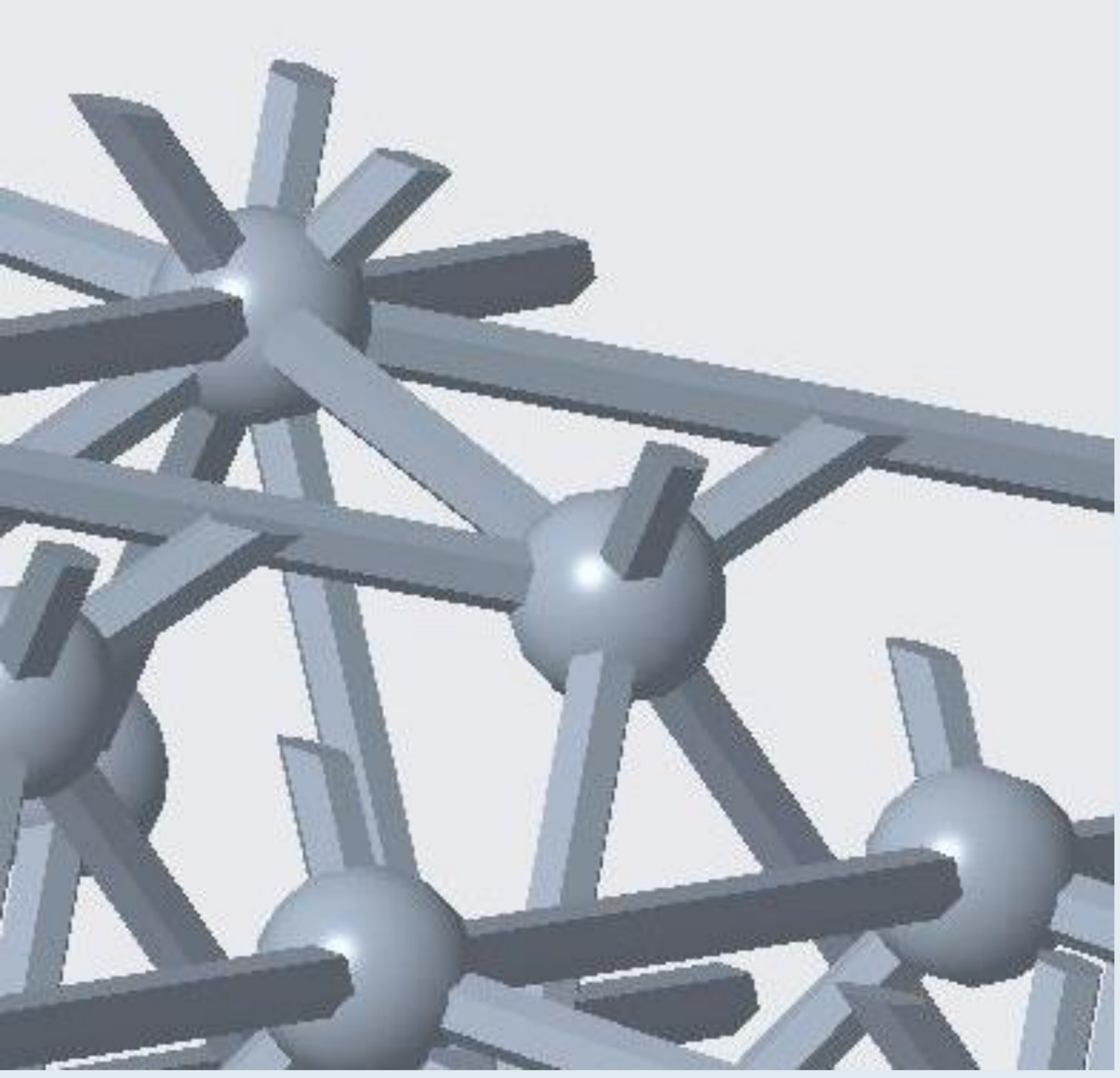

Beams-driven structures for piezoelectric energy harvesting/sensor and piezoelectric actuator

Eigen frequencies and frequency domain analysis of piezoelectric energy harvesters and actuators with various beam unit cell shapes, beam cross-sections, and piezoelectric materials using COMSOL multiphysics.

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Abstract

Piezoelectric energy harvesters have shown great promise as a way of powering small-scale electronic devices, such as sensors and monitoring equipment, in situations where battery replacement is costly or difficult. They can also be used to collect and process energy from the environment. The unique properties of piezoelectric materials make them useful in various applications, such as sensors, actuators, and energy harvesting. The current study presents different beams-driven structures for piezoelectric energy harvesting/sensor and piezoelectric actuator. The primary simulation studies consist of Eigen frequencies and frequency domain analysis of piezoelectric energy harvesters and actuators using COMSOL multiphysics. The various beam unit-cell shapes are considered hexagonal, square, and octagonal; reported the cell shape for optimum performance among the mentioned cell shapes. Furthermore, the impact of various beam cross-sections (circular, square, and hexagonal) on the output of piezoelectric energy harvesters and actuators is studied. Finally, parametric studies are performed on the piezoelectric materials for better performance.

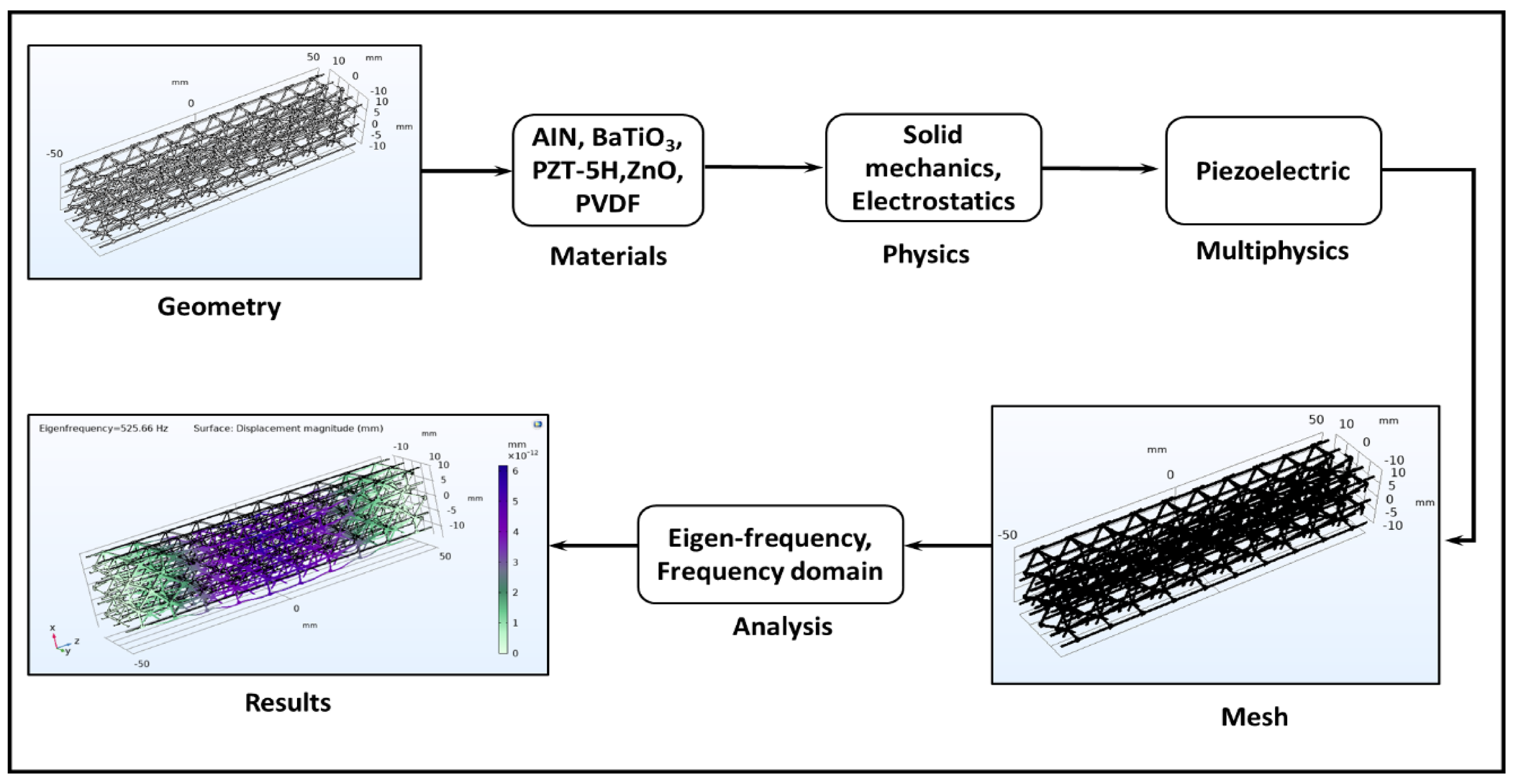

Figure 1. The flow chart of the step-by-step simulation procedure for COMSOL Multiphysics

Methodology

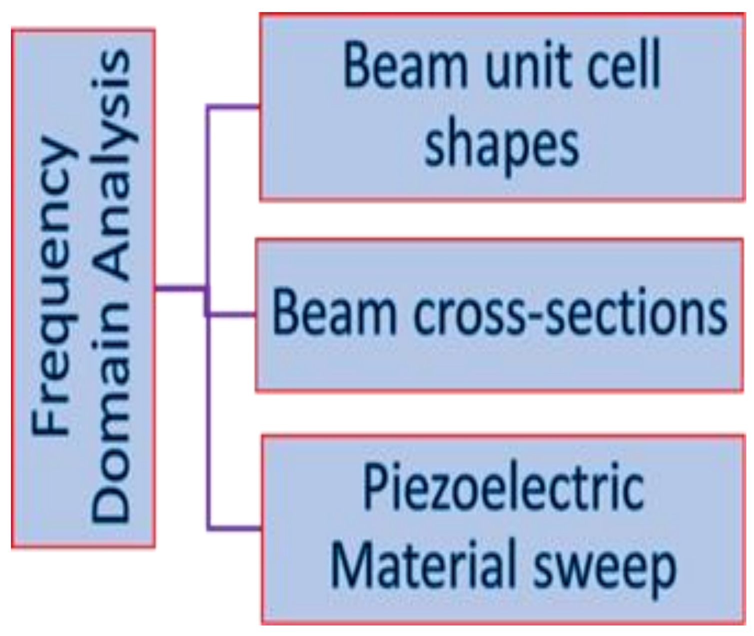

Figure 2. The frequency domain analysis of the system for different parameters.

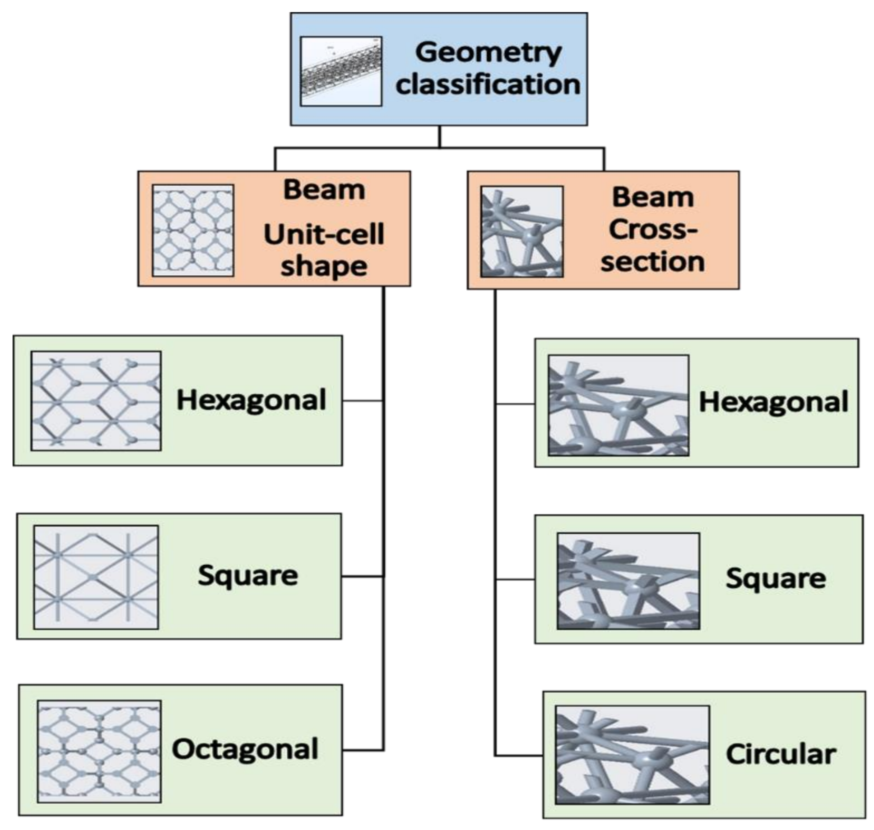

Figure 3. The various beam shapes and beam cross-sections of the structures.

Results

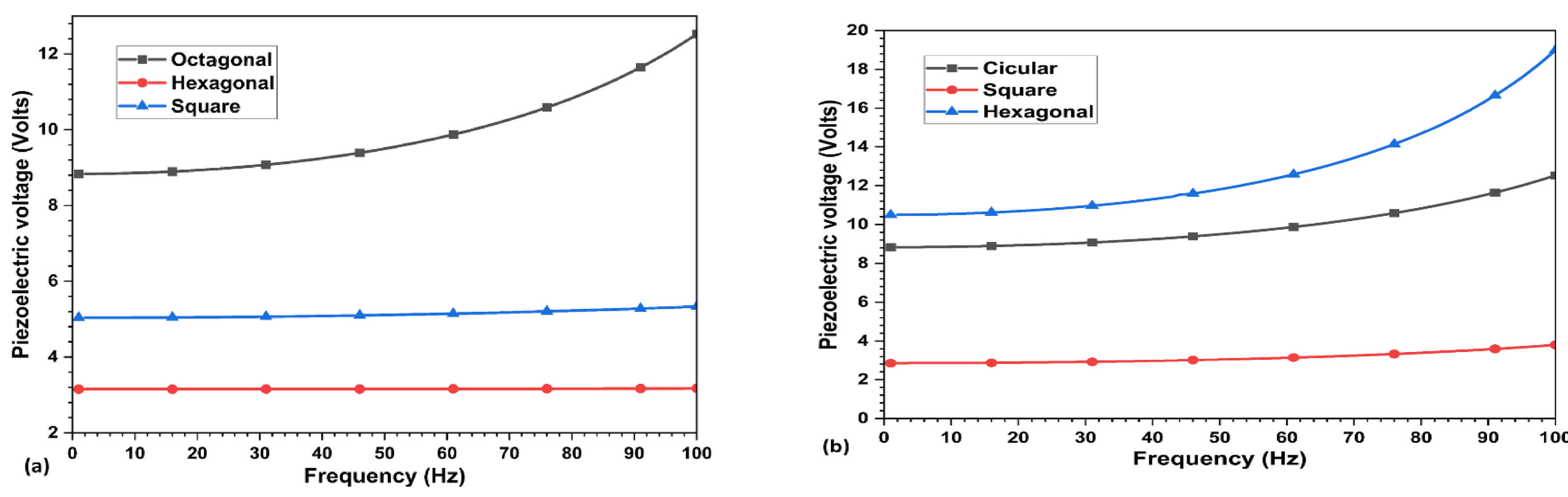

Figure 4. Voltage response of PEH (a) at various beam unit cells with circular beam cross-section, (b) at various beam cross-sections of the octagonal beam unit cell.

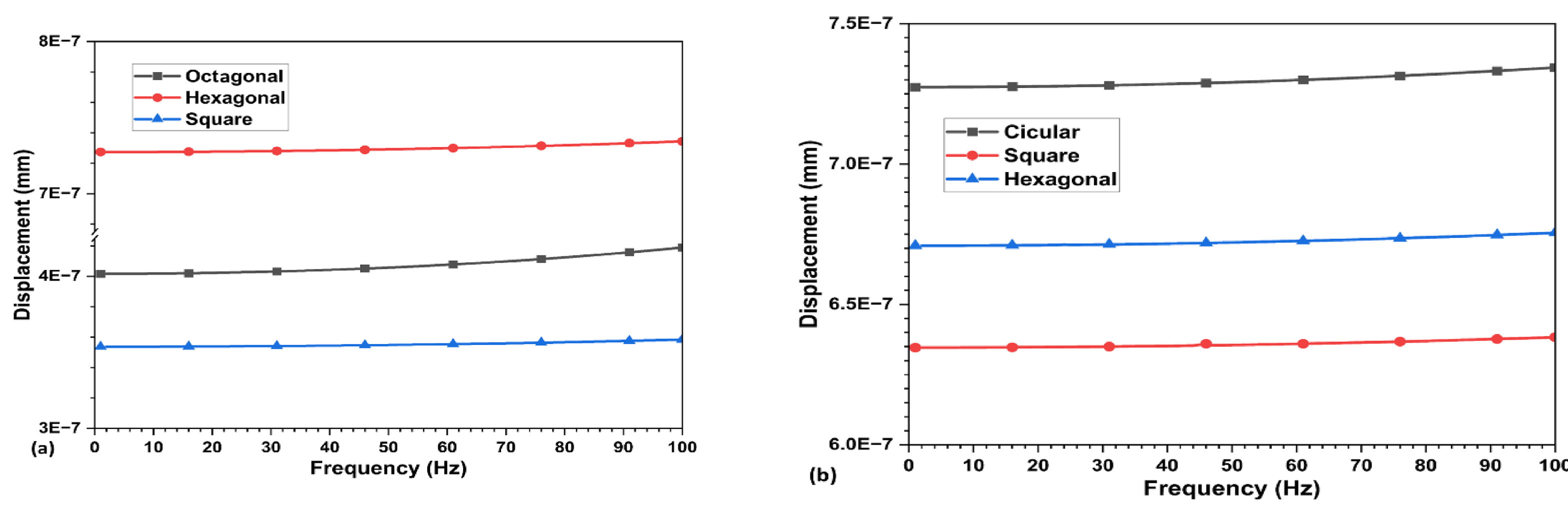

Figure 5. Dynamic response of PEA (a) at various beam unit cells with circular beam cross-section, (b) at various beam cross-sections of the hexagonal beam unit cell.

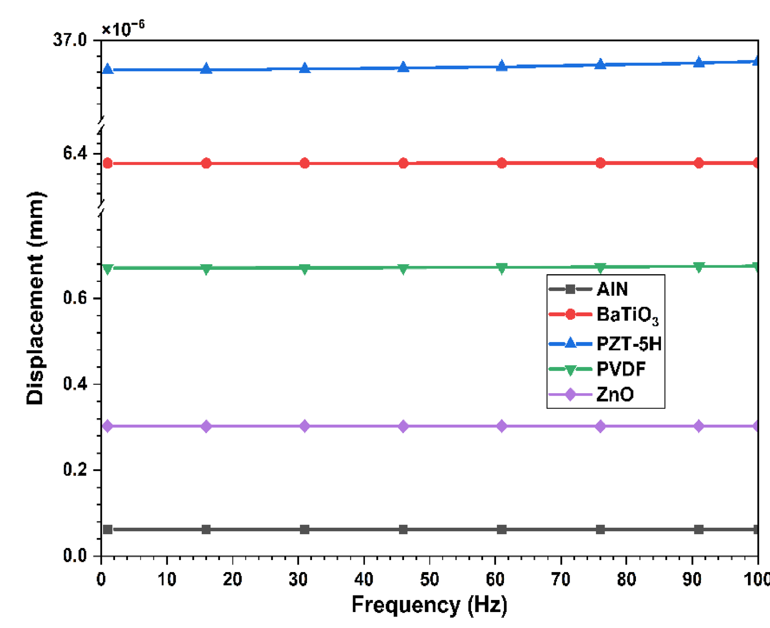

Figure 6. The dynamic response of a hexagonal beam unit cell with a circular beam cross-section PEA at various piezoelectric materials.

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[1] Upendra B, Panigrahi B, Sabareesh GR. Effect of geometric non-linearity and tip mass on the frequency bandwidth of a cantilever piezoelectric energy harvester under tip excitation. Physica Scripta. 2023 May 3;98(6):065203.

[2] Upendra, B., Panigrahi, B., Singh, K. and Sabareesh, G.R., 2023. Recent advancements in piezoelectric energy harvesting for implantable medical devices. Journal of Intelligent Material Systems and Structures, p.1045389X231200144.

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