Micromachined Piezoelectrically Actuated Flextensional Transducers For High Resolution Printing

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Abstract

In this talk, we present a technique for the deposition of inks, toner, organic polymers, fuels, small solid particles, biological and chemical fluids, using a fluid ejector. The ejector design is based on a flextensional transducer that excites the axisymmetric resonant modes of a clamped circular plate. It is constructed by depositing a thin piezoelectric annular plate onto a thin, edge clamped, circular plate. Liquids or solid-particles are placed behind one face of the plate which has a small orifice at its center. By applying an ac signal across the piezoelectric element, continuous or drop-on-demand ejection of fluids has been achieved. The ejected drop size ranges in diameter from 5 micrometers at 3.5 MHz to 150 micrometers at 7 kHz, the corresponding ejected drop volume ranges from 65 femtoliters to 1.5 nanoliters, and the corresponding flow rate ranges from 0.2 microliters per second to 10 microliters per second. The unique features of the device are that the fluid is not pressurized, the fluid container is chemically or biologically compatible with most fluids, and the vibrating plate contains the orifice as the ejection source. The device is manufactured by silicon surface micromachining and implemented in the form of two-dimensional arrays. Individual elements are made of thin silicon nitride membranes covered by a coating of piezoelectric zinc oxide. Classical thin plate theory, Mindlin plate theory, and variational methods are applied to derive two-dimensional plate equations for the transducer, and to calculate the coupled electromechanical field variables such as mechanical displacement. These methods use classical kinematic relations for a plate and a variational equation for the coupled electromechanical field to reduce three-dimensional field equations to two-dimensional plate equations. As a result, three different exact solutions to corresponding systems are obtained. An equivalent circuit of the transducer is also obtained from these solutions.

Biography

Gokhan Percin was born in Ezine, Canakkale, Turkey. He received the B.S. degree in electrical and electronics engineering from Bilkent University, Ankara, Turkey, in 1994 and the M.S. degree in electrical engineering from Stanford University, California, in 1996. Currently, he is with Adeptient, Los Altos, California, and is pursuing the Ph.D. degree in electrical engineering with minor subject in engineering-economic systems and operations research at Stanford University, California. His current research interests include micromachining, droplet ejection, ultrasonic transducers, and electromechanical devices. Mr. Percin is a student member of The Institute of Electrical and Electronics Engineers (IEEE), IEEE Ultrasonics, Ferroelectrics, and

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