UNIVERSITI MALAYSIA TERENGGANU

UMT

OfficialUMT

A Patternless Piezoelectric Energy Harvester for Ultra Low Frequency Applications

TEROKAAN SELUAS LAUTAN DEMI KELESTARIAN SEJAGAT OCEAN OF DISCOVERIES FOR GLOBAL SUSTAINABILITY

Universiti Malaysia Terengganu
UMT
OfficialUMT

By

M. R. Awal, M. Jusoh, T. Sabapathy, R. B. Ahmad, M. R. Kamarudin, M.N. Osman, M F. Ahmad, S. A. Rahman, and A. N. Dagang

Faculty of Ocean Engineering Technology and Informatics

Universiti Malaysia Terengganu (UMT)

Contents

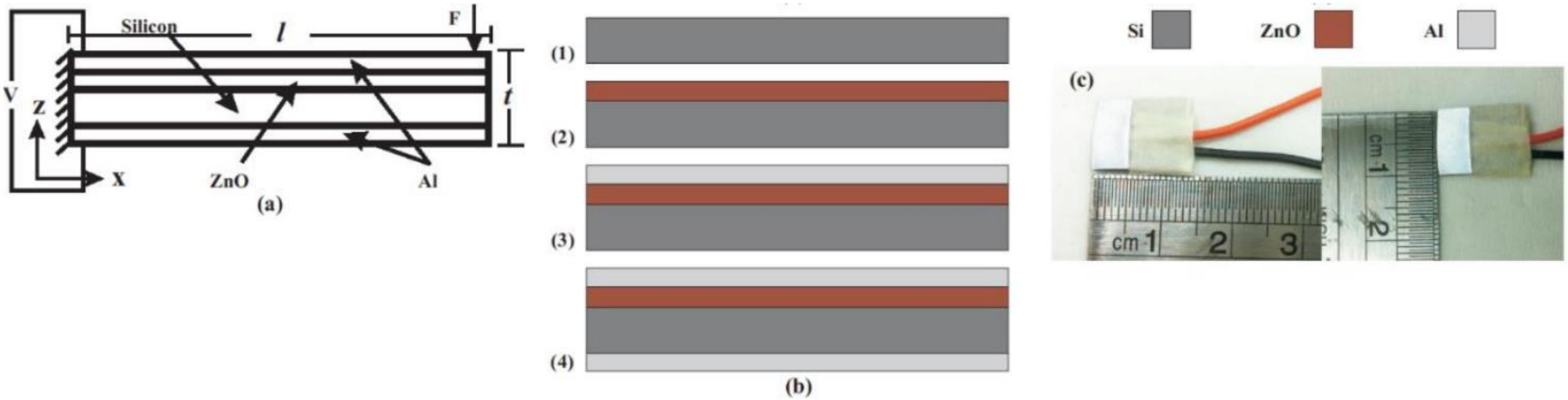
Introduction

- Patterned energy harvester results additional cost and steps.
- Most of the piezoelectric element with high efficiency are not environment friendly.
- Dual energy harvesting device is desired to harvest vibration and pressure energy.
- Low profile, Environment friendly competitive piezoelectric elements are desired.

Why This Proposal?

- ❖ **Pattern less harvester can reduce the processing steps.**
- ❖ **Simple sandwiched configuration can cause less cost.**
- ❖ **Rigid structure can be applied to several applications.**
- ❖ **Low frequency energy harvesting.**

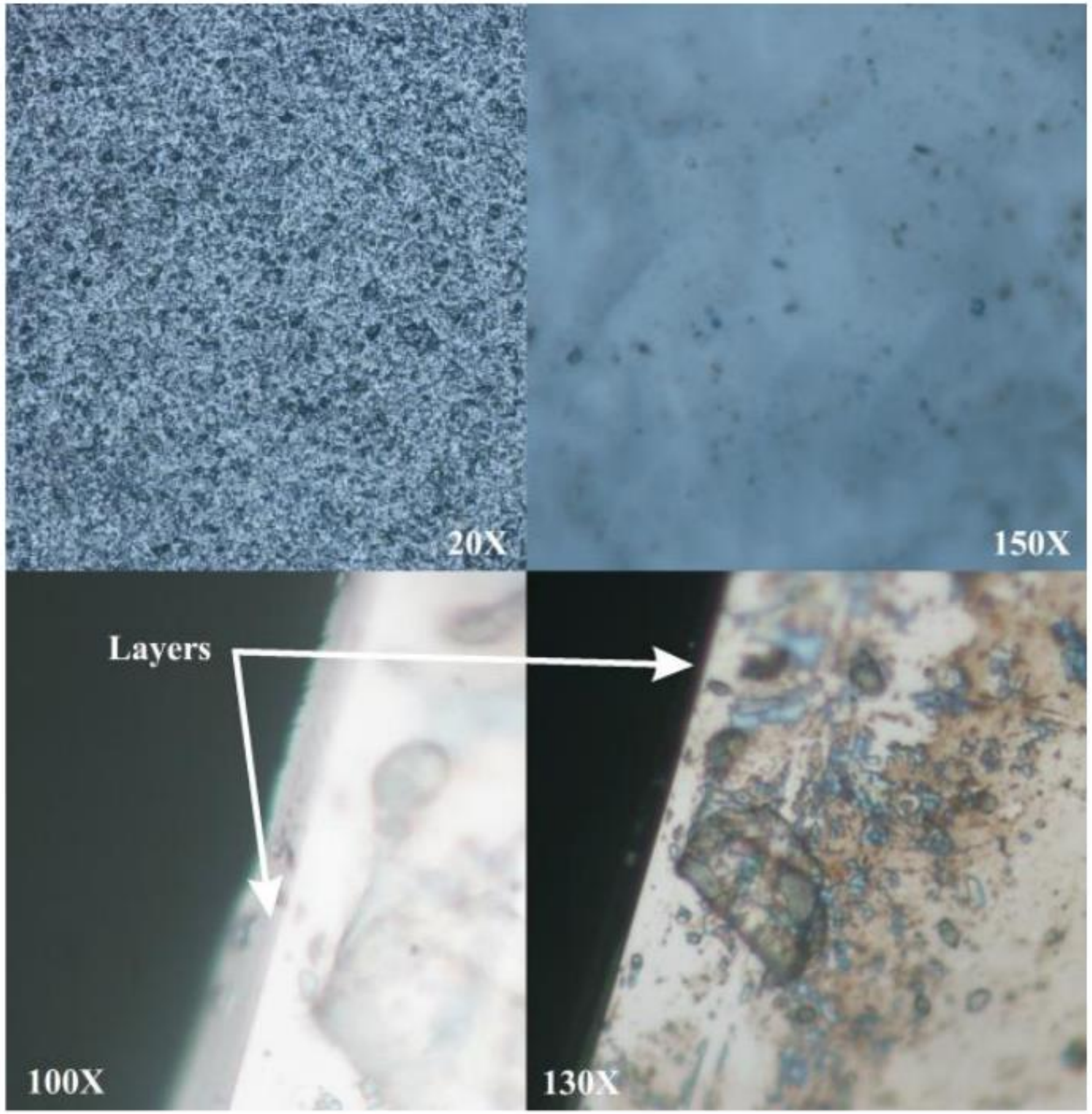
Fabrication



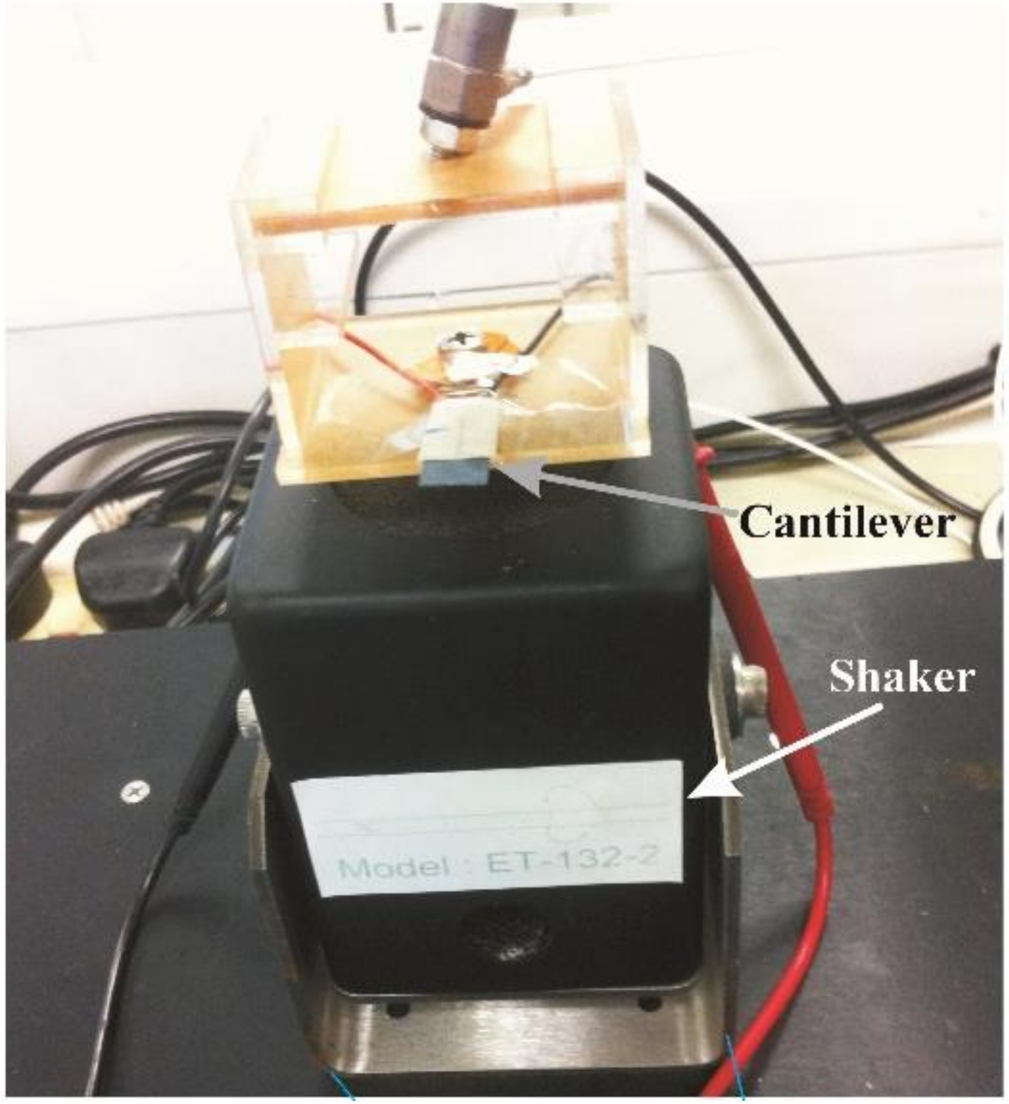
Proposed cantilever (a) classical descriptions, (b) fabrication process of cantilever beam, (c) fabricated cantilever (12 × 10 × 0.5009 mm)

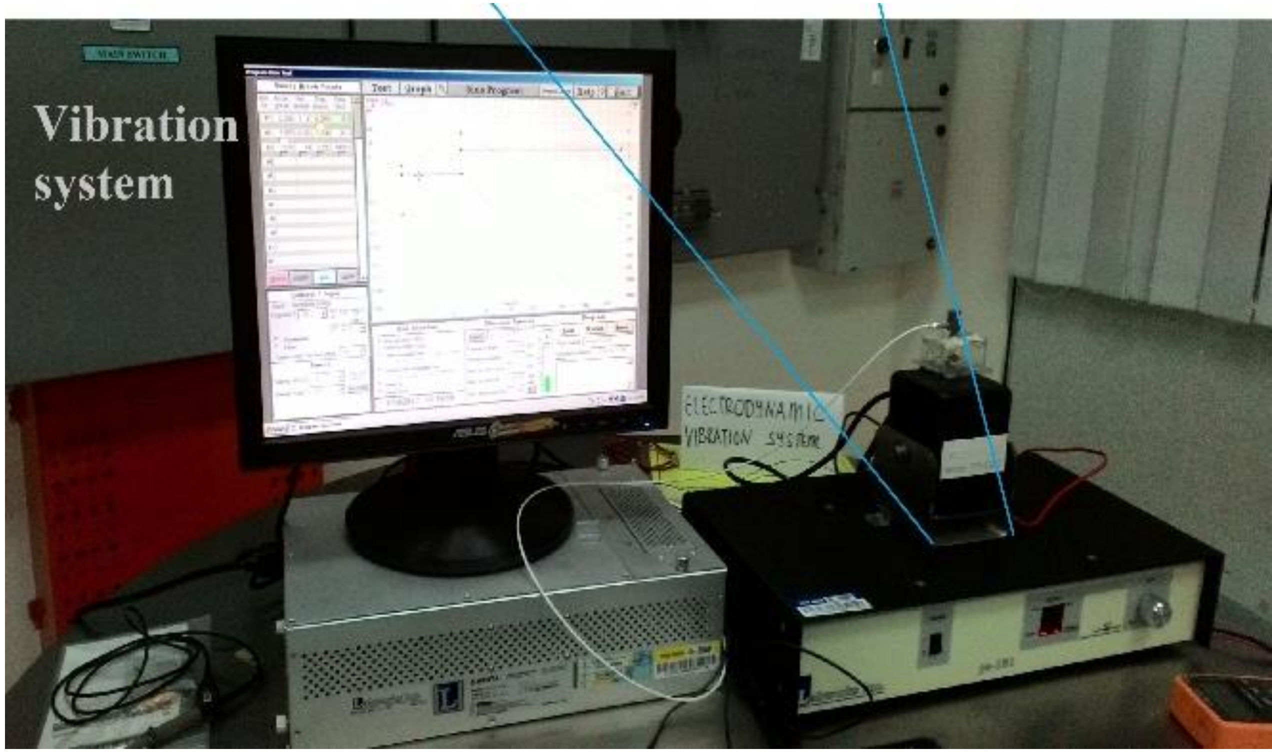
Fabrication cont…

Microscopic photograph of the deposition layers, deposited aluminum surface (top), ZnO and Al layers of the cantilever (bottom)



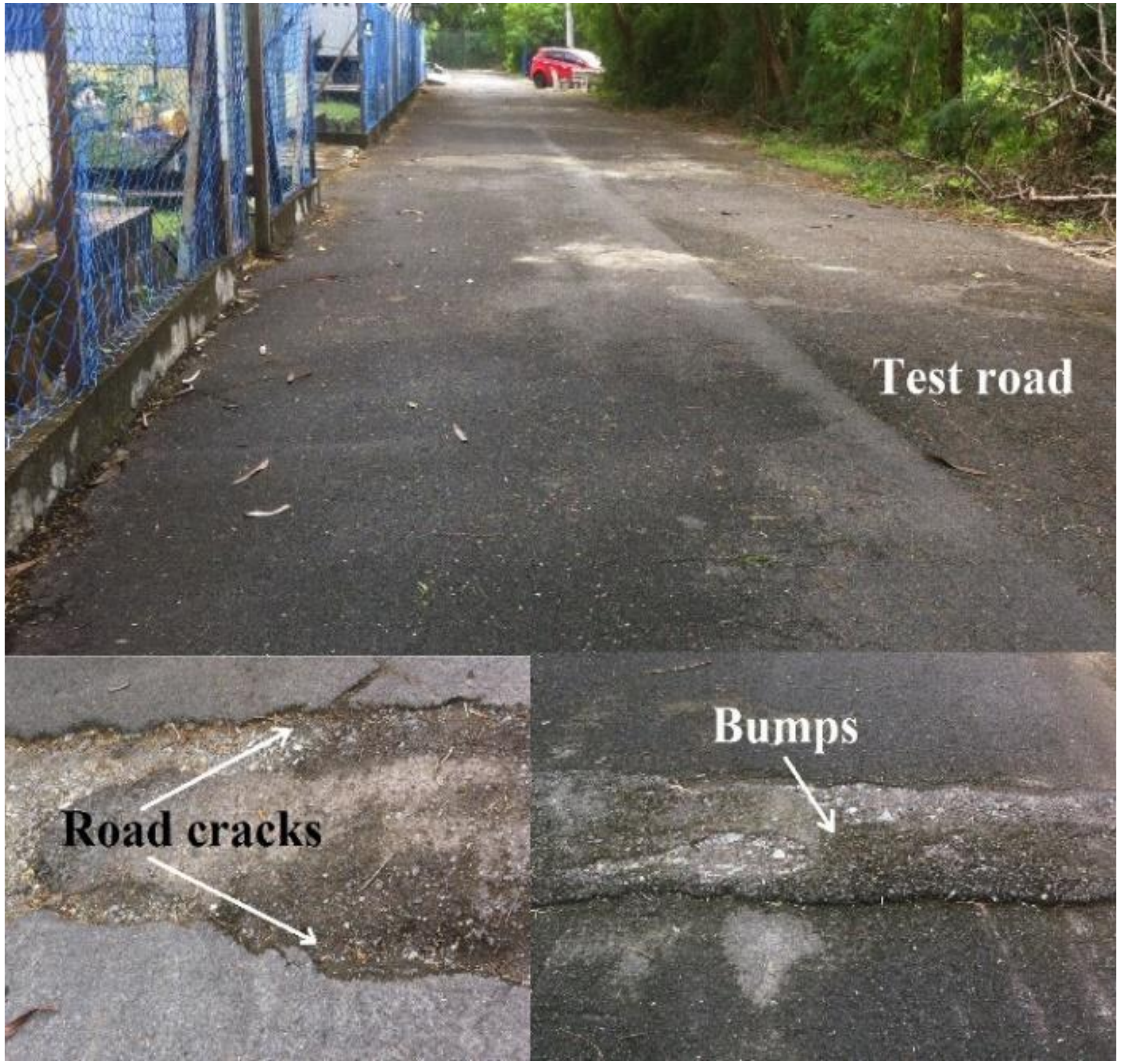
Experimental Setup: Indoor



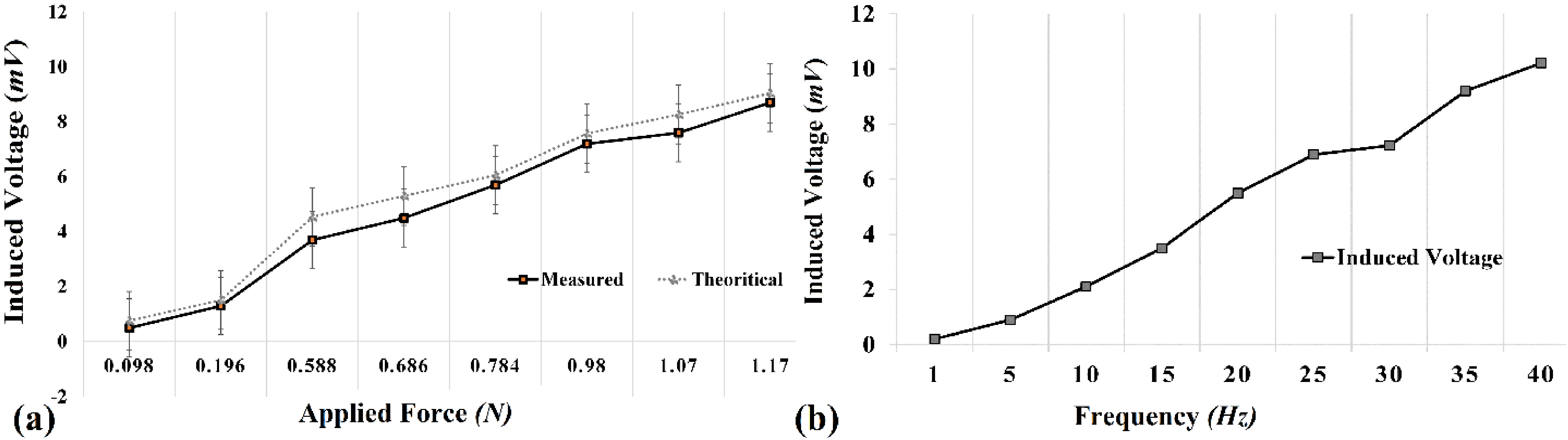


Experimental Setup: Outdoor

Test Road

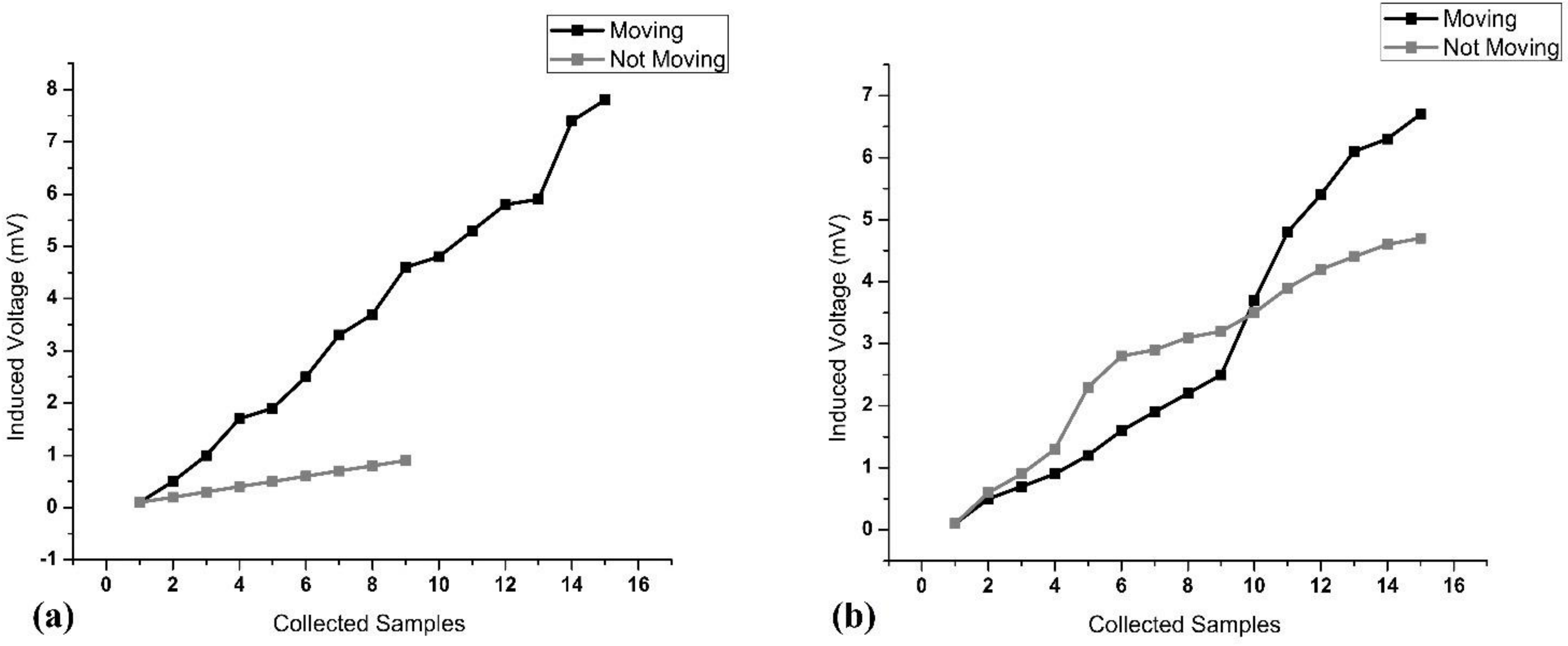


Performance



(a) Induced voltage vs. applied force, (b) Induced voltage vs. applied frequency

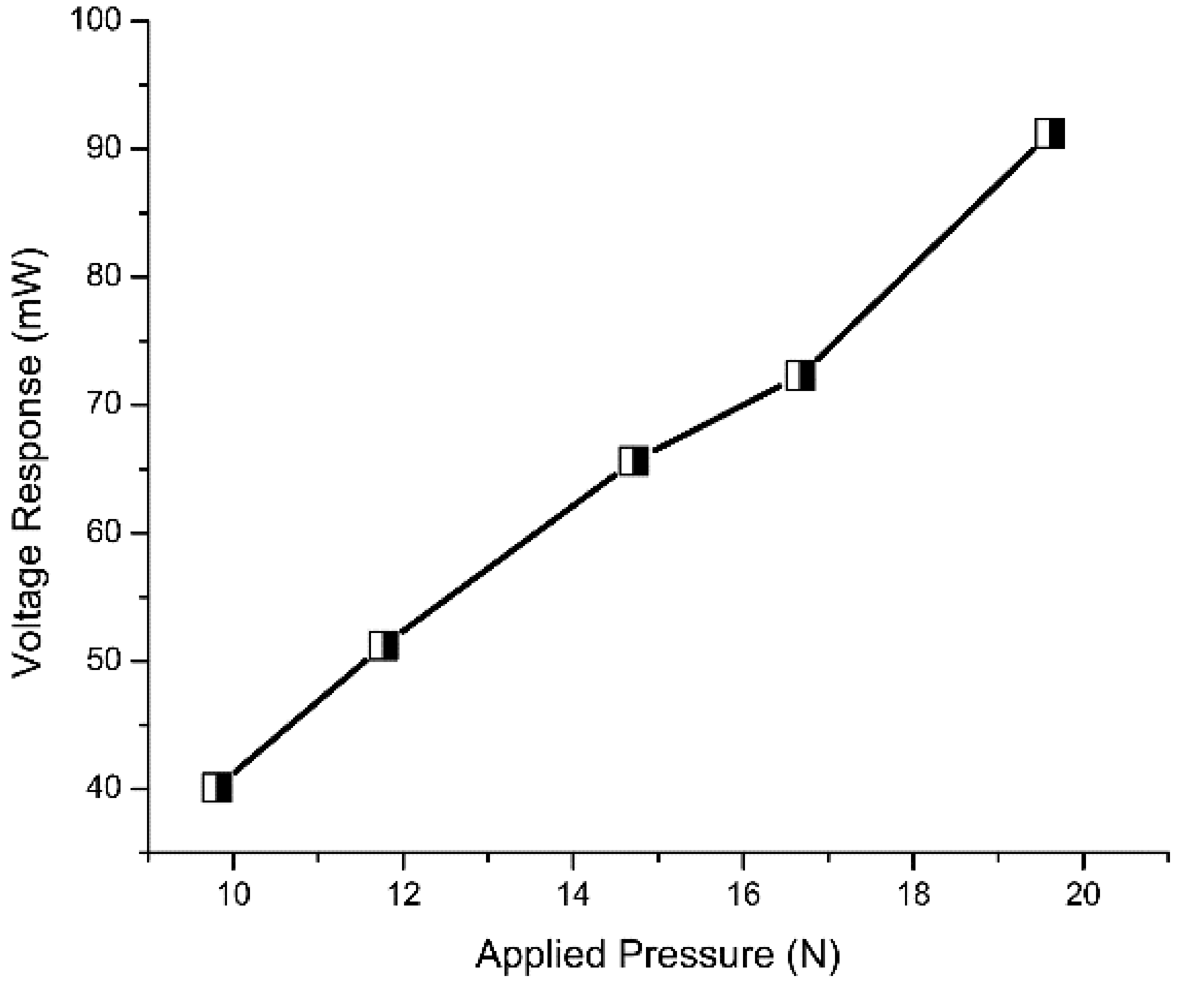
Performance cont…



(a) Induced voltage vs. applied force, (b) Induced voltage vs. applied frequency

Performance cont…

Voltage response under applied force



Performance cont…

Table 2 - Applied force response

Applied force (*N*)	Voltage response (*mV*)
9.81	40.1
11.77	51.2
14.71	65.6
16.67	72.3
19.61	91.2

Performance Summary

Table 3 - Summary of device comparison

Reference	Induced Voltage in <50 Hz	Materials	Device Dimension	Voltage Density (mV/mm^3)
[21]	≈ 4.5 V	PZT-5H	$115.25\times5.28\times0.45$ mm^3	16.43
[22]	≈ 13 V	Hybrid Piezoelectric	≈ 8466.59 mm^3	≈1.535
This work	≈ 91.2 mV	ZnO	≈$12\times10\times0.5009$ mm^3	1.517
[24]	≈ 4.9 V	Piezoelectric	$160\times85\times85$ mm^3	$4.238\times10-3$
[18]	280 mV	PZT Film	10×10 mm^2	2.8 (mv/ mm^2)
[25]	< 100 mV	ZnO Film	1 cm^2	1 (mv/ mm^2)
[16]	NA	PbZr0.52Ti0.48O3	0.6 mm^3	NA
[19]	NA	ZnO	$500\times100\times0.3$ μm^3	NA
[20]	NA	ZnO Film	50×50 mm^2	NA
[17]	0 mV	Piezoelectric	2039.68 mm^3	NA
[23]	NA	ZnO Film	$14.5\times14.5\times0.5$ mm^3	NA

Conclusions

- The harvester can produce voltage as high as 91.2 mV with 19.61 N applied force.
- With prescribed frequencies, the induced voltage can be as high as 10.21 mV.
- The device can harvest ultra low frequency (1 Hz - 40 Hz) vibration energy.
- Highly suitable for vibration energy harvesting.

Q & A

UNIVERSITI MALAYSIA TERENGGANU

UMT

TERIMA KASIH / *THANK YOU*

www.umt.edu.my

OfficialUMT