MEMS Acoustic Pixel

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Introduction

The world has evolved to a point where digital media and electronics play an important role in everyday life. The industry of electronics keeps growing with the pass of the months; where more improved components such as speakers, microphones, sensors and cameras among others are in high demand.

In our work we use COMSOL Multiphysics® to simulate the behavior of a micro-membrane (Acoustic Pixel) to be used as a potential acoustic transducer. The MEMS and Piezoelectric device modules are used to aid the design process of such transducer. A four-cantilever spring configuration is initially proposed. Each cantilever has a width of 30 µm and are connected to a central circular plate with a radius of 150 µm. A top view of the membrane is shown in Figure 1.

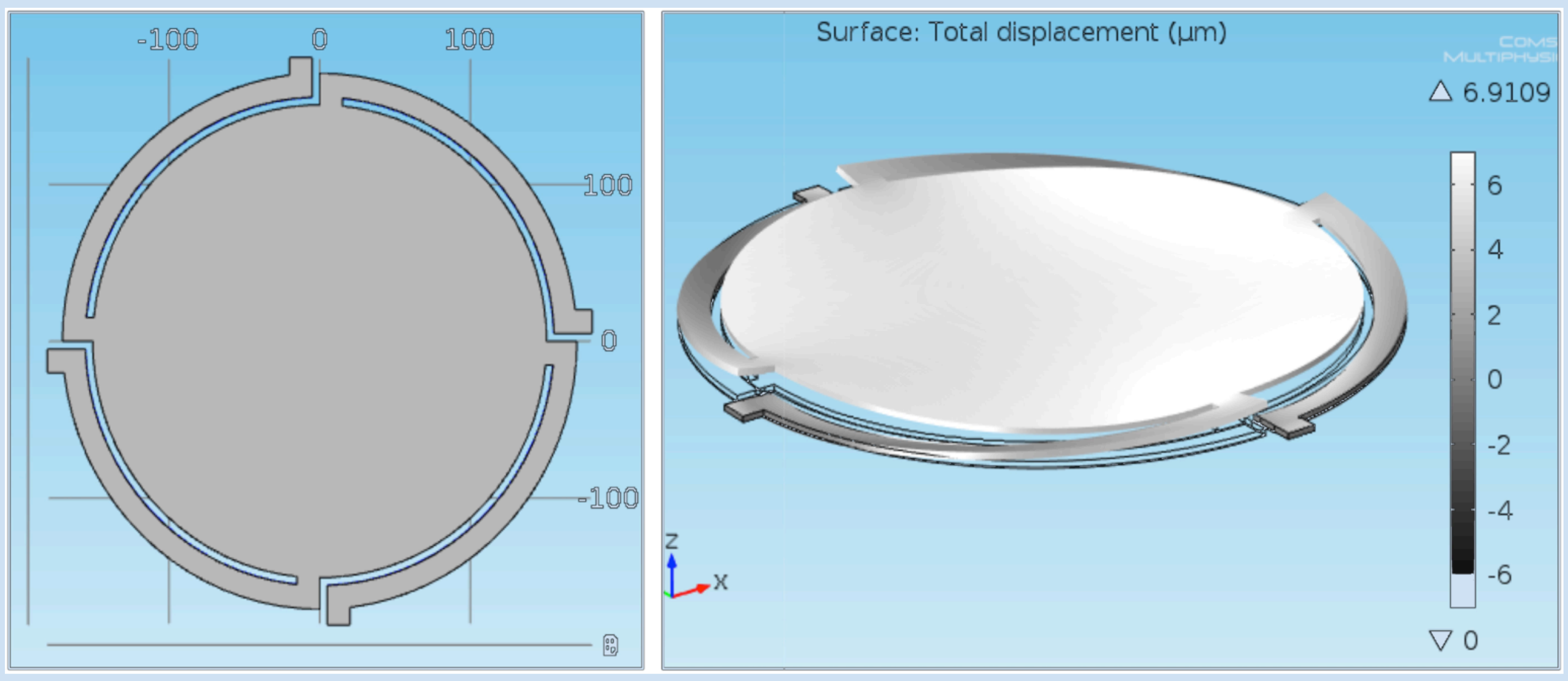

Figure 1 Top view of the Acoustic-pixel. Four curved cantilevers with a width of 30 µm connected to a circular plate with a radius of 150 µm. The material stack is Pt/PZT/Pt [100 nm/500 nm/100 nm].

Design modal analysis

The first calculations are intended to check the feasibility to generate audible pressure change with the proposed membrane size. The pressure that can be produced by the proposed membrane can be calculated using the simplified equation of a circular vibrating piston.

The current design has the following parameters: 394.173µg of mass and a spring constant of 1.17 N/m, using the resonant frequency mode of interest of 8.67kHz. It would be a matter of changing its geometry by increasing layer thicknesses or materials used.

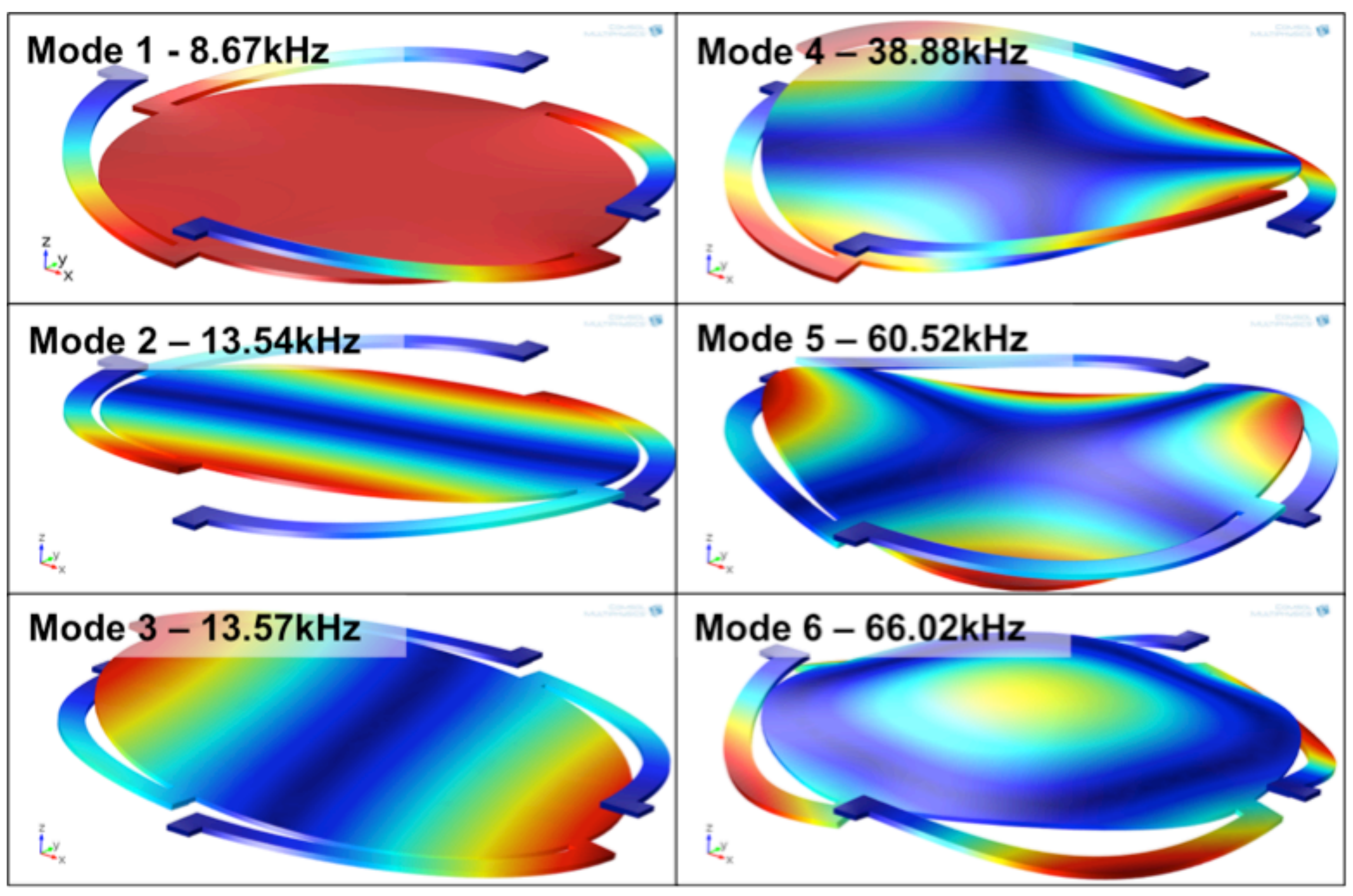

Figure 2 First six frequency modes of the membrane.

Results

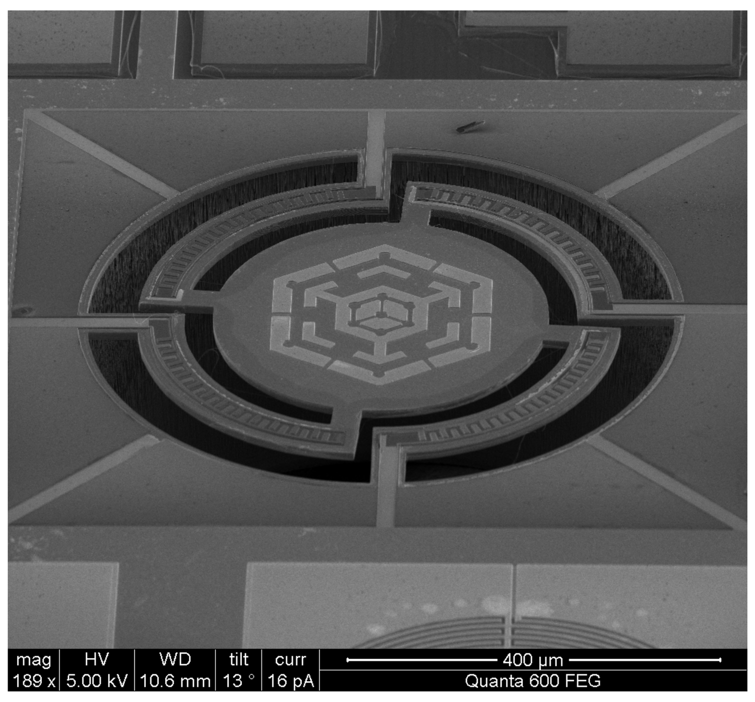

Figure 3. SEM image of fabricated device.

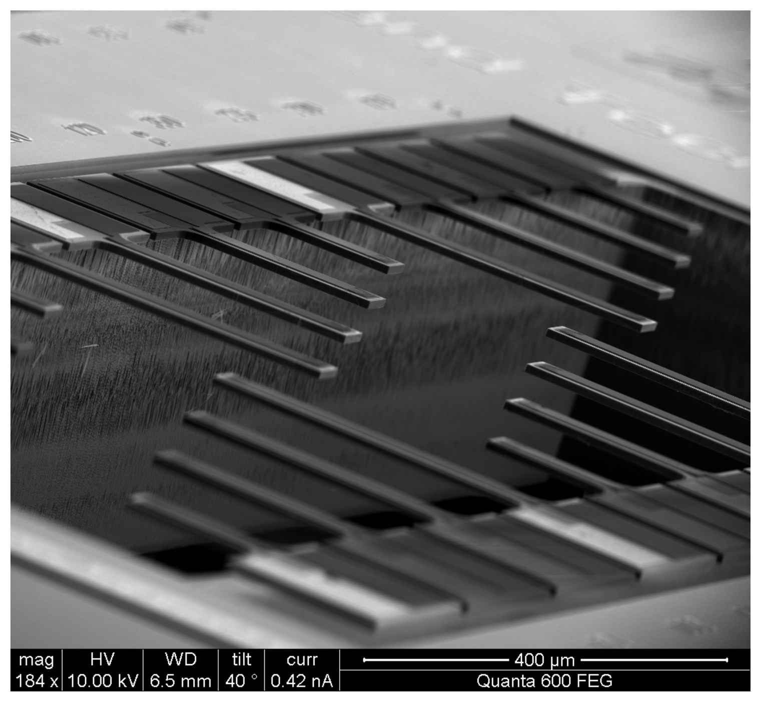

Figure 3. SEM image of test structures for d31 mode.

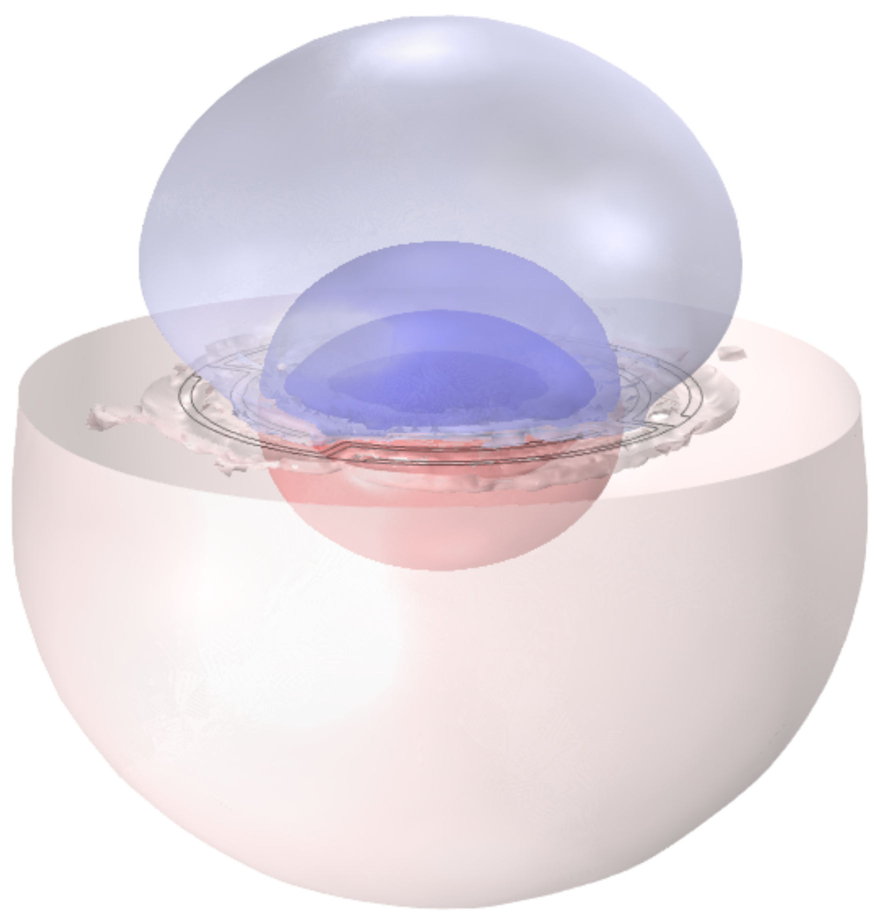

Figure 4. Simulation of the membrane using the Acoustic Module. The displacement of 6 µm at a frequency of 4 kHz would be able to prouce an acoustic pressure change of approximately 20 dB at 1 meter distance in front of the membrane

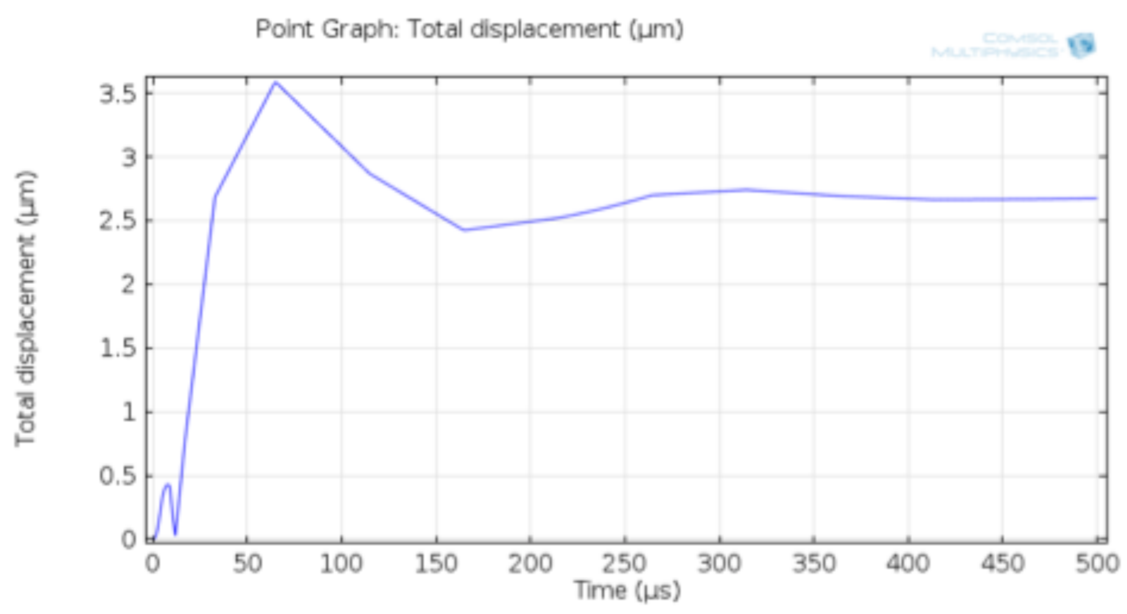

Figure 6. Total Membrane center Displacement vs. Time. Membrane was actuated with 10 V. Response Time of the membrane.

COMSOL Multiphysics® has help ed in better understanding the system presented in this work. The next step in this project is to fabricate an array of similar membranes to create a digital micro loudspeaker. The development and innovation of a Digital Micro-Loudspeaker would directly impact the electronics industry, by creating new components that utilize less power and space on a circuit board, decreasing its fabrication costs without compromising the sound quality, but rather improving it.

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