Chapter 5 Conclusion and future work

5.1 Conclusion

The system analysis and simulation of the device was accomplished. Simulation showed that the power output of 32.3 μW or power density of 29.6μW/cm^3 could be achieved with the input voltage of 3.3V. Device was fabricated and measured. Mechanical measurements showed that the feature size of the device shrunk about 3 μm and resulted in the decrease of spring constants. The variable capacitor was vibrated on the shaker and displacements were recorded. The resonant frequency of the device was about 800 Hz with a Q-factor of 9.6. AC Current measurement using schematic Figure 4.10 was failed due to the parasitic resistance in parallel to the variable capacitor. Measured static capacitance was about 500 pF, which was mainly the parasitic capacitance between the center plate and the substrate. Parasitic resistance measured was 2.5 kΩ. .The device has been successfully resonant by the driving vibration and the fabrication experience was gained through the experiments. Solutions of the issues faced are proposed and the future improvements are suggested in next section.

5.2 Future work

The AC current measurement could not be accomplished due to the instrumentation limit. Therefore, a higher resolution instrument should be used for current measurement.

Future works on the new design includes,

(1) , Improvements on the fabrication process should be noticed. As mentioned in Chapter 4, the change of fabrication process with the PECVD oxide layer added serve as the hard mask of deep RIE process will help. Process fine tune in photolithography and deep RIE process must be conducted. Back side etching to remove the substrate is a must done process to reduce the parasitic capacitance and resistance.

(2), The energy conversion process needs an external DC voltage source such as battery included. This limits the application of the converter. Advanced method using pre-charged electret as the initialize polarizing voltage source has been reported [28]. With the electret included, there will be no need of external battery and thus extend the application space.

(3), New variable capacitor topology can be used to reduce overall device size and mass. The fixed gap in-plane gap closing comb drive topology suffers a problem that in order to gain large change in capacitance, large area and appendix mass were needed. The devices are therefore very expensive and hardly commercialize. It is preferred to propose a new type of variable capacitor topology such as flexible structure design in Figure 5.1. And the out-of plane dynamic safety factor should be considered.

(4), The details about the output power of the proposed circuit models in Figure 2.1 and Figure 4.10 should be calculated with the output load impedance taken into consideration. A more realistic output power estimation under practical conditions can thus be obtained.

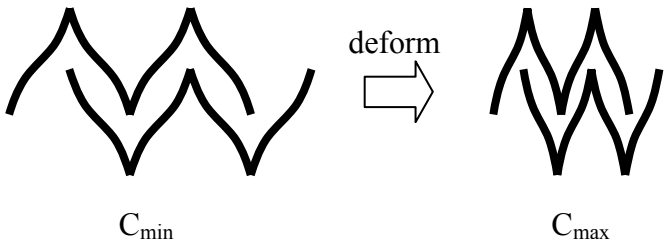

Figure 5.1 Flexible variable capacitance chart