MEMS密闭腔内微气流的挤压膜阻尼效应研究

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基金项目：

摘 要：

针对MEMS密闭腔内微气流与压电驱动机构的耦合振动，综合采用空气挤压膜阻尼效应和能量法进行理论分析。根据等温雷诺方程求解气体压力分布，进而计算微气流挤压膜阻尼能，将其代入能量方程，与压电-硅膜的耦合动能、势能、压电电场能进行能量耦合，将由能量方程确定的压电-硅膜-微气流耦合作用下的位移振形待定系数1 ¢ 与无气流影响下的压电-硅膜耦合振动位移振形待定系数● 对比后，找到了增加的阻尼项，微气流对驱动结构振动位移的影响正是通过该阻尼项体现的。研究可为微流体的驱动及协调控制提供相关理论基础及控制策略。

关键词：微机电系统；微流体；微驱动；挤压膜阻尼；雷诺方程；能量法

Squeeze Film Damping Effect of the Micro Airflow in a MEMS Sealed Chamber

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Abstract:

The squeeze film damping effect between the air gap and the PZT actuator in a sealed chamber is analyzed. Both the gas damping effect and the Rayleigh-ritz energy method are utilized to investigate the coupled effect between the micro airflow and its actuator. The air pressure distribution of the micro airflow is determined by solving the nondimensionalized and linerized isothermal compressible Reynolds equation and combined with the sealed pressure boundary condition. The coupled model of piezoelectric-Silicon film-micro airflow is derived according to the Rayleigh-Ritz energy method. By comparing the undetermined coefficient 1 of the displacement function without micro airflow and the undetermined coefficient 1 ¢ with micro airflow, the air damping factor is extracted. The influencing of micro airflow squeeze film damping on PZT actuator can be exhibited by such air damping factor. All the investigation provide theoretical foundation and control strategy for microfluid actuating.

Keywords: MEMS; microfluid; micro actuator; squeeze-film air damping; Reynolds equation; Rayleigh-ritz energy method

投稿时间：**2010-04-27**

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