

Low Frequency MEMS Vibrational Energy Scavenging
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Abstract:

Vibrational energy scavenging utilizing ambient vibrational energy provides an excellent alternative to conventional battery technology for energizing low-power applications. Modeling and fabrication of a vibrational-based, piezoelectric, micro-power generator has been performed to scavenge commonly occurring low-level vibrational energy (~200 Hz) to generate voltage. It was expected that with a sufficient number of cantilevers in a die enough power can be generated from ambient vibrational energy to energize a miniaturized wireless system. The novelty of this work was to utilize a large array of piezoelectric cantilevers rather than a single element device, where each cantilever configuration is designed to resonate at a predefined external excitation frequency of 200Hz. Figure 1 shows the simulation results for the voltage generated at resonance mode for a single piezoelectric cantilever configuration. A voltage of 23 mV was generated across each cantilever. An array of over 500 cantilevers generates more than 10 V and 275 Hz. A 2µm thick piezoelectric layer of lead zirconate titanate (PZT) (Pb(Zr,Ti)O₃) has been deposited using a sol-gel deposition technique (PT/Pt/Cr/SiO₂/Si) where PT (lead-titanate) serves as the seed layer for PZT. Platinum/Titanium was selected as the bottom electrode in order to prevent the diffusion of PZT into the silicon substrate and achieve the desired [111] crystal orientation by annealing Pt while chrome gold was selected as the top electrode due to its high oxidation resistance and high electrical conductivity. The micro power generator would be subjected to input vibrations of a known frequency and amplitude through a shaker table in order to study its electrical response in the form of voltage and current output.

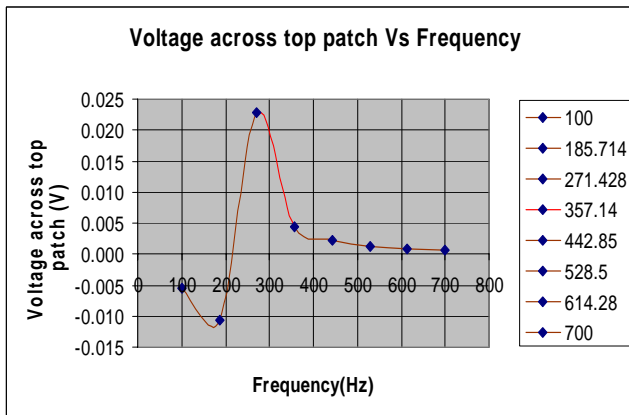


Fig 1a

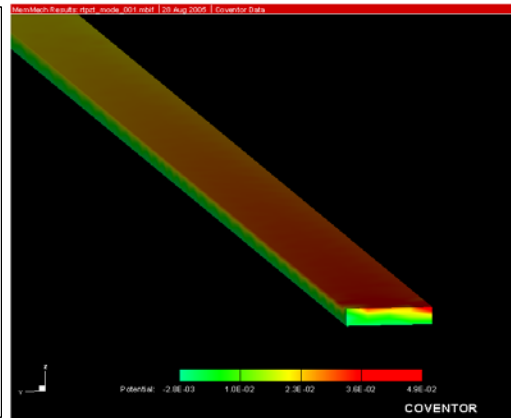


Fig 1b

Figure 1a The voltage as a function of frequency while Fig 1b showing the voltage distribution across the piezoelectric beam at the resonant mode in Coventorware.