Fabrication and Packaging of a MEMS Based Energy Harvester

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Abstract

A prototype electromechanical MEMS based-transducer is fabricated using a combination of lithography, 3D printing, and machine shop techniques. The transducer spring bed design uses a modified version of the classic 4 bar linkage spring design, the long beams are tapered to reduce stress, such that the end connecting to the guide rod is wider than the connecting region to the shuttle, which houses the magnet. The transducer spring bed is made from silicon with a deep reactive-ion etching process. This process allows for near vertical sidewalls, which increases device efficiency. The transducer is housed in a series of 3D printed plastic package parts. The top and bottom parts houses the coils, which are fixed in place using paraffin wax. The middle insert houses the spring bed containing the magnet. The parts come together to provide the desired spacing between the magnet and the coils. The coils are manually wound using 44 AWG enamel coated copper wires on a custom made mandrel. With two coils placed at the desired distance above and below the magnet's plane of motion. When attached to the source of vibration, the magnet vibrates in between the coils, inducing an EMF in the coils in accordance with Lenz's Law. The coils are connected in series and the induced voltage adds to produce an output voltage, which is interfaced with custom designed circuitry for energy harvesting. The assembled mechanical harvester is capable of delivering 1mW of output power at resonance with a matched load.