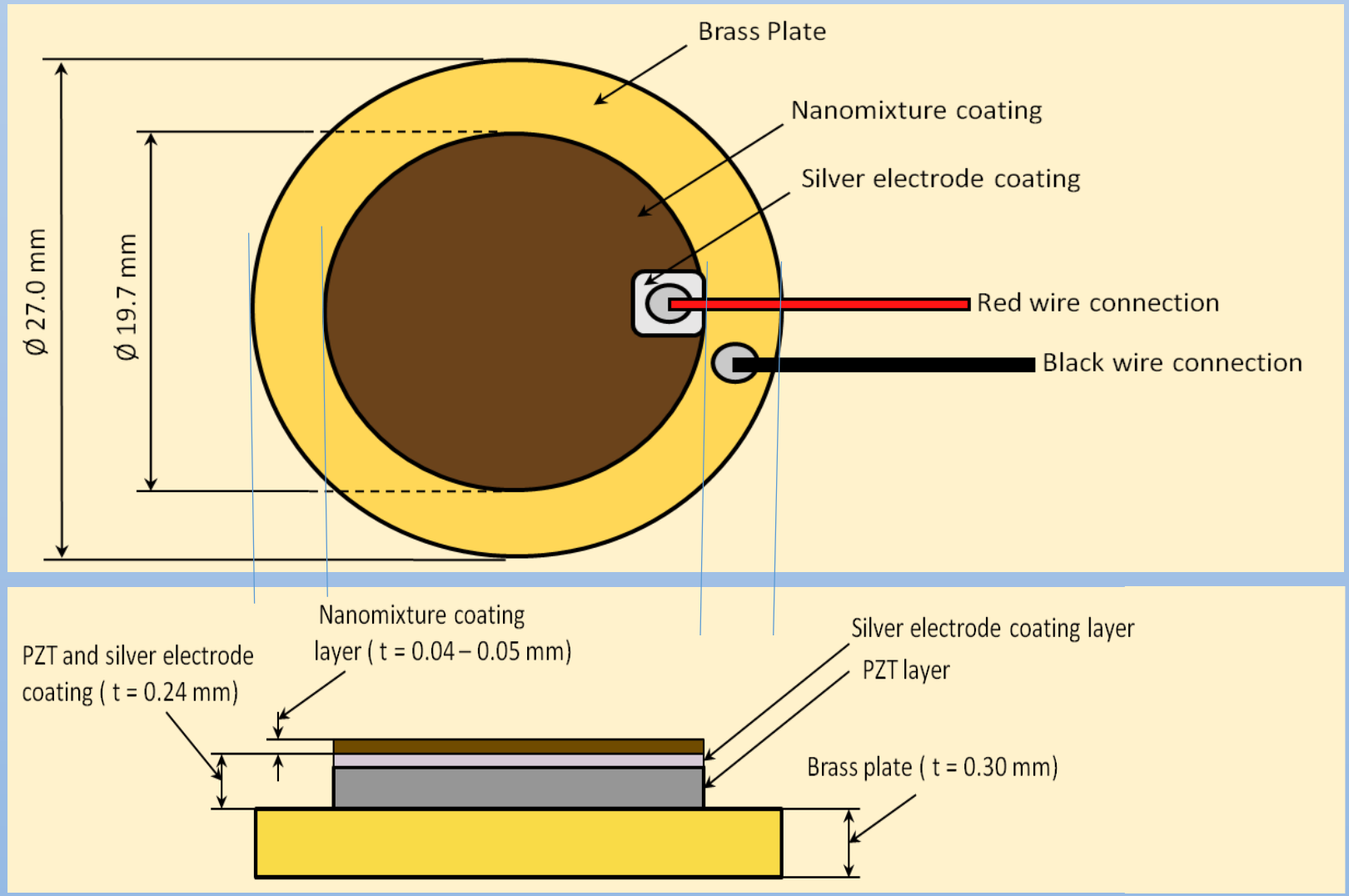
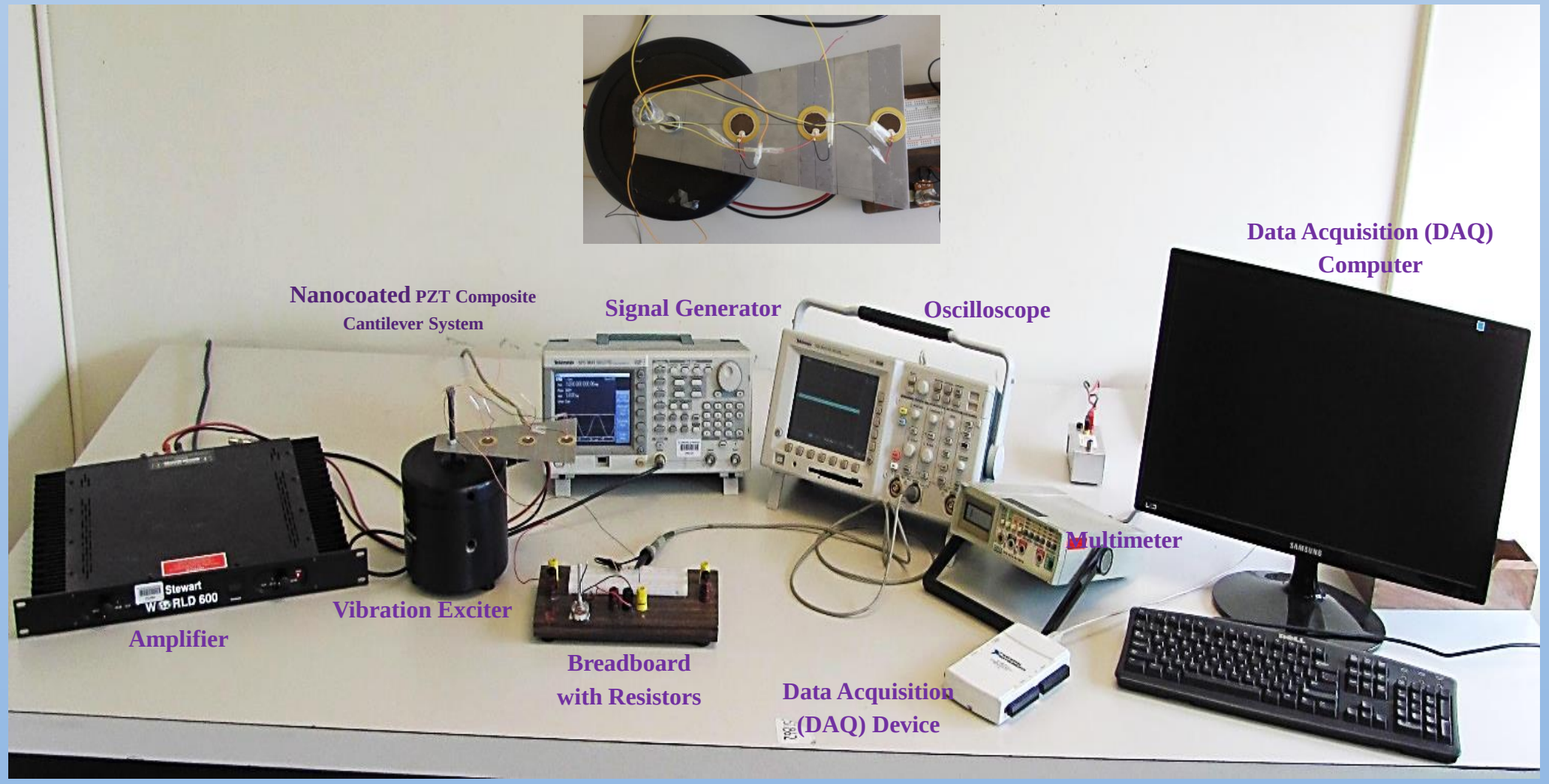
–Epoxy Resin Binder

Nano Coated PZT Composite Showing Different Layers [Top & front View] with all dimensions.

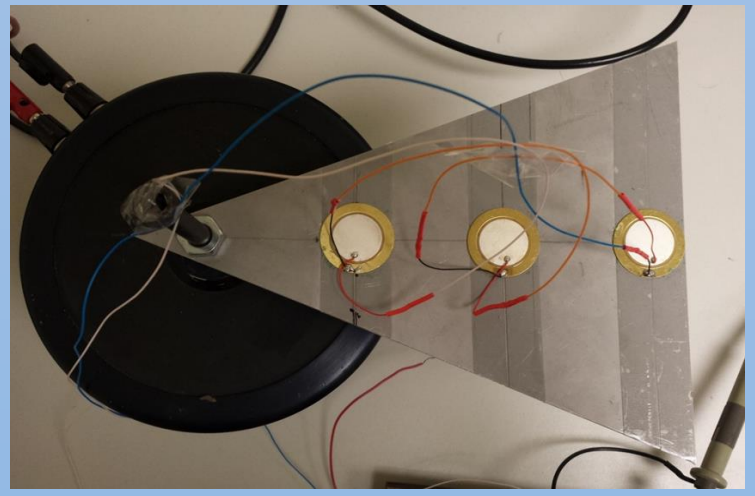


Experimental Set-up showing testing of a Steel Trapezoidal Plate Cantilver with three Coated PZT

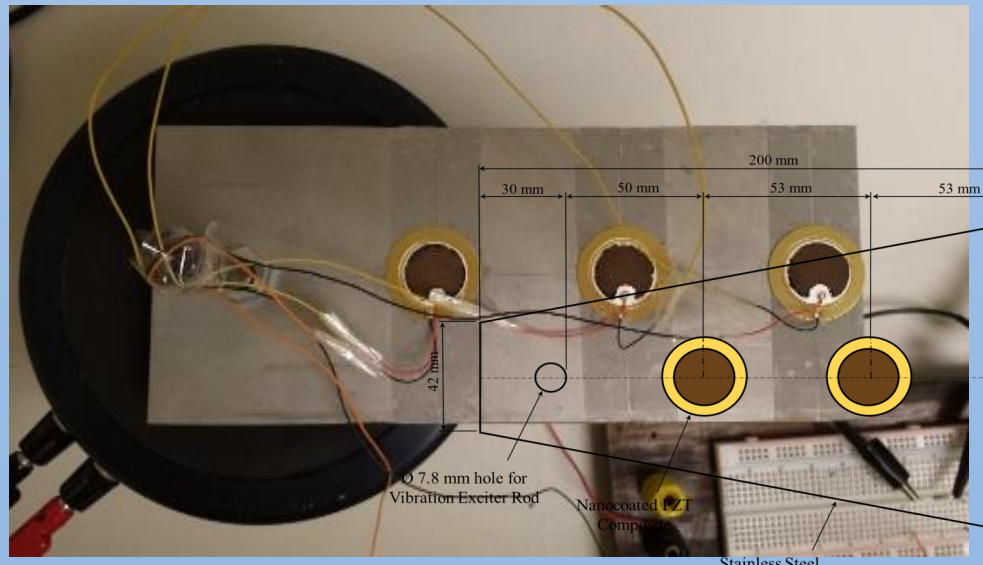


Three Stainless steel plate cantilevers having different geometry with three coated and uncoated Piezos were tested for Energy Harvesting to check the shape effect and placement of Piezo to form suitable Arrays

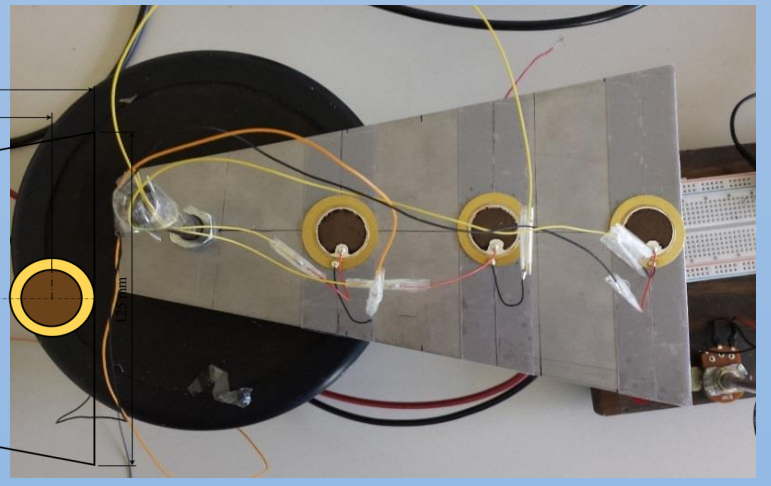
Triangular Cantilever



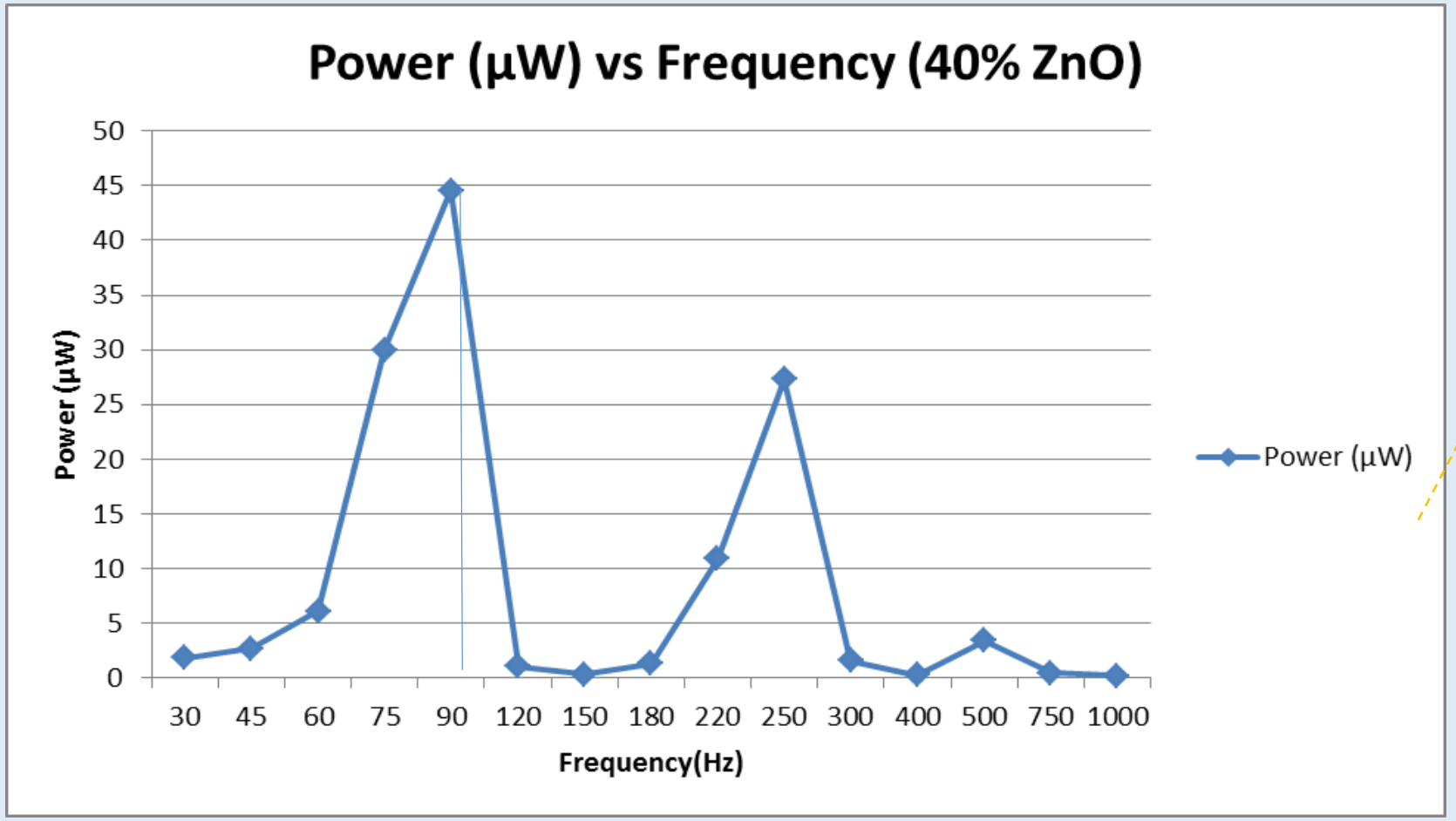
Rectangular Cantilever



Trapezoidal cantilever

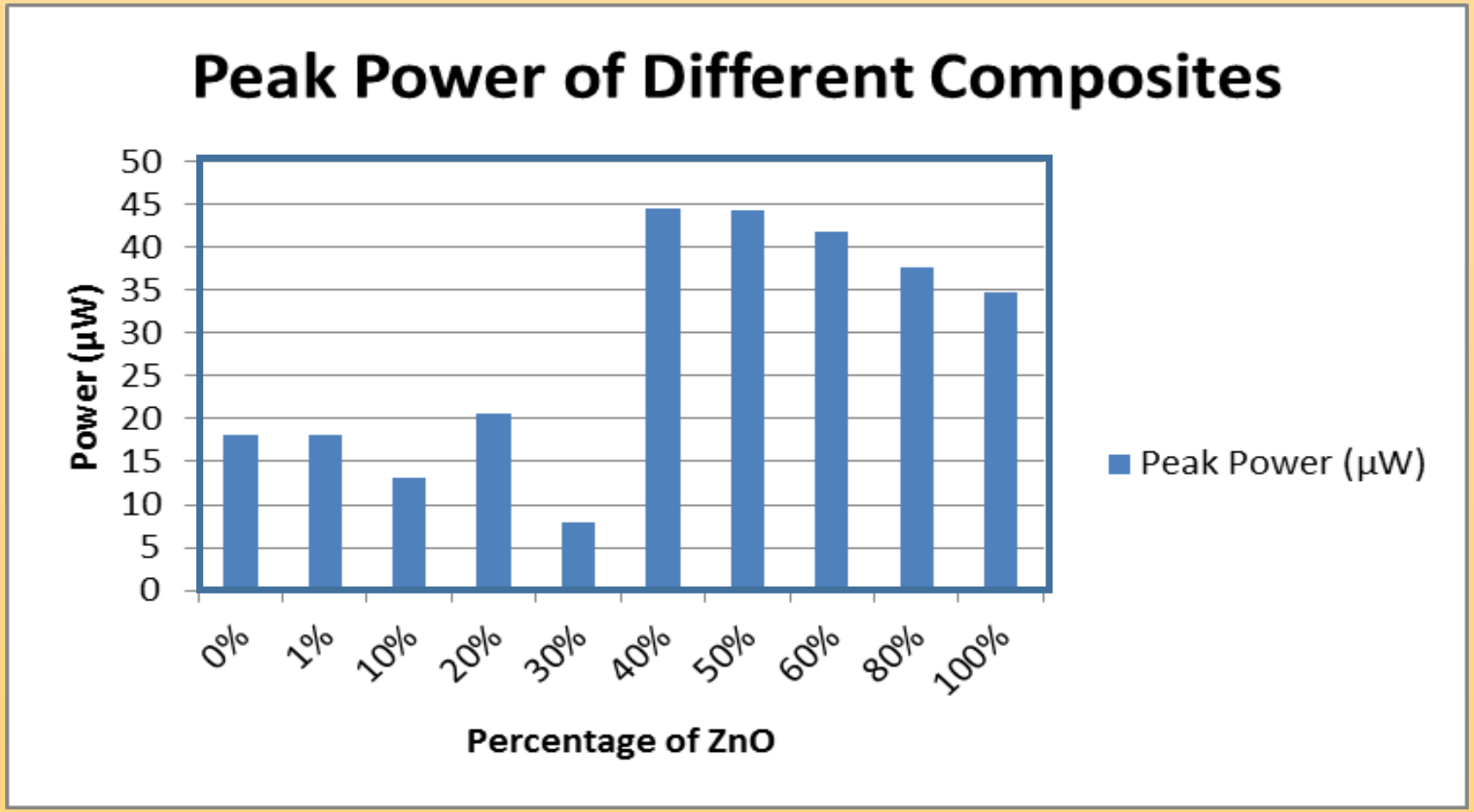


Sample Results for the Optimized Coating

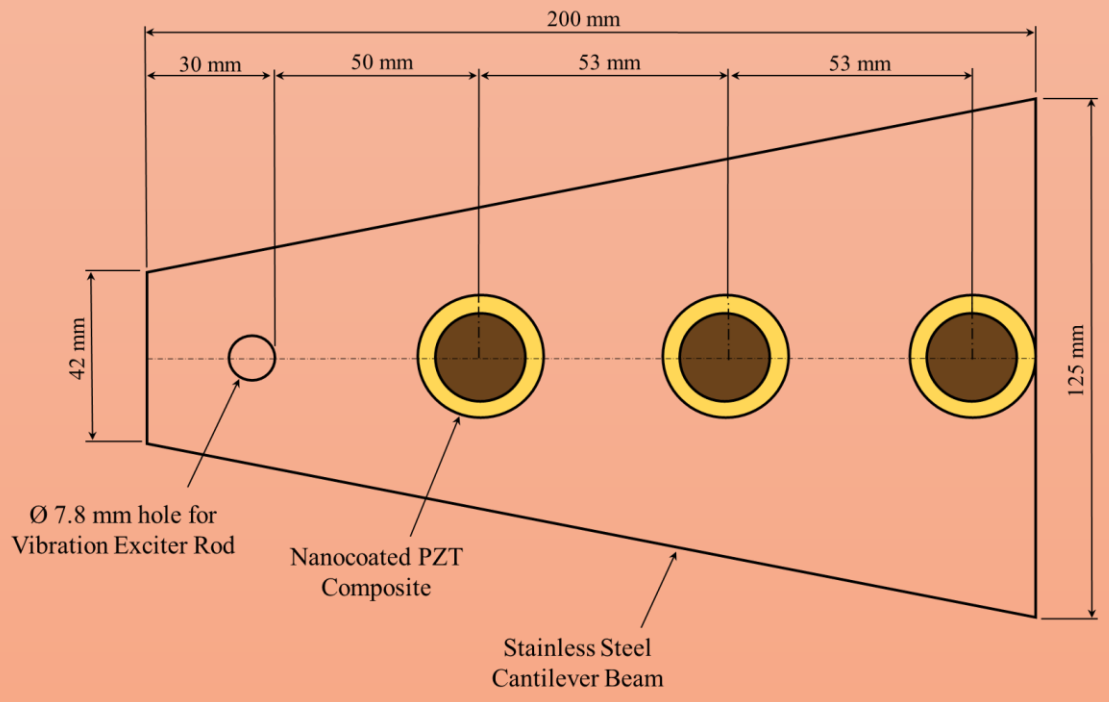


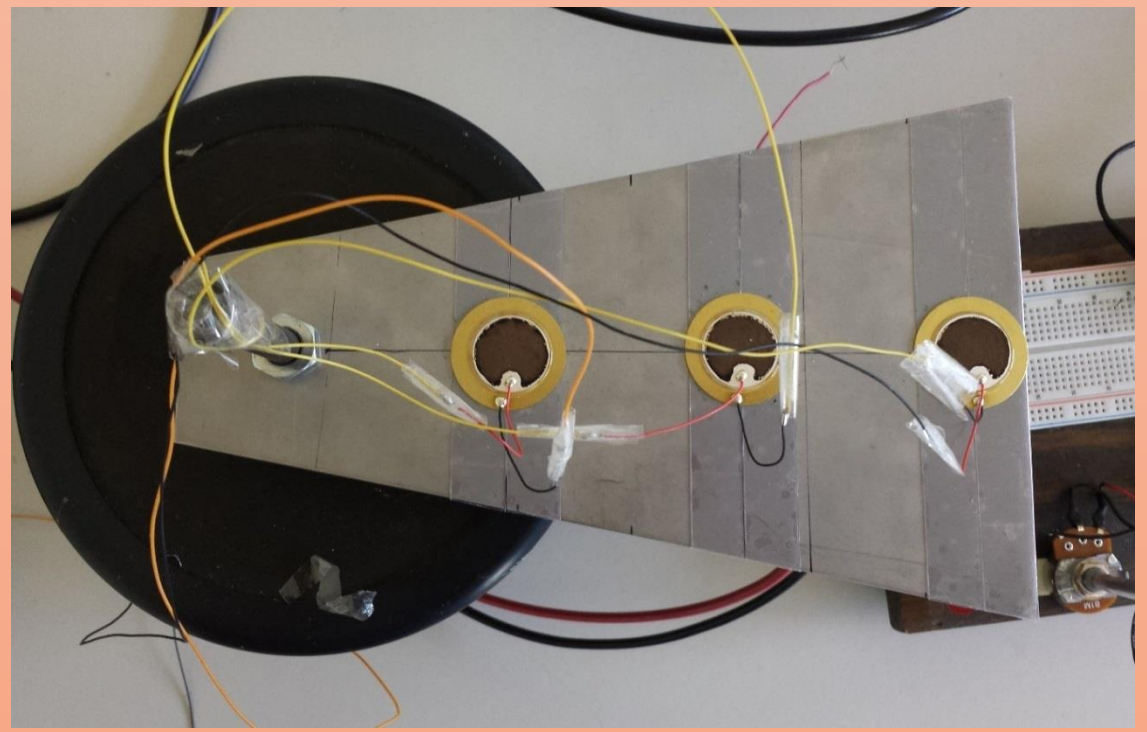
Three Power peaks were identified with maximum at 45 microwatt at 90 Hz

Optimization of the Coating Mixture to Improve the PZT Energy Harvesting Capability

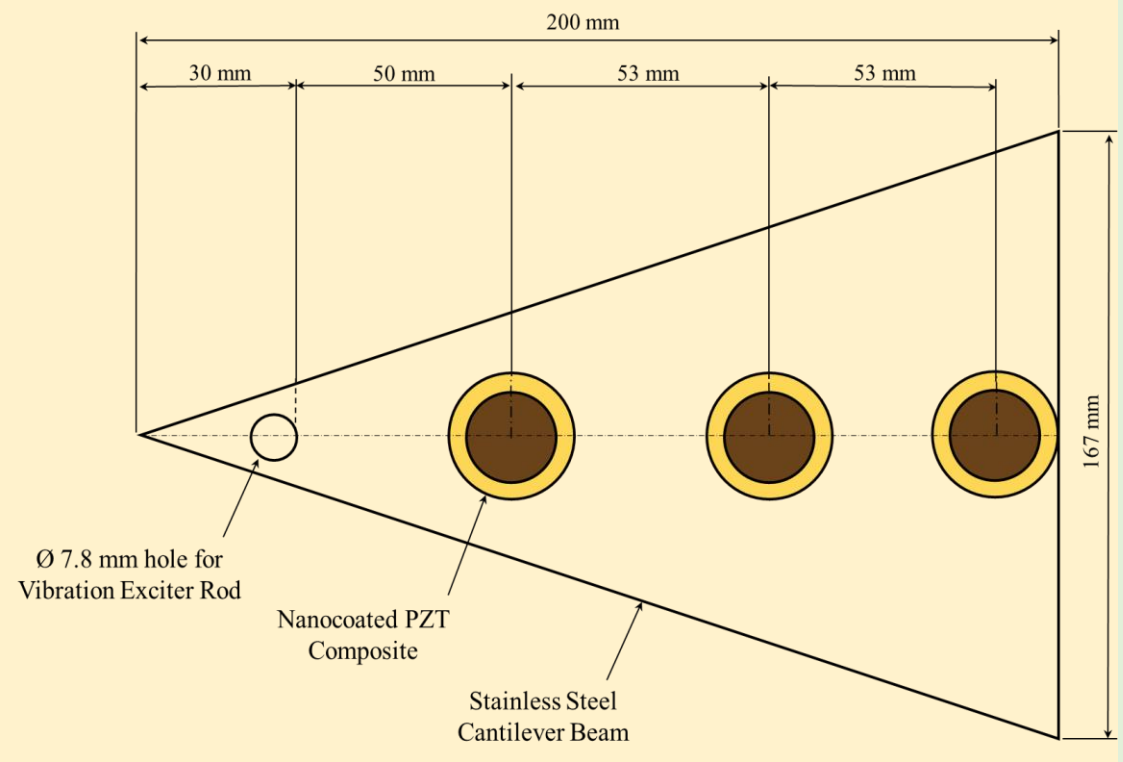


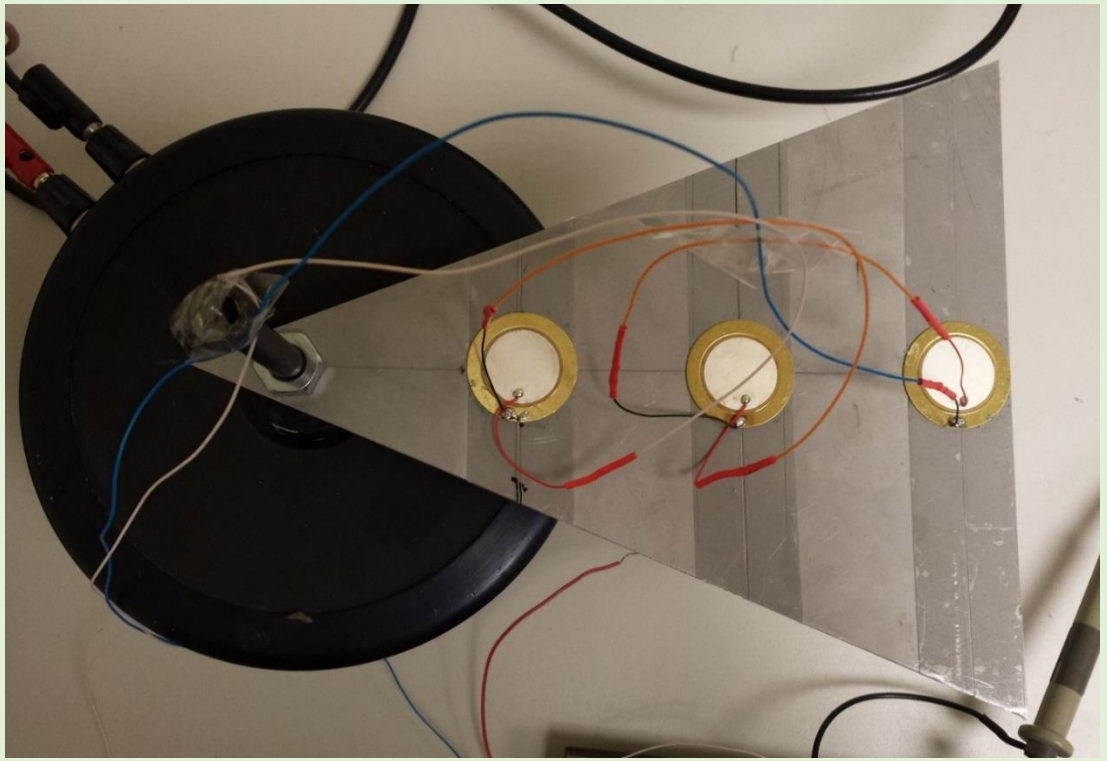
Trapezoidal Stainless Steel Cantilever Beam with Three Nano Coated PZT Composites.



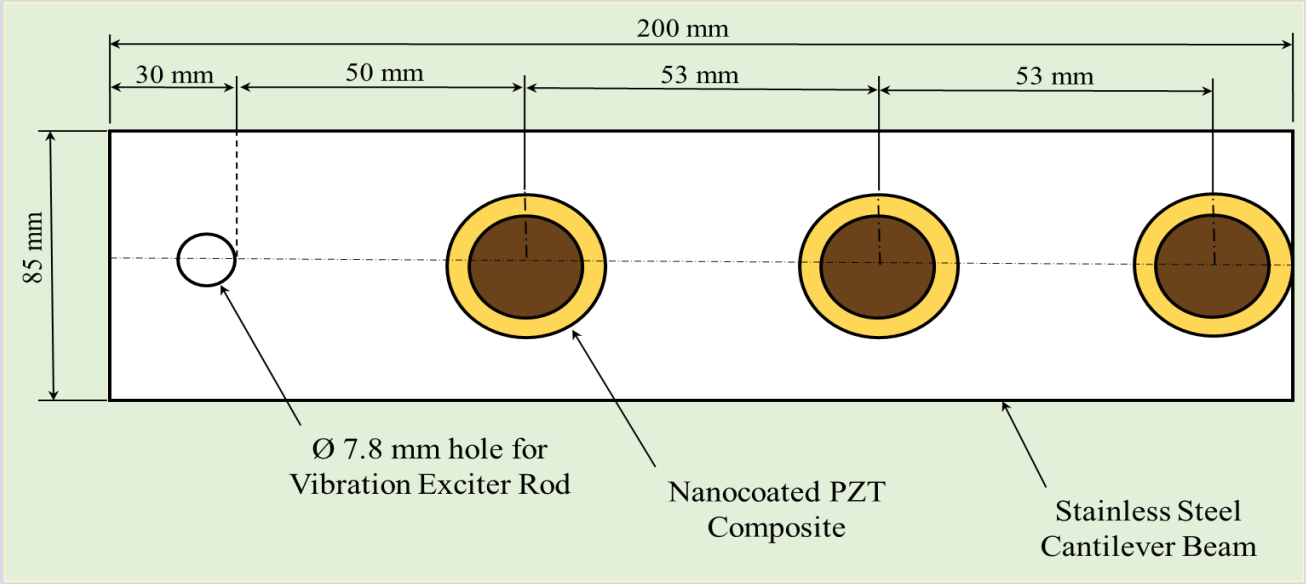


Triangular Stainless Steel Cantilever Beam with Three Uncoated PZT Composites.





Rectangular Stainless Steel Cantilever Beam with Three Nano Coated PZT Composites.



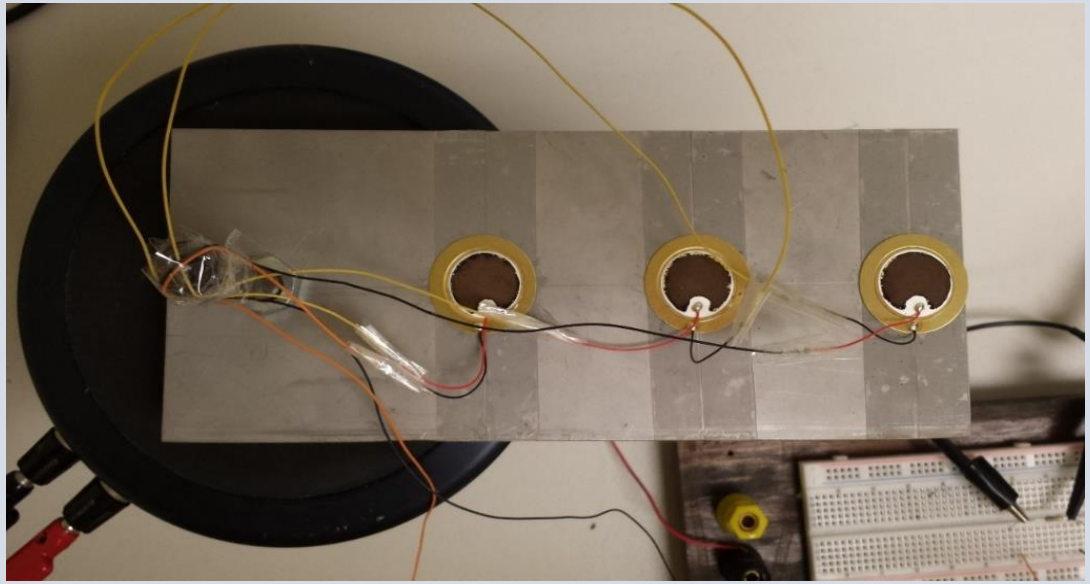
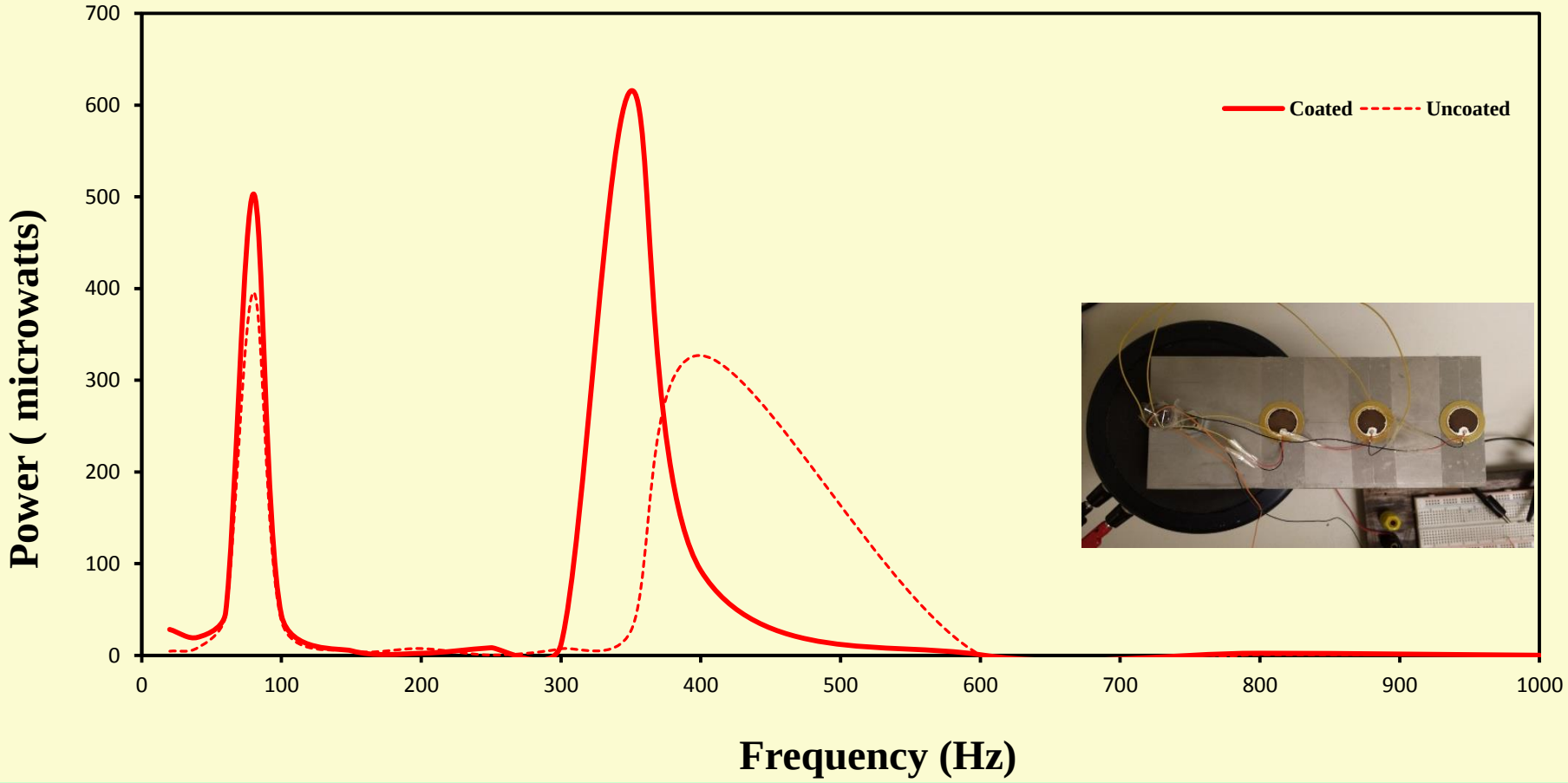


Table 1 - Rectangular Steel Plate Cantilever Energy Harvesting Data with Uncoated and Coated PZT

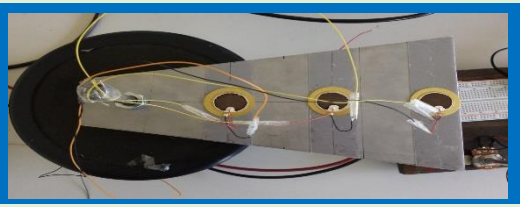
S.No.	Frequency (Hz)	Resistance (megaohm)	Uncoated Multi PZT Cantilever System		Coated Multi PZT Cantilever System	
			Voltage (volt)	Power (microwatt)	Voltage (volt)	Power (microwatt)
1	20	1	2.125	4.516	5.316	28.260
2	40	1	2.893	8.369	4.439	19.705
3	60	1	6.624	43.877	6.811	46.390
4	80	1	**19.890**	**395.612**	**22.430**	**503.105**
5	100	1	6.058	36.699	6.615	43.758
6	150	1	2.281	5.203	2.253	5.076
7	200	1	2.725	7.426	1.510	2.280
8	250	1	0.640	0.410	2.887	8.335
9	300	1	2.683	7.198	3.488	12.166
10	350	1	5.179	26.822	**24.810**	**615.536**
11	400	1	**18.080**	**326.886**	9.615	92.448
12	600	1	0.664	0.441	0.842	0.709
13	800	1	0.858	0.736	1.533	2.350
14	1000	1	0.662	0.438	0.361	0.130

Comparison of Harvested Energy from coated and uncoated 3 PZT Arrays on a Rectangular Cantilever plate



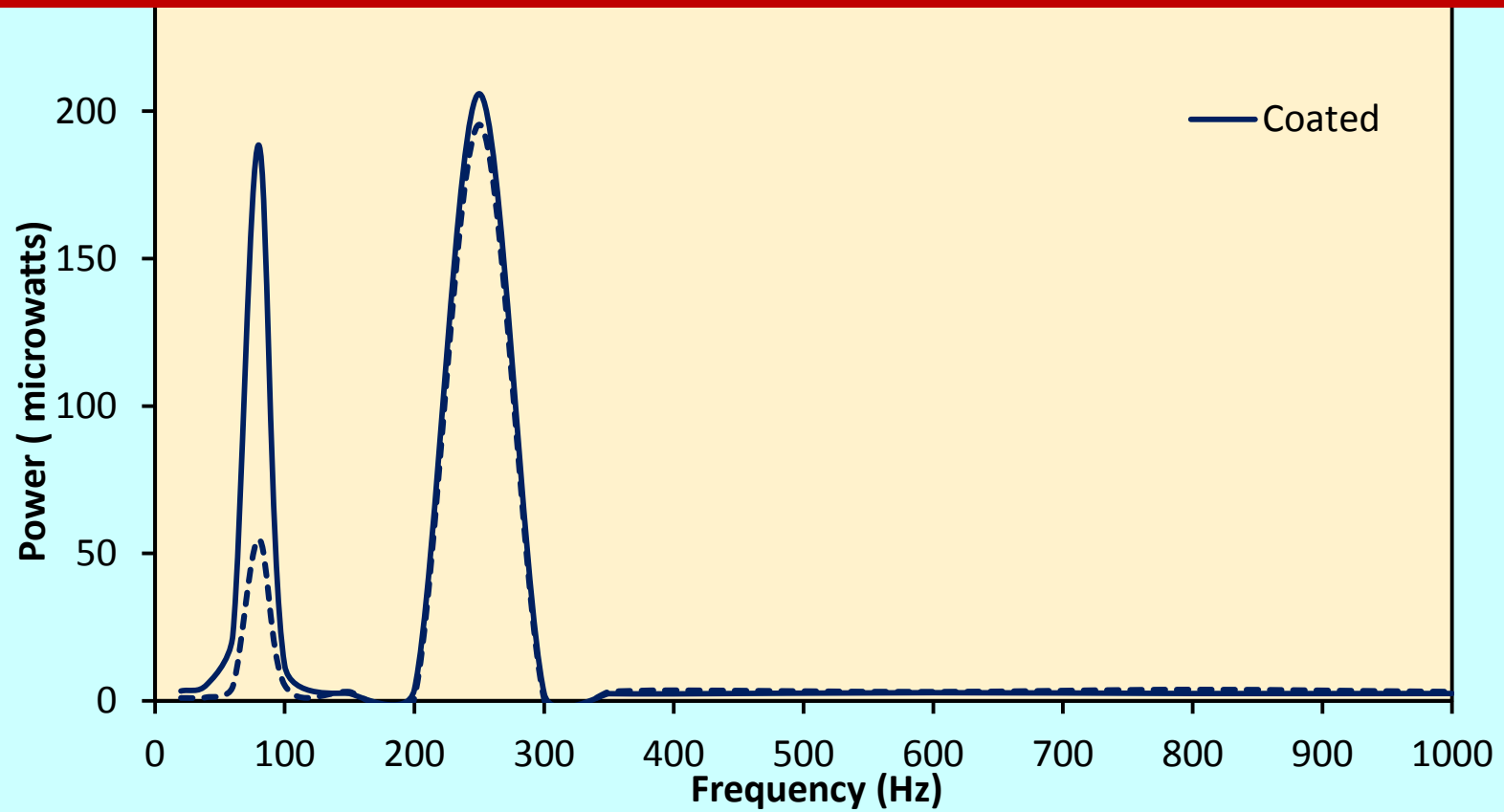
Energy Harvested Profiles as a function of frequency with coated and uncoated PZT

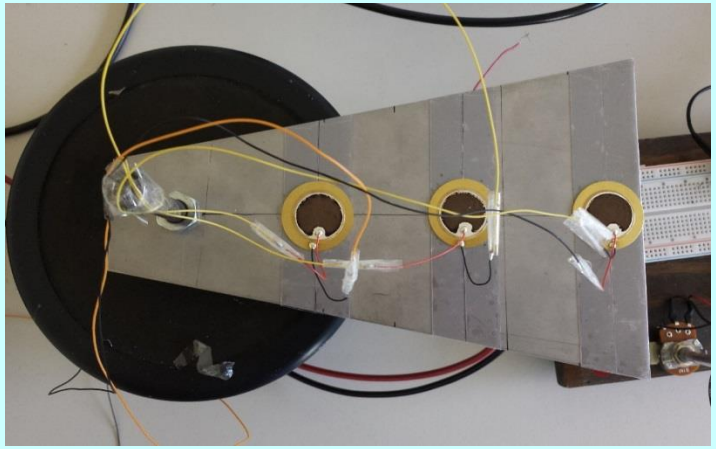
Table Showing Energy Harvesting data from Trapezoidal Steel Cantilever plate for Uncoated and Coated PZT



S.No.	Frequency (Hz)	Resistance (mega-ohm)	Uncoated multi PZT Cantilever System		Coated multi PZT Cantilever System	
			Voltage (volt)	Power (microwatt)	Voltage (volt)	Power (microwatt)
1	20	1	0.981	0.962	1.824	3.327
2	40	1	1.108	1.228	2.351	5.527
3	60	1	2.217	4.915	4.705	22.137
4	80	1	7.400	54.760	13.730	188.513
5	100	1	2.300	5.290	3.466	12.013
6	150	1	1.744	3.042	1.579	2.493
7	200	1	1.004	1.008	1.958	3.834
8	250	1	13.980	195.440	14.350	205.923
9	300	1	0.740	0.548	1.612	2.599
10	350	1	1.749	3.059	1.555	2.418
11	400	1	1.885	3.553	1.535	2.356
12	600	1	1.748	3.056	1.661	2.759
13	800	1	1.950	3.803	1.575	2.481
14	1000	1	1.752	3.070	1.574	2.477

Energy Peaks for coated and uncoated 3 PZT Arrays during vibration of Steel Trapezoidal Cantilever System for frequencies between 0 to 1000Hz



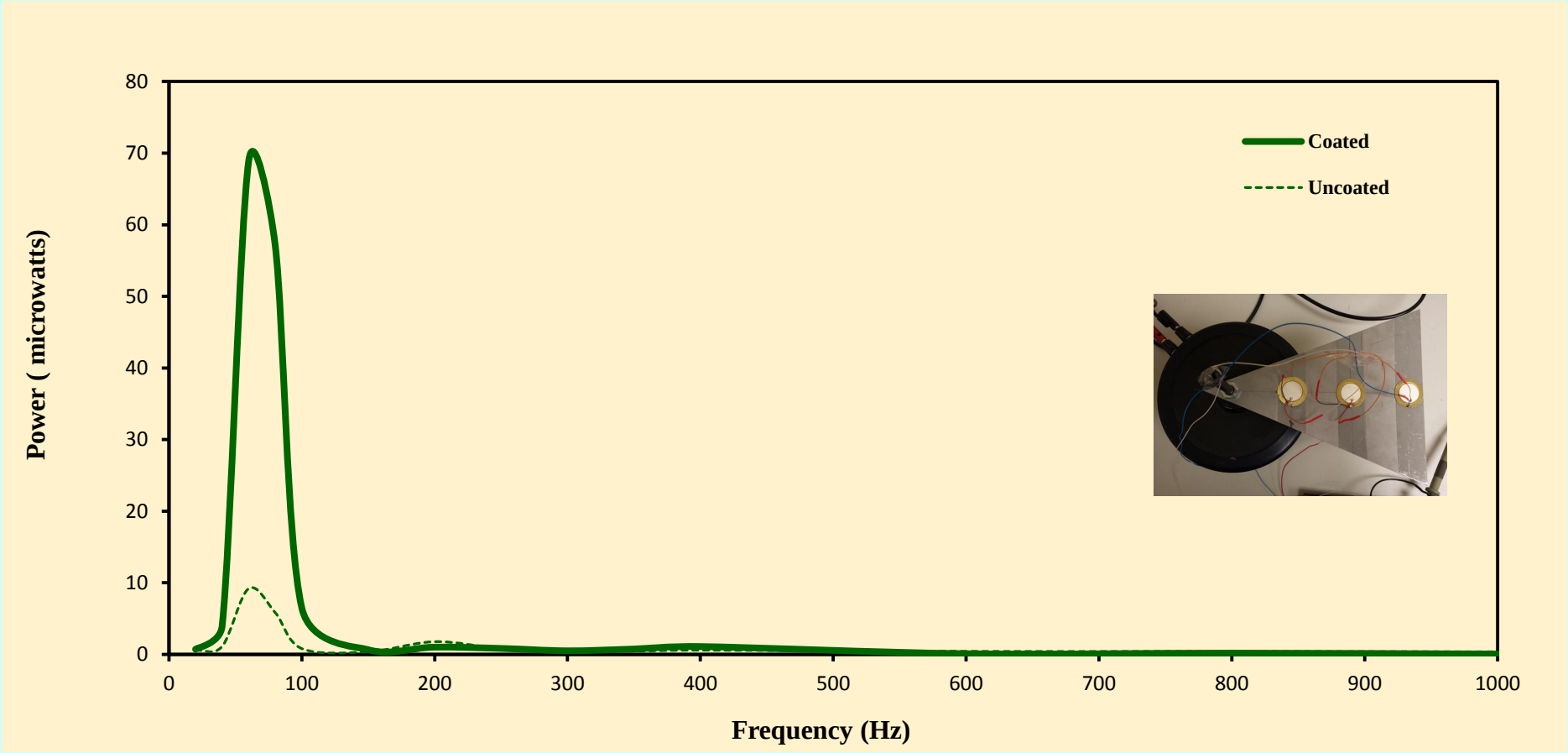


Energy peaks at 80 Hz and at 250 Hz

Energy Harvesting from 3 Piezo arrays on a triangular Steel Plate Cantilever vibration in the range of 0-1000 Hz showing maximum between Hz

S.No.	Frequency (Hz)	Resistance (megaohm)	Uncoated multi PZT Cantilever System		Coated multi PZT Cantilever System	
			Voltage (volt)	Power (microwatt)	Voltage (volt)	Power (microwatt)
1	20	1	0.732	0.536	0.844	0.712
2	40	1	1.051	1.105	1.983	3.932
3	60	1	3.030	9.181	8.300	68.890
4	80	1	2.410	5.808	7.556	57.093
5	100	1	0.887	0.787	2.544	6.472
6	150	1	0.585	0.342	0.806	0.650
7	200	1	1.327	1.761	1.007	1.014
8	250	1	0.880	0.774	0.911	0.830
9	300	1	0.641	0.411	0.706	0.498
10	350	1	0.658	0.433	0.863	0.745
11	400	1	0.758	0.575	1.045	1.092
12	600	1	0.637	0.406	0.301	0.091
13	800	1	0.619	0.383	0.413	0.171
14	1000	1	0.584	0.341	0.212	0.045

Energy Harvesting profiles of Uncoated and Coated Multi (3) PZT array on Triangular shaped Steel Cantilever System at Different Frequencies.



Three Coated PZT in series shows only one peak for energy at 70 microwatts almost 7 times more than that of uncoated PZT

CONCLUSION

Different cases has been used to check if the coating does help in improving energy harvesting energy as compared to that of noncoated PZT

Case 1: Rectangular plate: the maximum peak power percentage increased 155%

Case 2: Trapezoidal plate: the maximum peak power percentage increase 292%

Case 3: Triangular plate: the maximum peak power percentage change 700%

All these cases suggests that there is an increase in energy harvesting due to the special coating

ACKNOWLEDGEMENT

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