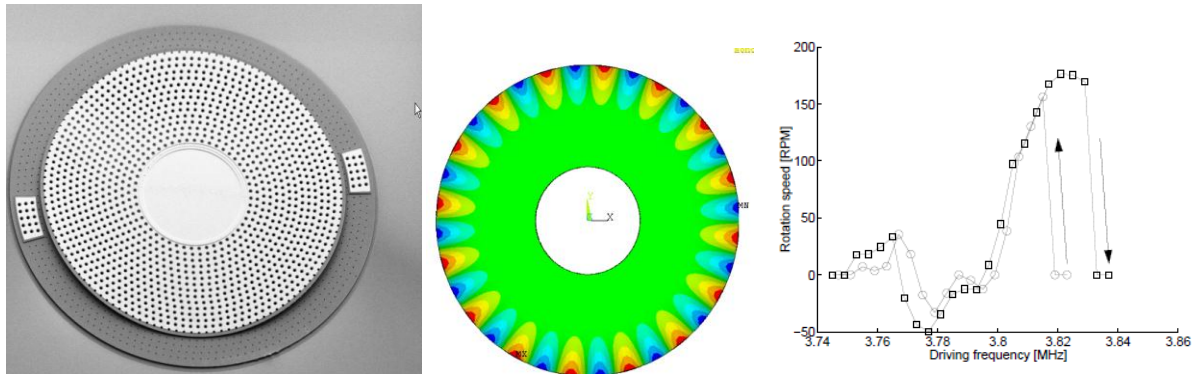


**Title:** Analysis of Acoustic Streaming Induced Levitation and Rotation in a Piezo based Ultrasonic MEMS motor using FSI simulations.

**Abstract:**

Functioning of an Ultrasonic MEMS motor, driven by a PZT plate attached to the chip's base is analyzed in this work. The motor with a diameter of 425  $\mu\text{m}$ , thickness of 1.5  $\mu\text{m}$ , operating at 10V in a frequency range of 2-4 MHz, shows rotation speeds of up to 300 rpm in air and a static torque of  $1\mu\text{N}$ . It is determined that the acoustic pressure between the vibrating substrate and the rotor causes it to levitate, allowing it to freely rotate about its axis. At high enough actuation voltages, the large displacement response of the stator causes coupling of degenerate structural modes, leading to travelling wave generation on its periphery. Interaction of the stator motion with surrounding air results in the formation of standing wave in the air gap between the rotor and the stator. Spatio-temporal variation of acoustic intensity in the gap causes steady circulation of the air, termed as acoustic streaming. The resulting drag on the rotor leads to rotation, which shows hysteretic dependence on frequency sweeping. Nonlinear analysis of this system is presented using perturbation methods, which reveal bifurcations in the system and is verified using numerical simulations. Due to strong fluid-structural coupling in the problem an FSI (Fluid Structure Interaction) based finite element approach is employed. The analysis was used to redesign the motor to demonstrate enhanced performance.



**Biography**

Manoj Pandey finished his Bachelor's degree in Ocean Engineering and Naval Architecture from Indian Institute of Technology Madras in 2001. He then completed his M.S./ Ph.D. in 2007 from Cornell University, NY in Theoretical and Applied Mechanics under the guidance of Prof. Alan Zehnder with focus on mechanics and dynamics of optical MEMS resonators. Following this he worked with the Finite Element software company, Abaqus and consulted for manufacturing division of glass company Corning Inc. Since September 2009 he has been a post doctoral Research Associate at the SonicMEMS lab of Electrical and Computer Engineering in Cornell University under the guidance of Prof. Amit Lal.