# Research on Causes of Cavitation Generation on Textured Surface under Hydrodynamic Lubrication

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## 1. Abstract

One of the effects of surface texturing under hydrodynamic lubrication is increasing load capacity. It is said that this effect is caused by generation of cavitation around the geometry by the surface texturing and presence of the cavity is observed by experiments. Considering the generation of the cavity, there are two kinds of cavitation phenomenon. One is vaporous cavitation, the other is gas cavitation. However, the detailed mechanism of cavitation on the textured surface is not clear since it is difficult to perform in-situ observation of the sliding surfaces. For this reason, numerical analyses were conducted to investigate the mechanism of the cavitation with cavitation models. However, it is considered that most of them are not accurate because the mechanisms of generation of cavitation are unclear. We think further discussion about cavitation is needed.

The objective in our research is to verify the mechanism of generation of cavitation by using CFD (Computational Fluid Dynamics). A new model, growth of a bubble, is proposed and is applied for CFD analysis.

In our simulations, a flow field is assumed to be two-dimensional, laminar and incompressible. Governing equations are Continuity and Navier-Stokes equations. These equations are numerically solved using marker and cell method (MAC). The computational domain and the dimensions of the dimple are illustrated in Figure 1. As boundary conditions, the parallel walls have relative velocity of 0.1, 0.5, 1.0 and 3.0 m/s. Pressure of inlet and outlet is atmospheric pressure, 101.3 kPa. In addition, as physical properties of working fluid, viscosity is 0.052 Pa s, and density is 826 kg/m$^3$.

Figure 2 shows maximum decrease of pressure. We can observe that minimum pressure is larger than saturation vapor pressure. Therefore, it is considered that vaporous cavitation does not occur. In addition, gas cavitation is not generated from the perspective of supersaturation.

We propose a new model, growth of bubble, based on an assumption that bubbles generated by something except for the texture intrude the sliding surface. The growth of bubble is calculated by use of Young-Laplace equation and two-film model with Pressure field simulated by CFD. Parameters of the calculation of the bubble growth are listed in Table 1. Figure 3 shows the calculation results. The changes of bubble diameter caused by decrease of pressure are confirmed. We can observe that the increase of the bubble diameter when sliding velocity and gas solubility are high.

Table 1 Parameter of Bubble Growth

| | | | |
|---|---|---|---|
| Initial Bubble Diameter | $d_b$ | [μm] | $h$/2 |
| Surface Tension | $\gamma$ | [dyne/cm] | 36.0 |
| Overall Mass Transfer Coefficient | $K_L$ | [m/s] | 0.00016 |
| Henry Coefficient | $H$ | [Pa·m$^3$/mol] | 2028 |
| Solubility of Gas | $C_A$ | [mol/m$^3$] | 50, 100, 200, 300 |
| Molar Mass | $K_L$ | [m/s] | 0.00016 |
| Gas Constant | $R$ | [J/kgK] | 8.314 |
| Temperature | $T$ | [ºC] | 20 |

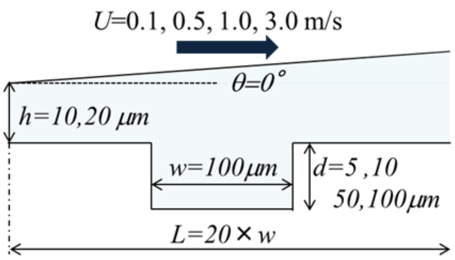


Fig. 1 Simulation Domain

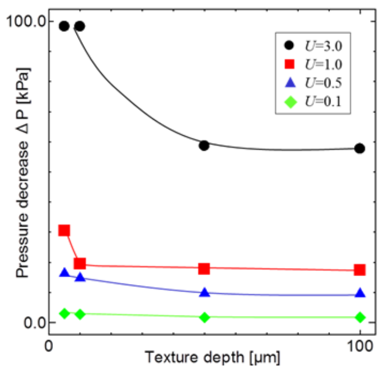


Fig. 2 Decrease of Pressure ($h$=10μm)

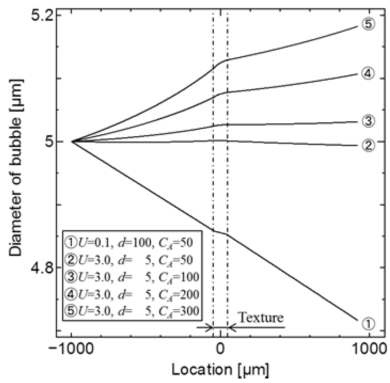


Fig. 3 Growth of bubble with presented model