Abstract

Non-contact bearings based on acoustic/ultrasonic levitation are investigated in this thesis. Both standing wave type and squeeze film type ultrasonic levitation are investigated theoretically and experimentally.

The conventional standing wave type ultrasonic levitation has not found technical applications in non-contact bearings due to the fact that it has very limited load capacity and can only levitate elements which are smaller than the sound wavelength. In this thesis work, a new configuration of standing wave levitation is presented which is able to levitate large planar object at a position of multiple times of a half wavelength of the sound wave. The theoretical model for the proposed levitation system is established and a prototype system is constructed accordingly. A CD is successfully levitated with the proposed system at a height of half a wavelength. A levitation force of 1 N is measured at the position of half wavelength.

Squeeze film type ultrasonic levitation is investigated theoretically to find the crucial design parameters and to improve the levitation capacity. Two analytical models based on acoustic theory and fluid dynamics are presented and compared. The governing fluid dynamics equation is solved numerically to obtain precise pressure distributions. Based on the theoretical investigation, a novel non-contact journal bearing is developed for suspension of a solid steel spindle with diameter of 50 mm. The maximum load capacity of 51 N (6.37 N/cm^2) is obtained which is considerably larger than the previously reported squeeze film bearings whose load capacities are usually within a few Newton (less than 1 N/cm^2).