Documents

Asmadi, M.A.F.B.N., Ralib, A.A.M., Nordin, A.N., Saidin, N.B.

Finite Element Simulation of Single Zinc Oxide Nanorod for Piezoelectric Nanogenerator
(2023) *Proceedings - 2023 IEEE Regional Symposium on Micro and Nanoelectronics, RSM 2023*, pp. 138-141.

DOI: 10.1109/RSM59033.2023.10327222

International Islamic University, Kulliyyah of Engineering, ECE Department, Malaysia

Abstract
The growing demand for sustainable and clean energy sources has motivated the development of wearable energy harvesters for portable and wearable electronic devices. However, the use of bulky and hazardous batteries poses challenges in terms of size, flexibility, and environmental impact. This paper addresses these challenges by presenting a 3D finite element simulation of single Zinc Oxide (ZnO) nanorod that has potential application as a wearable energy harvester. The effect of varying the aspect ratio (diameter/length) of ZnO nanorods toward the generated output voltage was investigated. The relationship between the variation of applied force to the output voltage and displacement of the vibration was also presented. The analysis results revealed that increasing the aspect ratio of the single ZnO nanorod led to higher generated output voltages. Similarly, applying higher forces resulted in increased voltage output. The optimum design of the single ZnO nanorod that has the highest output voltage is D=30nm L=9000nm force=500nN. The simulation results also demonstrated that the length and diameter of the nanorods influenced the generated piezoelectric potential. © 2023 IEEE.

Author Keywords
aspect ratio; energy harvester; finite element simulation; Nanogenerator; output voltage; Zinc Oxide nanorod

Index Keywords
Environmental impact, Finite element method, II-VI
semiconductors, MEMS, Nanogenerators, Nanorods, Piezoelectricity, Wearable technology, Zinc oxide; Aspect-ratio, Clean energy sources, Energy Harvester, Finite elements simulation, Growing demand, Nanogenerators, Output voltages, Piezoelectric nanogenerator, Sustainable energy sources, Zinc oxide nanorods; Aspect ratio

Funding details
Asian Office of Aerospace Research and DevelopmentAOARDSPI21-082-0082

ACKNOWLEDGMENT This work was supported by the Asian Office of Aerospace Research and Development (AOARD) Sponsored Project (International) (SPI) Research Project SPI21-082-0082

References

- Chandrasekaran, S.
  Micro-scale to nano-scale generators for energy harvesting: Self powered piezoelectric, triboelectric and hybrid devices
  (2019) *Phys Rep*, 792, pp. 1-33.
- Fan, F.R., Tang, W., Wang, Z.L.
  Flexible nanogenerators for energy harvesting and self-powered electronics
  (2016) *Advanced Materials*, 28 (22), pp. 4283-4305.
- Briscoe, J., Dunn, S., Briscoe, J., Dunn, S.
  Nanostructured Materials
  (2014) *Nanostructured Piezoelectric Energy Harvesters*, pp. 19-55.
- Wang, Z.L.
  Zinc oxide nanostructures: Growth, properties and applications
  (2004) *Journal of Physics: Condensed Matter*, 16 (25), p. R829.
- Bahl, S., Nagar, H., Singh, I., Sehgal, S.
  Smart materials types, properties and applications: A review
  (2020) *Mater Today Proc*, 28, pp. 1302-1306.

- Izyumskaya, N., Alivov, Y.-I., Cho, S.-J., Morkoc, H., Lee, H., Kang, Y.-S.
  Processing, structure, properties, and applications of PZT thin films
  (2007) *Critical Reviews in Solid State and Materials Sciences*, 32 (3-4), pp. 111-202.

- Pawar, O.Y., Patil, S.L., Redekar, R.S., Patil, S.B., Lim, S., Tarwal, N.L.
  Strategic Development of Piezoelectric Nanogenerator and Biomedical Applications
  (2023) *Applied Sciences*, 13 (5), p. 2891.

- Jarjour, A., Cox, J.W., Ruane, W.T., Von Wenckstern, H., Grundmann, M., Brillson, L.J.
  Single metal ohmic and rectifying contacts to ZnO nanowires: A defect based approach
  (2018) *Ann Phys*, 530 (2), p. 1700335.

- Cha, X.
  Superhydrophilic ZnO nanoneedle array: Controllable in situ growth on QCM transducer and enhanced humidity sensing properties and mechanism
  (2018) *Sens Actuators B Chem*, 263, pp. 436-444.

- Tie, W.
  Facile synthesis of carbon nanotubes covalently modified with ZnO nanorods for enhanced photodecomposition of dyes
  (2019) *J Colloid Interface Sci*, 537, pp. 652-660.

- Xie, M., Zhang, D., Wang, Y., Zhao, Y.
  Facile fabrication of ZnO nanorods modified with RGO for enhanced photodecomposition of dyes
  (2020) *Colloids Surf A Physicochem Eng Asp*, 603, p. 125247.

- Ahmed, R., Kumar, P.
  (2023) *Determining the Most Efficient Geometry Through Simulation Study of ZnO Nanorods for the Development of High-performance Tactile Sensors and Energy Harvesting Devices*,
  arXiv preprint arXiv:230109370

- Abubakar, S.
  Controlled Growth of Semiconducting ZnO Nanorods for Piezoelectric Energy Harvesting-Based Nanogenerators
  (2023) *Nanomaterials*, 13 (6), p. 1025.
  Mar

- Sekimoto, H., Tamura, T., Goka, S., Watanabe, Y.
  (1987) *IEEE Standard on Piezoelectricity, ANSI/IEEE Standard 176 IEEE Standard on Piezoelectricity*,
  ANSI/IEEE Standard 176

- Hyland, M., Hunter, H., Liu, J., Veety, E., Vashaee, D.
  Wearable thermoelectric generators for human body heat harvesting
  (2016) *Appl Energy*, 182, pp. 518-524.

- Kholkin, A.L., Pertsev, N.A., Goltsev, A.V.
  Piezoelectricity and crystal symmetry
  Piezoelectric and Acoustic Materials for Transducer Applications, 2, pp. 17-38.

Correspondence Address
Asmadi M.A.F.B.N.; International Islamic University, Malaysia; email: adhwa1729131@gmail.com

Publisher: Institute of Electrical and Electronics Engineers Inc.

Conference name: 14th IEEE Regional Symposium on Micro and Nanoelectronics, RSM 2023
Conference date: 28 August 2023 through 30 August 2023
Conference code: 195010

ISBN: 9798350323689

Language of Original Document: English
Abbreviated Source Title: Proc. - IEEE Reg. Symp. Micro Nanoelectron., RSM
2-s2.0-85179851126
Document Type: Conference Paper
Publication Stage: Final
Source: Scopus