# Thin-Film Thickness Influence on Anisotropic MEMS Damping

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**Introduction**: The analyzed MEMS oscillator is composed by a spring supported mass that needs to vibrate with a high Q-factor in the horizontal plane and a low one along the transverse plane. Different parameters were swept to assess their influence, namely thin-film gap thickness, ambient pressure and surface texture.

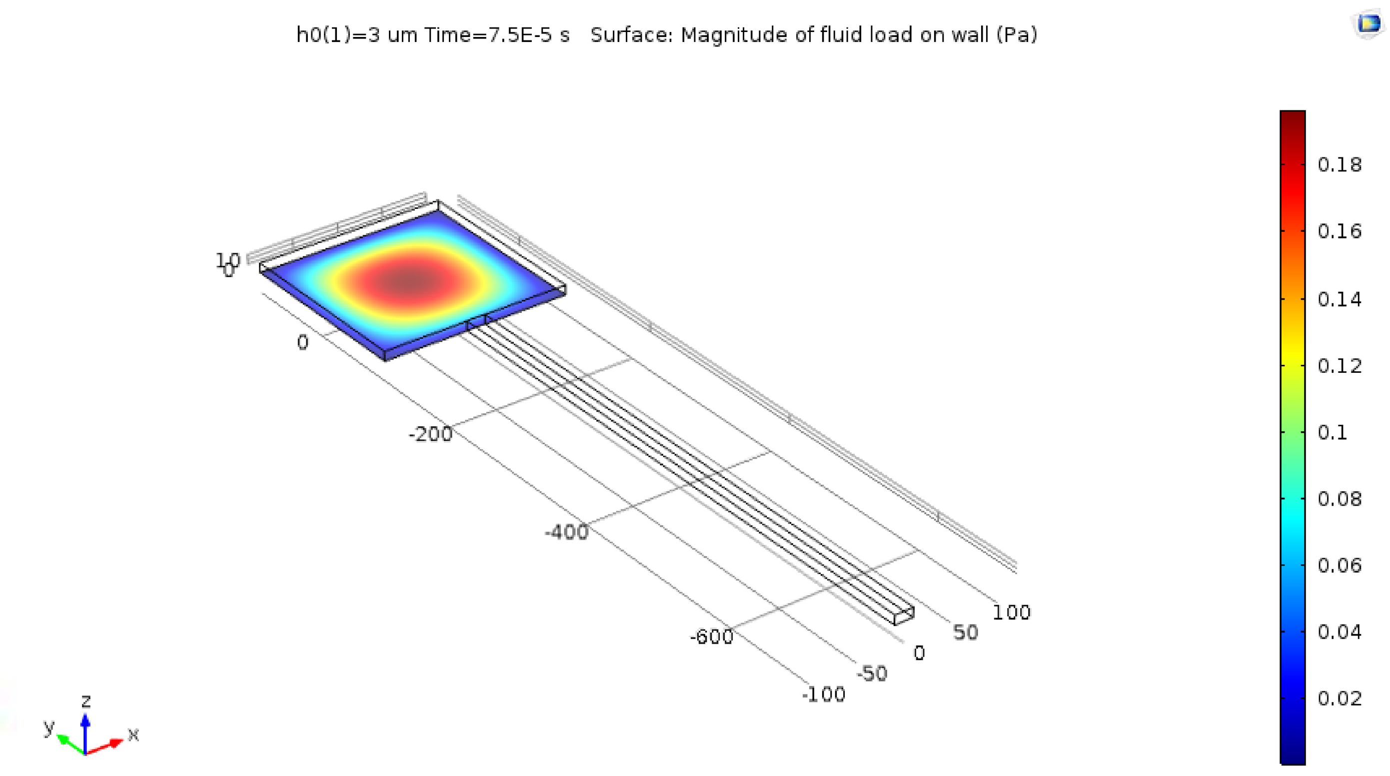


**Figure 1.** Fluid load distribution

**Computational Methods**: The analysis consisted in a particular case of Fluid-Structure Interaction. The modified Reynolds equations were solved to work out the fluid load on surface. To perform such coupled study, Thin-Film Damping boundary condition within Solid Mechanics Physics was used.

$$p_a\left(\frac{\partial^2 p}{\partial x^2}+\frac{\partial^2 p}{\partial y^2}\right)-\frac{12\mu\omega l^2}{h_0^2}\frac{\partial p}{\partial t}=\frac{12\mu p_a}{h_0^3}\frac{dh}{dt}$$

The dynamic behavior of the system was analyzed by applying a body force F = ρa, in which a was equal to half the gravitational acceleration.

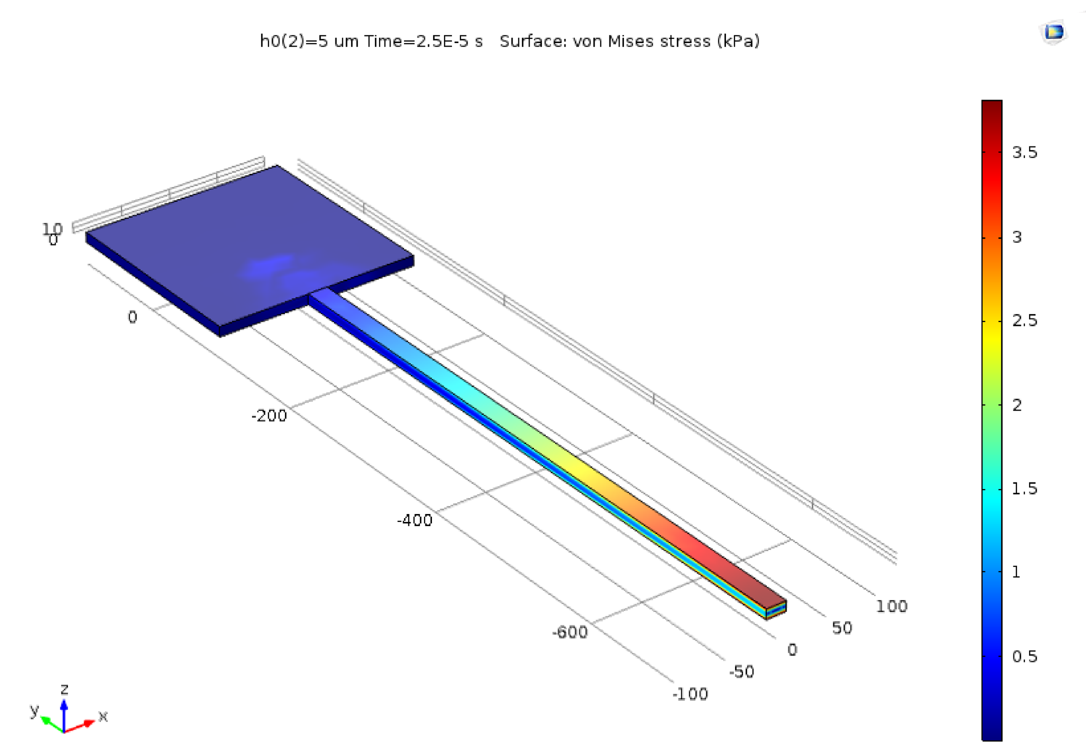


**Figure 2.** Von Mises stress at t = 0.002 s

**Results**: The ambient pressure was lowered down to 10 kPa without altering the damping significantly. Once the little influence on X-damping by squeeze-film was found, optimization was run to make the device critically damped along Z. The gap height, which fulfilled such requirement, was found to be 4.5 μm.

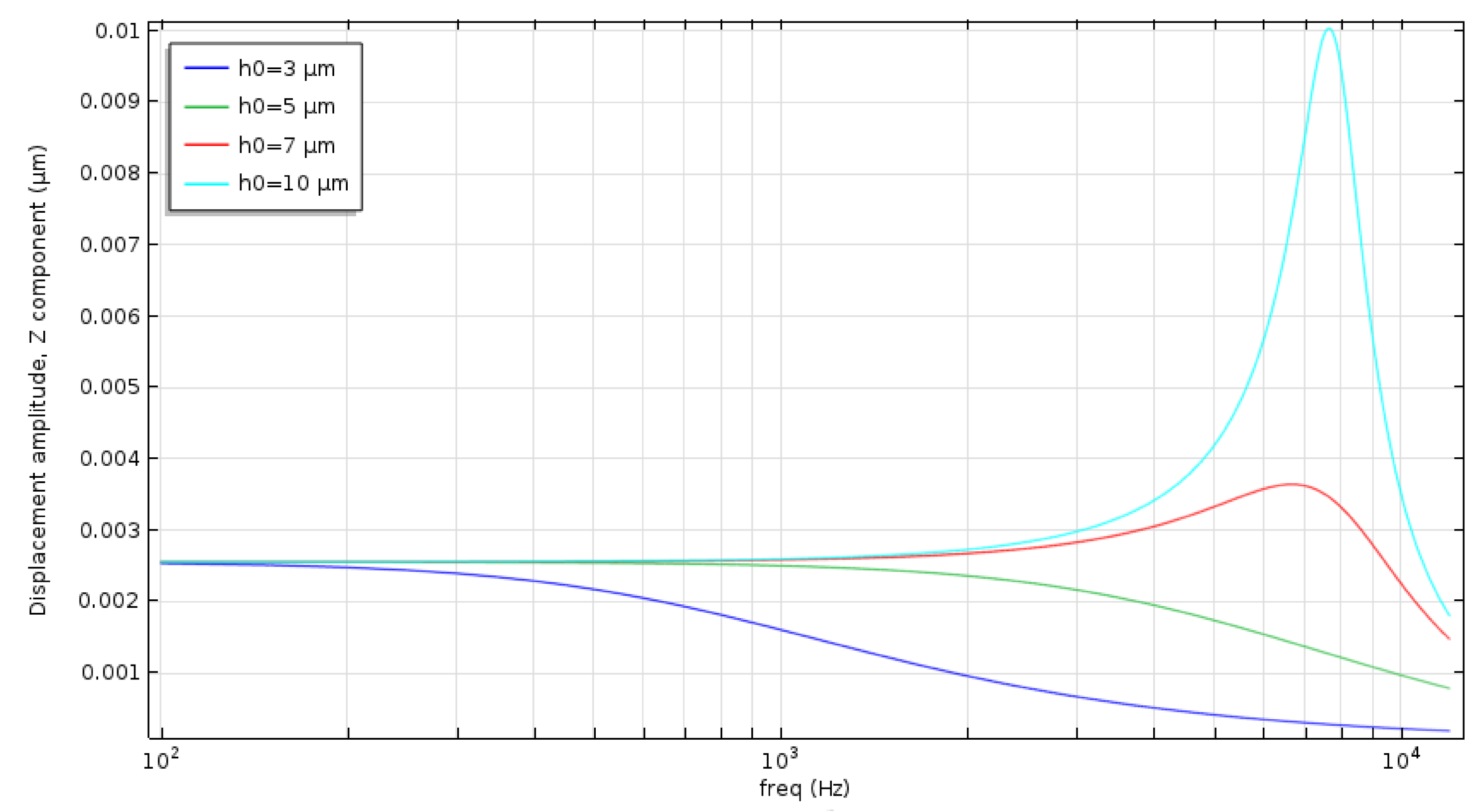


**Figure 3.** Frequency response in displacement Z amplitude For different gap heights

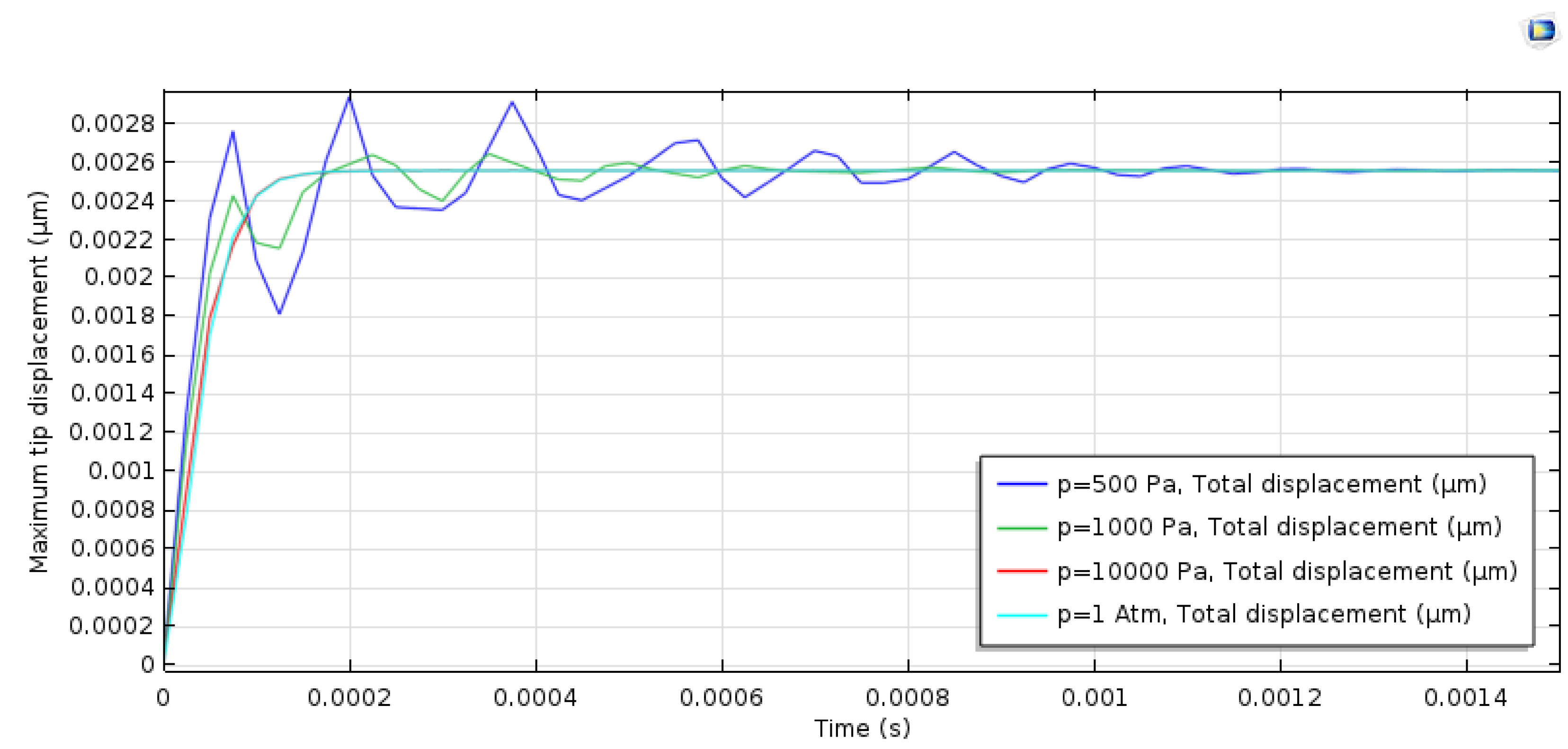


**Figure 4.** Tip displacement for different ambient pressures

**Conclusions**: Second-order differential equation, based on modified Reynolds, predicted the behavior acceptably. Successful optimization of the damping in both vertical and horizontal plane.

**References**:

1. Bao M. and Yang H., Squeeze film air damping in MEMS, *Sensors and Actuators*, **A 163**, (2007) 3-27
2. Andrews M., Harm I. and Turner G., A comparison of squeeze-flm theory with
measurements on a microstructure, , *Sensors and Actuators*, **A 36**, (1993) 79-81

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