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Comparative Investigation of Two Non-Contact Prototype Designs Based on a Squeeze-Film Levitation Approach

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Abstract : Transportation and handling of delicate and lightweight objects is currently a significant issue in some industries. Two common contactless movement prototype designs, ultrasonic transducer design and vibrating plate design, are compared. Both designs are based on the method of squeeze-film levitation, and this study aims to identify the limitations, and challenges of each. The designs are evaluated in terms of levitation capabilities, and characteristics. To this end, theoretical and experimental explorations are made. It is demonstrated that the ultrasonic transducer prototype design is better suited to the terms of levitation capabilities. However, the design has some operating and mechanical designing difficulties. For making accurate industrial products in micro-fabrication and nanotechnology contexts, such as semiconductor silicon wafers, micro-components and integrated circuits, non-contact oil-free, ultra-precision and low wear transport along the production line is crucial for enabling. One of the designs (design A) is called the ultrasonic chuck, for which an ultrasonic transducer (Langevin, FBI 28452 HS) comprises the main part. Whereas the other (design B), is a vibrating plate design, which consists of a plain rectangular plate made of Aluminium firmly fastened at both ends. The size of the rectangular plate is 200x100x2 mm. In addition, four rounded piezoelectric actuators of size 28 mm diameter with 0.5 mm thickness are glued to the underside of the plate. The vibrating plate is clamped at both ends in the horizontal plane through a steel supporting structure. In addition, the dynamic of levitation using the designs (A and B) has been investigated based on the squeeze film levitation (SFL). The input apparatus that is used with designs consist of a sine wave signal generator connected to an amplifier type ENP-1-1U (Echo Electronics). The latter has to be utilised to magnify the sine wave voltage that is produced by the signal generator. The measurements of the maximum levitation for three different semiconductor wafers of weights 52, 70 and 88 [g] for design A are 240, 205 and 187 [um], respectively. Whereas the physical results show that the average separation distance for a disk of 5 [g] weight for design B reaches 70 [um]. By using the methodology of squeeze film levitation, it is possible to hold an object in a non-contact manner. The analyses of the investigation outcomes signify that the non-contact levitation of design A provides more improvement than design B. However, design A is more complicated than design B in terms of its manufacturing. In order to identify an adequate non-contact SFL design, a comparison between two common such designs has been adopted for the current investigation. Specifically, the study will involve making comparisons in terms of the following issues: floating component geometries and material type constraints; final created pressure distributions; dangerous interactions with the surrounding space; working environment constraints; and complication and compactness of the mechanical design. Considering all these matters is essential for proficiently distinguish the better SFL design.

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