Modeling of the Clamping Fixture of a Piezoelectric Cantilever-type Energy Harvesting Device

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Abstract

Over the last decade, ambient vibration energy harvesting by piezoelectric materials has been an area of extensive research. This technology enables to convert wasted mechanical energy available in our environment into useful electrical energy to power up autonomous wireless sensors supply, for structural health monitoring applications, or implantable medical devices.

The most common structure used in vibrational energy harvesting is a clamped/free piezoelectric bimorph cantilever beam, which is made up of two thinned-bulk piezoelectric layers separated with an inner shim material. To understand and predict the behavior of such a cantilever-based mechanical energy harvester, analytical and numerical models are developed.
In our work, the pursued goal is to build a three-dimensional (3D) finite element model (FEM) for the design of a cantilever-based mechanical energy harvester. To this end, the characterization of the piezoelectric material before its integration into a piezoelectric bimorph cantilever has been carried out.

This cantilever-based mechanical energy harvester is now simulated in vibration thanks to COMSOL Multiphysics® FEA software by using the Piezoelectric Devices interface of the Structural Mechanics Module and making a Frequency Domain study. As a discrepancy between simulation and measurement results is observed, different ways of modeling the clamping fixture of the beam are considered. In modal analysis, the study deals with configurations of increasing complexity, from the ideal clamped-free boundary condition up to the 3D FEM model of the fixing system imported from the CAD CAM integrated software TOPSOLID by using the CAD Import Module.
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