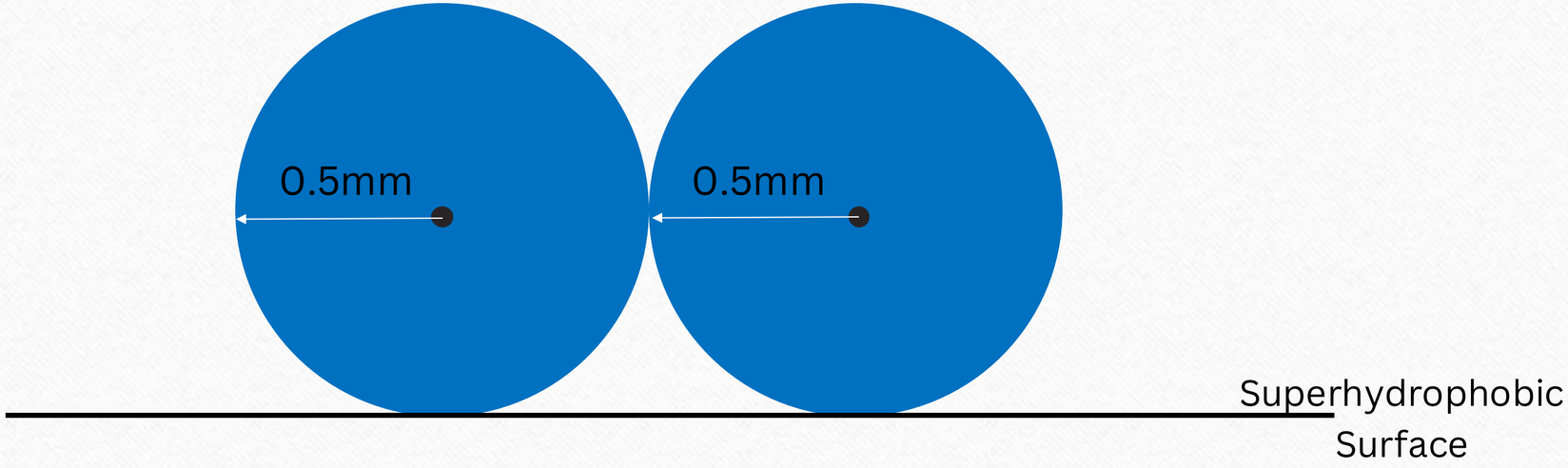
Droplet Coalescence Simulation Results

COALESCENCE

- Coalescence refers to the process in which two or more particles, droplets, bubbles, or other small entities merge together to form a single larger entity. In the context of fluid dynamics and CFD (Computational Fluid Dynamics), coalescence typically describes the merging of liquid droplets or gas bubbles due to surface tension forces when they come into close proximity.

Problem Statement

Two 1 mm water droplets on a superhydrophobic surface, initially at rest and just touching, collapse into each other. The goal is to determine the resulting jumping velocity and compare it with experimental results.



Diameter = 1mm
Velocity = 0 m/s

Program Files

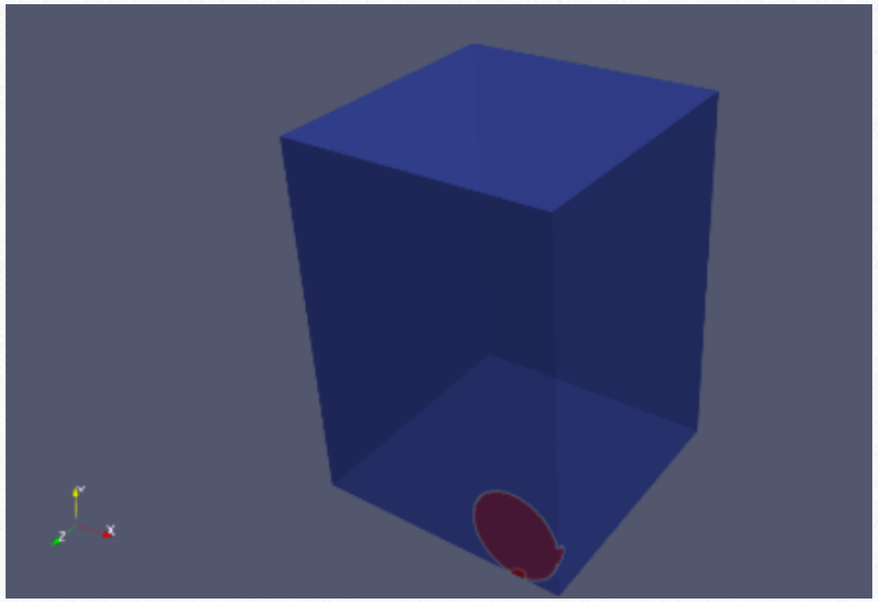
BlockMeshDict

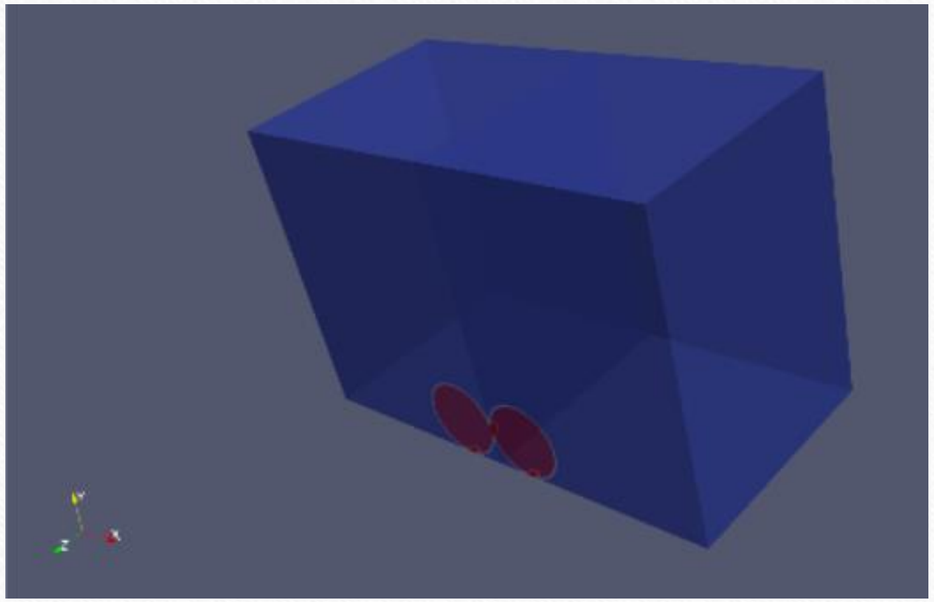
```
boundary(

caxis1 {type symmetryPlane;
        faces ( (5 1 2 6) );
          }
caxis2 {type symmetryPlane;
faces ( (5 6 7 4) );
          }
bottomwall {type wall;
              faces ((5 1 0 4));
              }
atmosphere{type patch;
              faces ((6 2 3 7)
              (1 2 3 0)
              (4 0 3 7));
               }
);
```

alpha.water

```
boundaryField{

caxis1 { type symmetryPlane; }

caxis2 { type symmetryPlane; }

bottomwall { type constantAlphaContactAngle;
              theta 180;
              limit gradient;
              value uniform 180}

atmosphere { type inletOutlet;
              inletValue uniform 0;
              value uniform 0;}

}
```

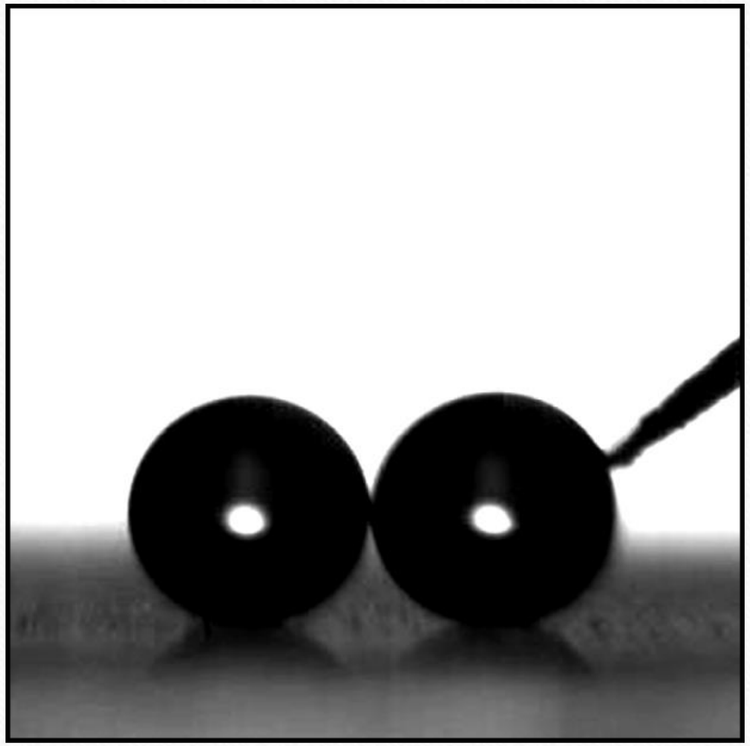
Computational Domain



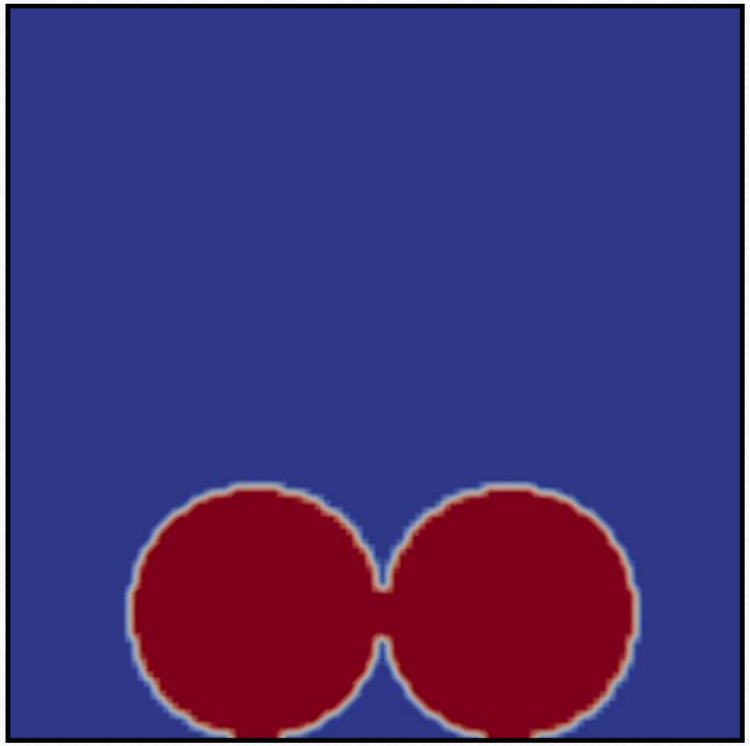


•The domain is a quarter-symmetric block with half a droplet.
•Reflection generates two closely spaced droplets.
•Grid: 120×120×120120 \times 120 \times 120120×120×120 cells.
•Domain size: 3 mm in each direction.

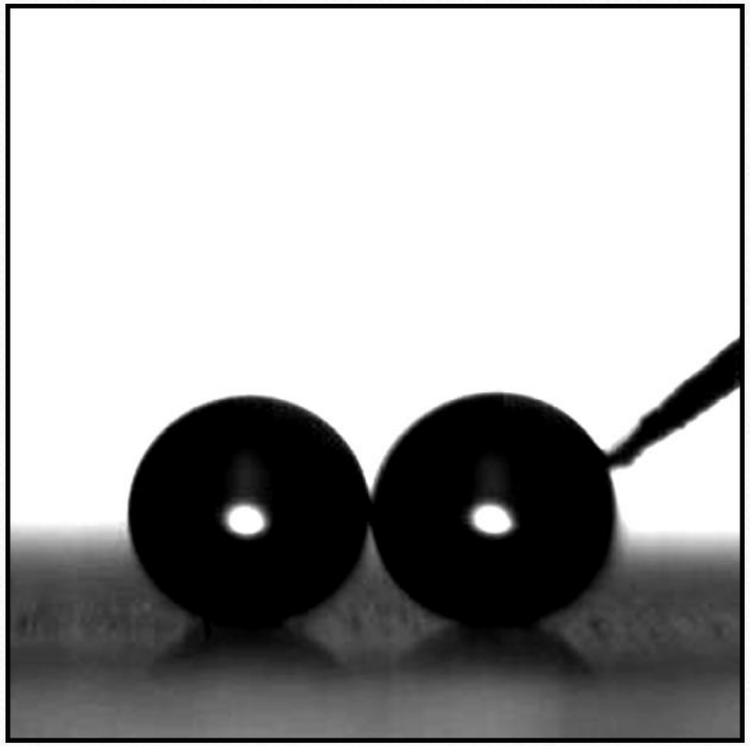
Experimental Results



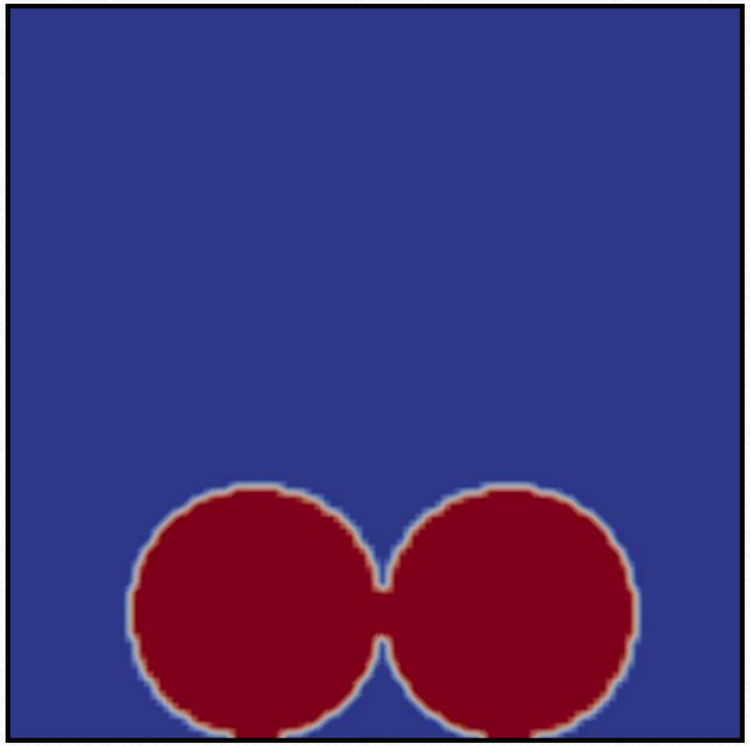
Simulation Results



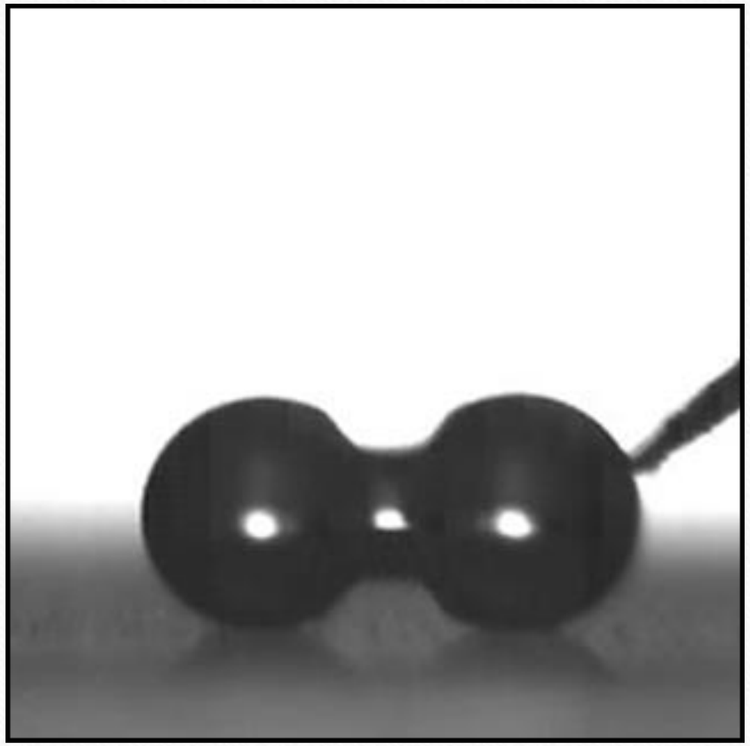
Experimental Results



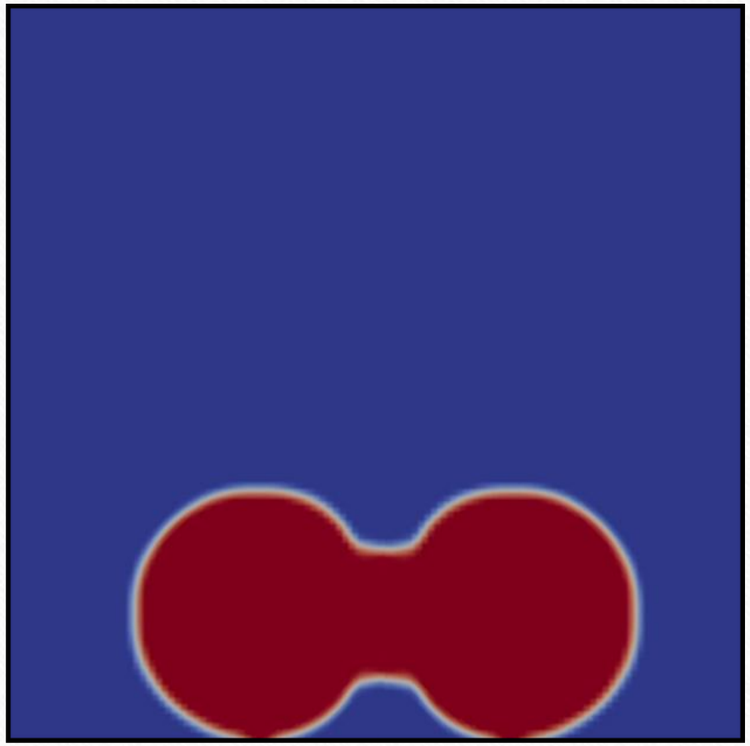
Simulation Results



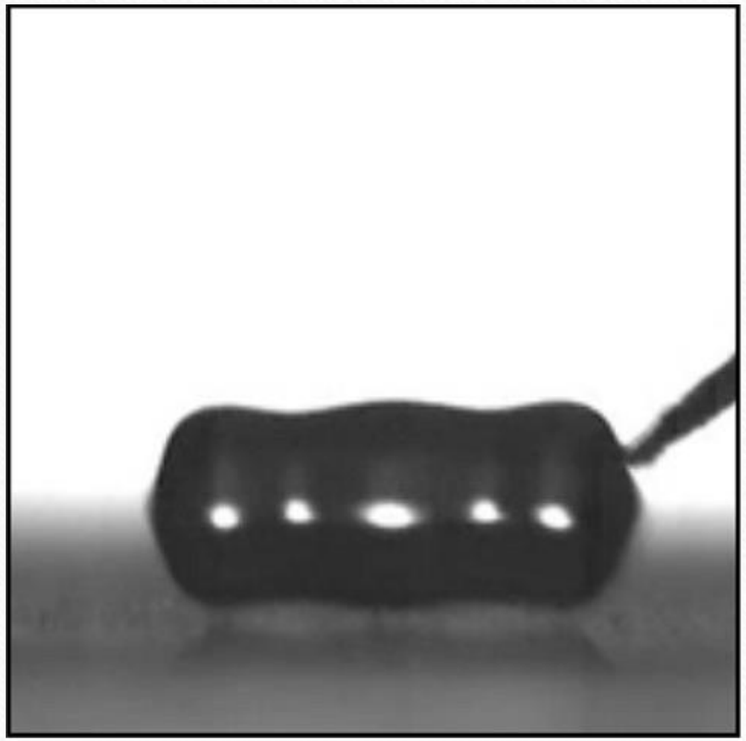
Experimental Results



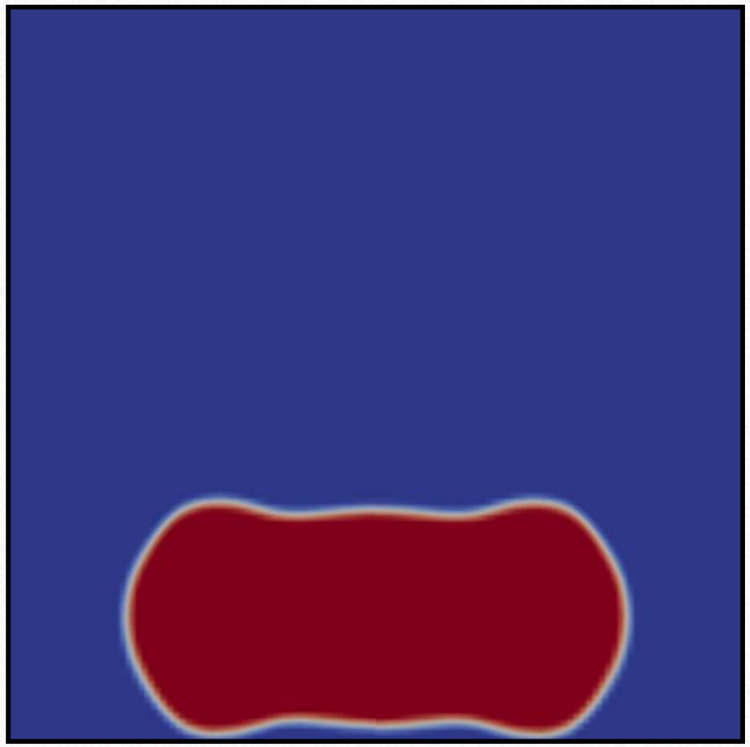
Simulation Results



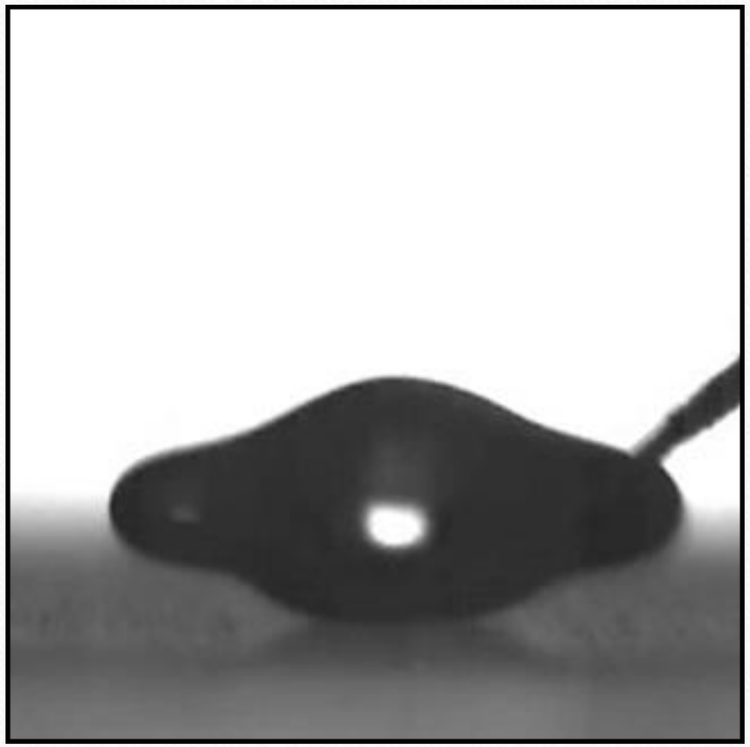
Experimental Results



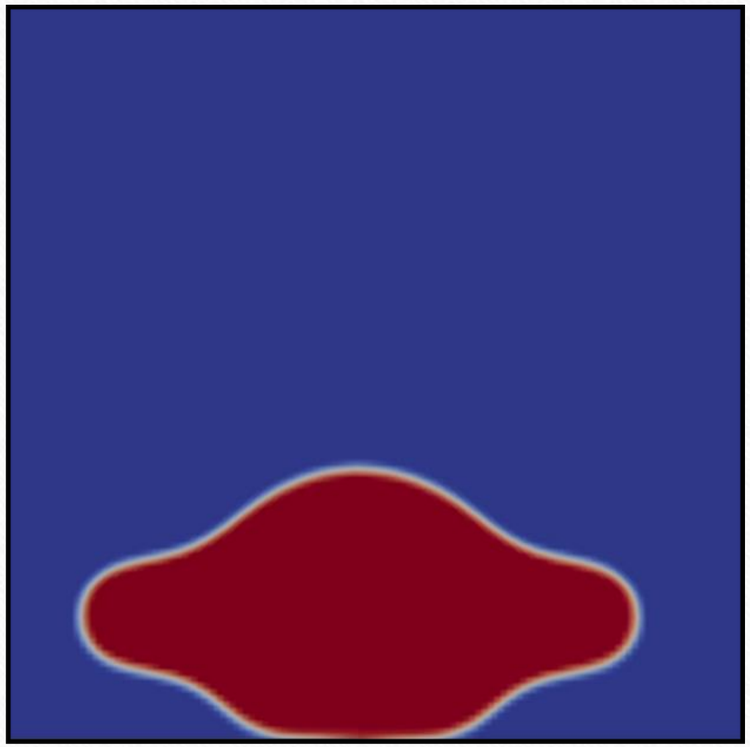
Simulation Results



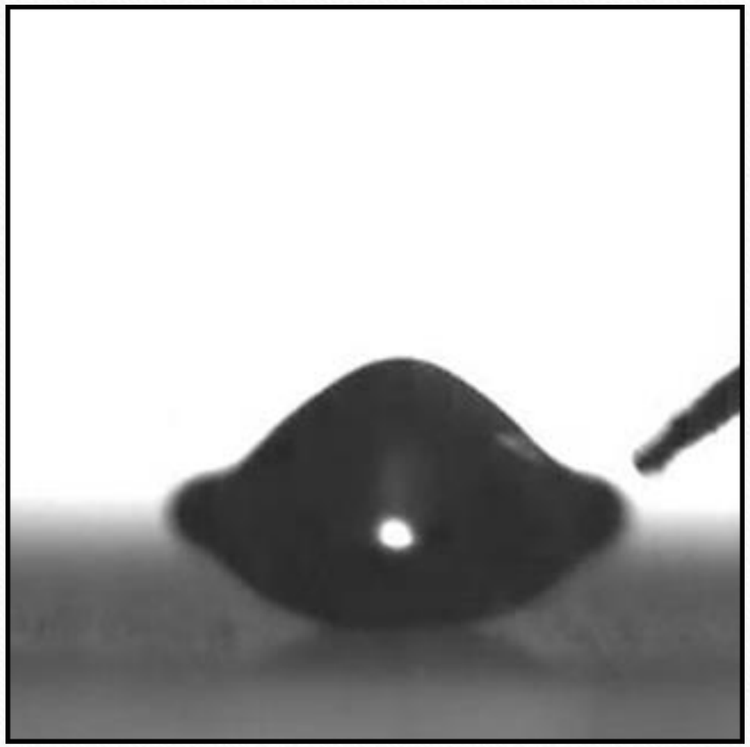
Experimental Results



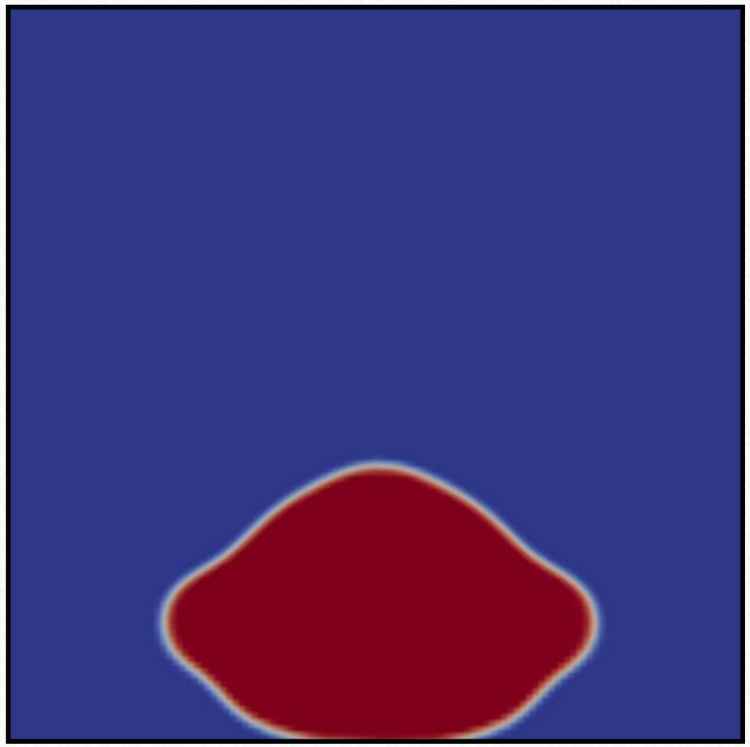
Simulation Results



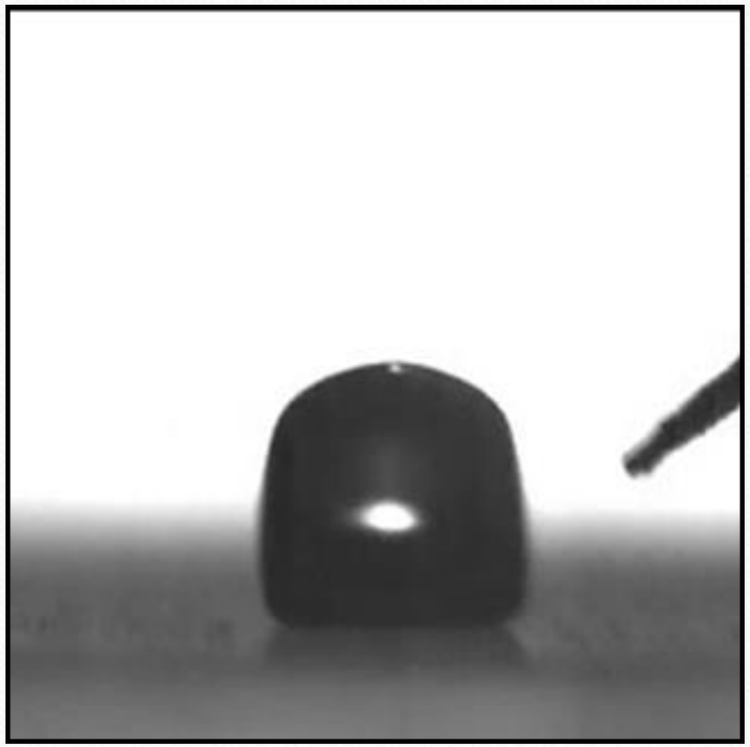
Experimental Results



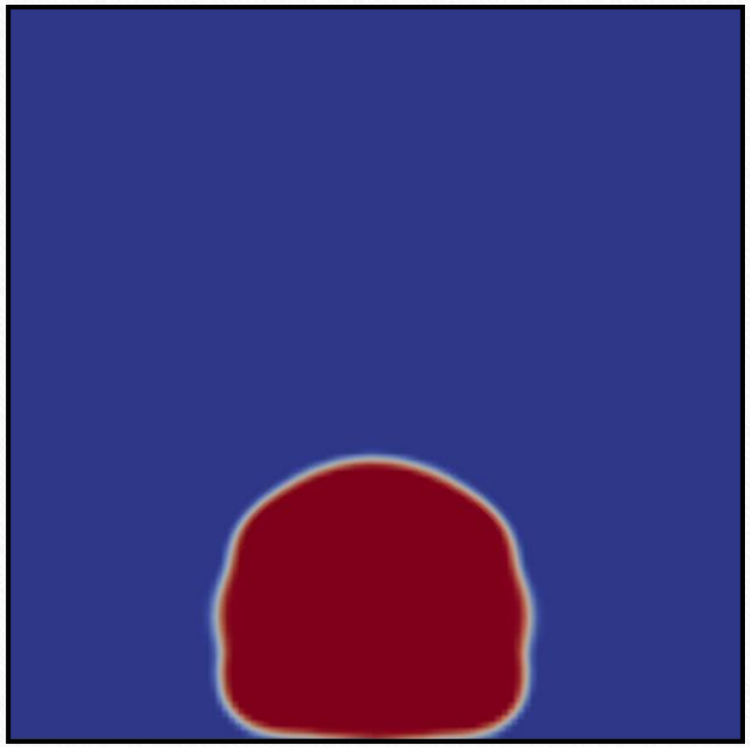
Simulation Results



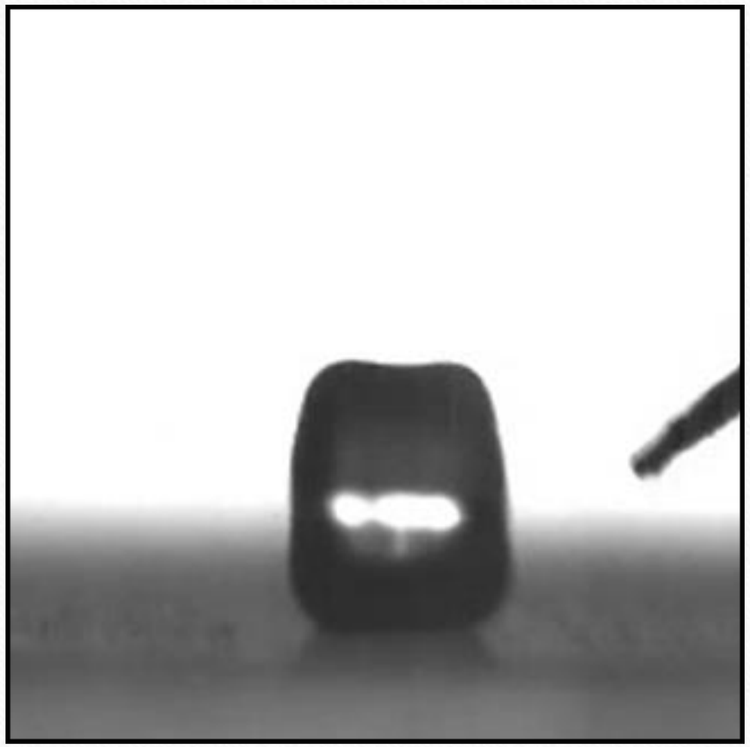
Experimental Results



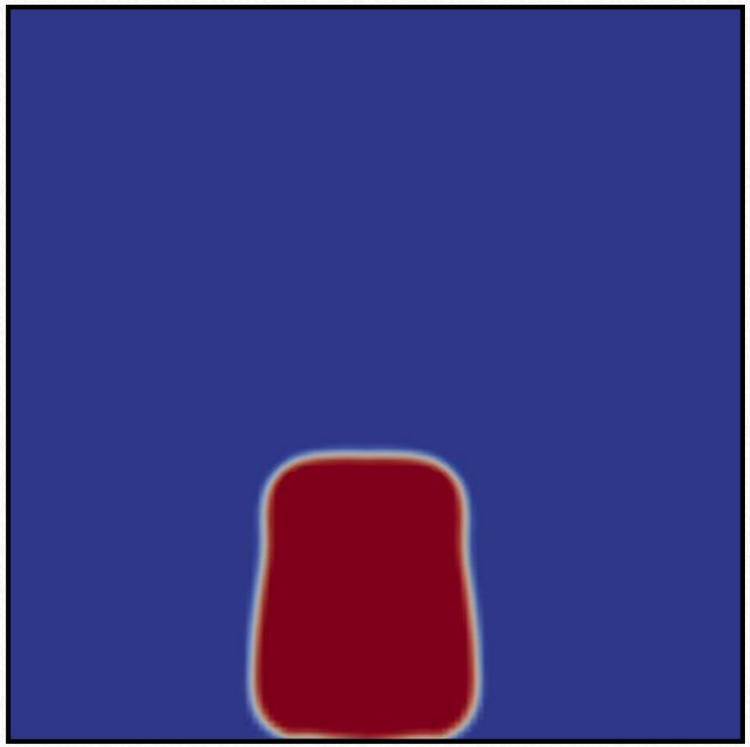
Simulation Results



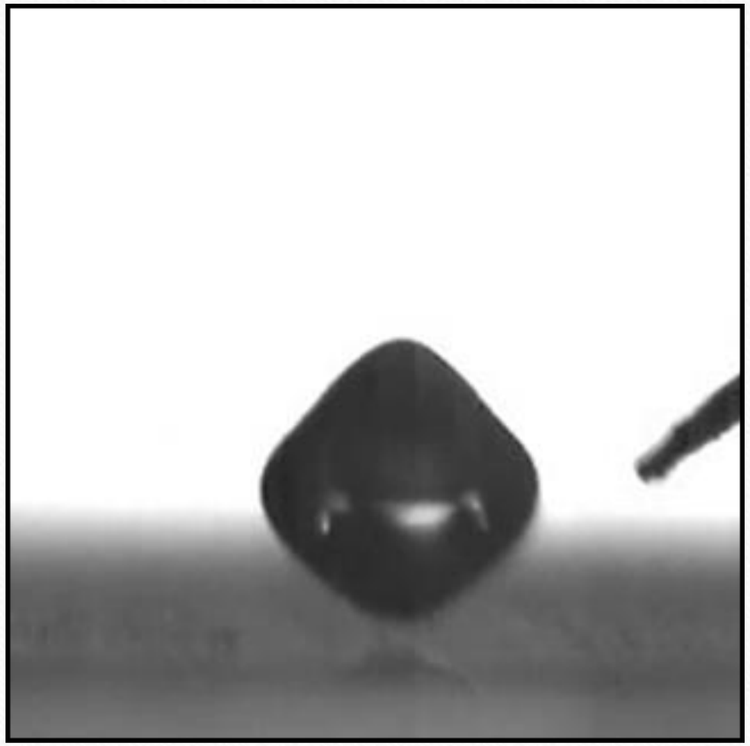
Experimental Results



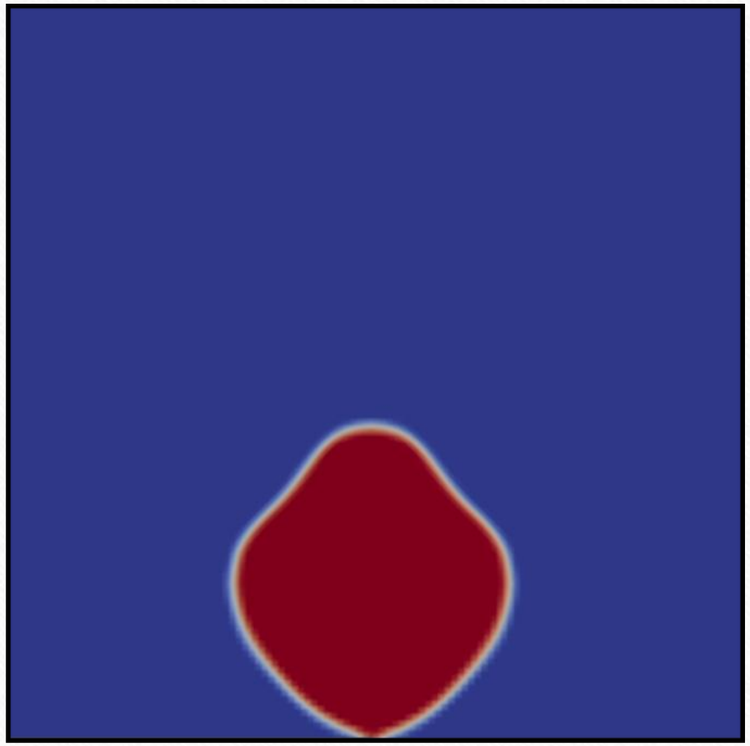
Simulation Results



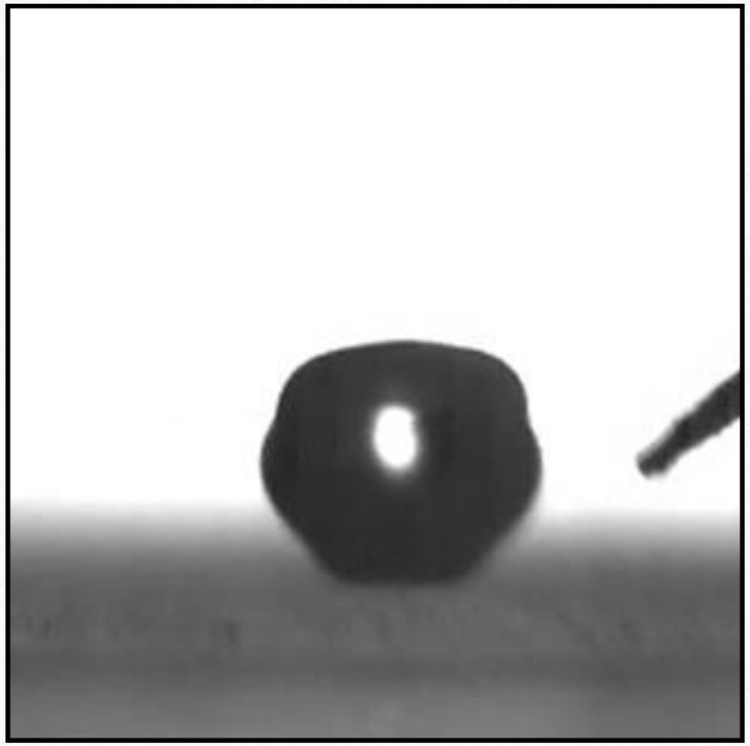
Experimental Results



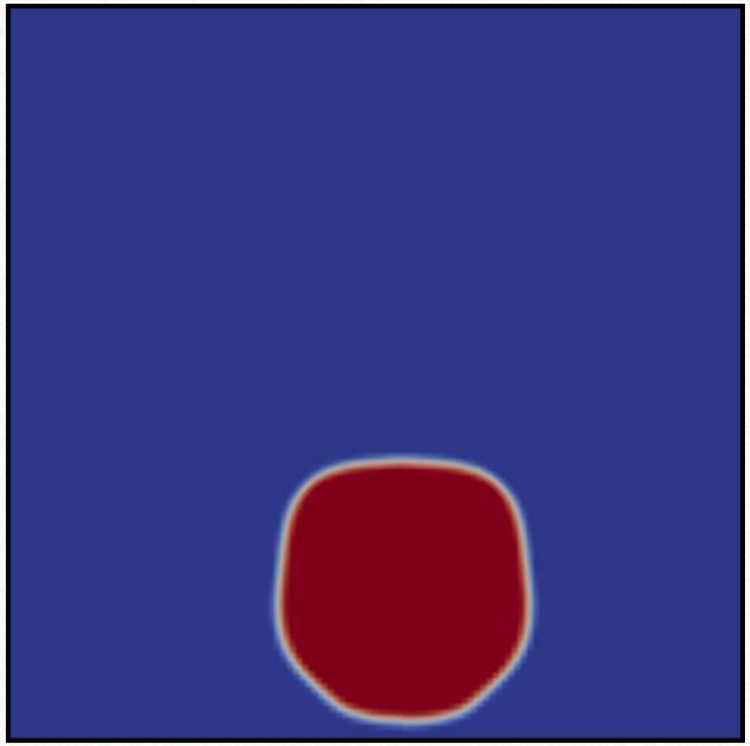
Simulation Results



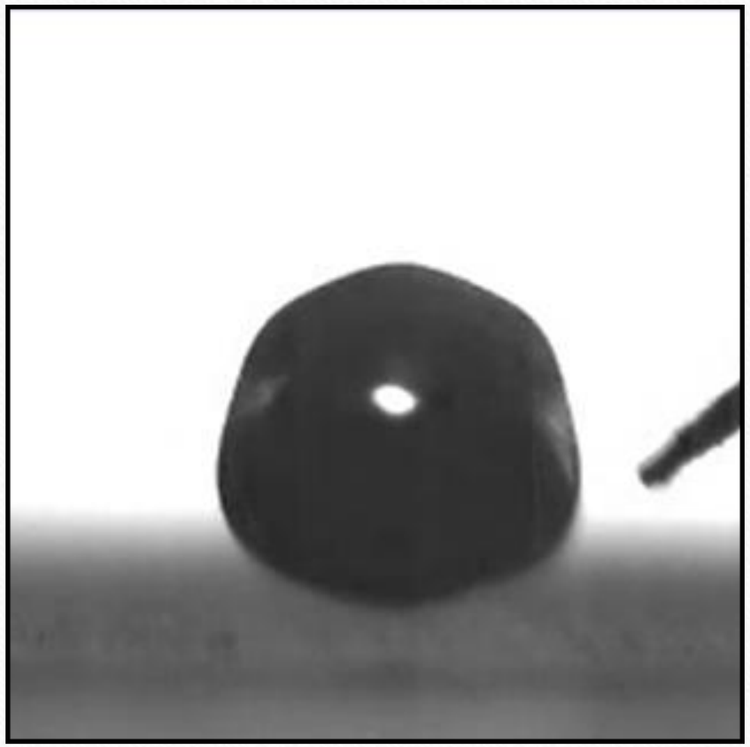
Experimental Results



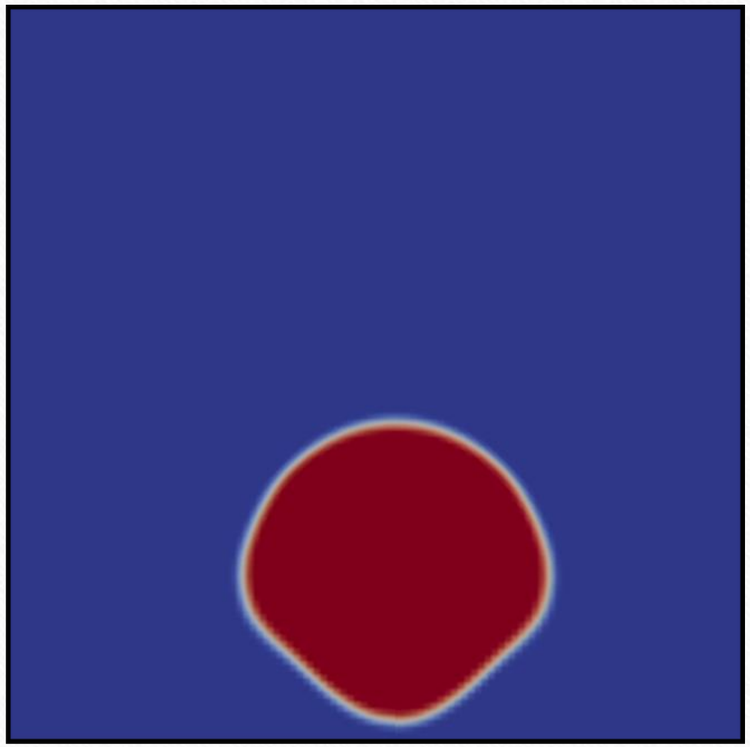
Simulation Results



Experimental Results



Simulation Results

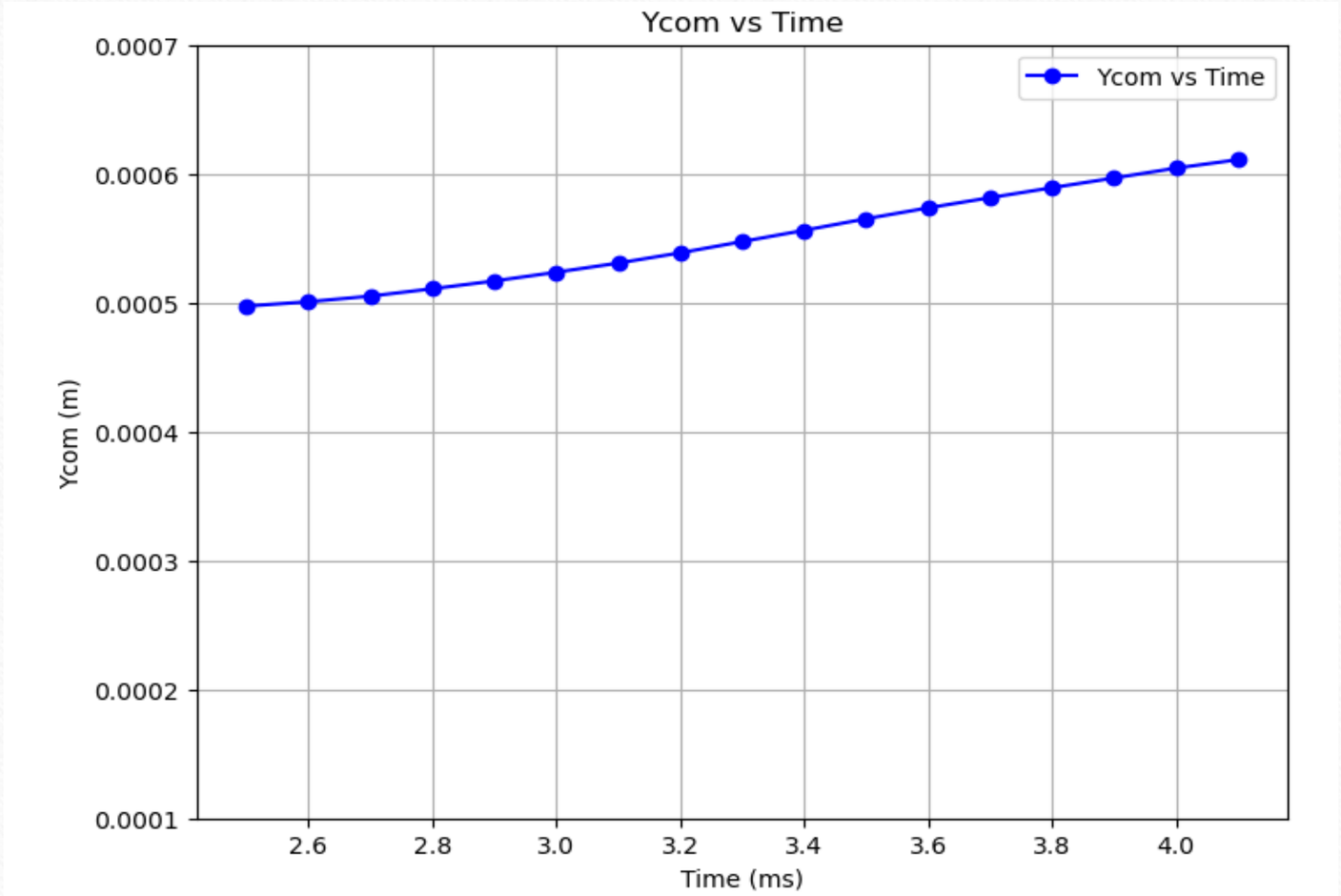


Result Video

COM Data

S No.	Time in ms	Ycom in m	Vcom in m/sec	Vcom(avg) in m/sec	V(experimental) in m/s	% Error
1	2.5	0.000497301				
2	2.6	0.000500689	0.03388			
3	2.7	0.000505048	0.04359			
4	2.8	0.000510769	0.05721			
5	2.9	0.000516811	0.06042			
6	3	0.000523604	0.06793			
7	3.1	0.000530682	0.07078			
8	3.2	0.000538646	0.07964			
9	3.3	0.000547353	0.08707	0.0872175	0.11	20.70%
10	3.4	0.000556096	0.08743			
11	3.5	0.000565055	0.08959			
12	3.6	0.000573533	0.08478			
13	3.7	0.000581407	0.07874			
14	3.8	0.000589157	0.0775			
15	3.9	0.000596661	0.07504			
16	4	0.000604357	0.07696			
17	4.1	0.000610865	0.06508			

COM Graph


Ycom vs Time
Ycom vs Time
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
Ycom (m)
2.6
2.8
3.0
3.2
3.4
3.6
3.8
4.0
Time (ms)

Droplet Impact Simulation Results

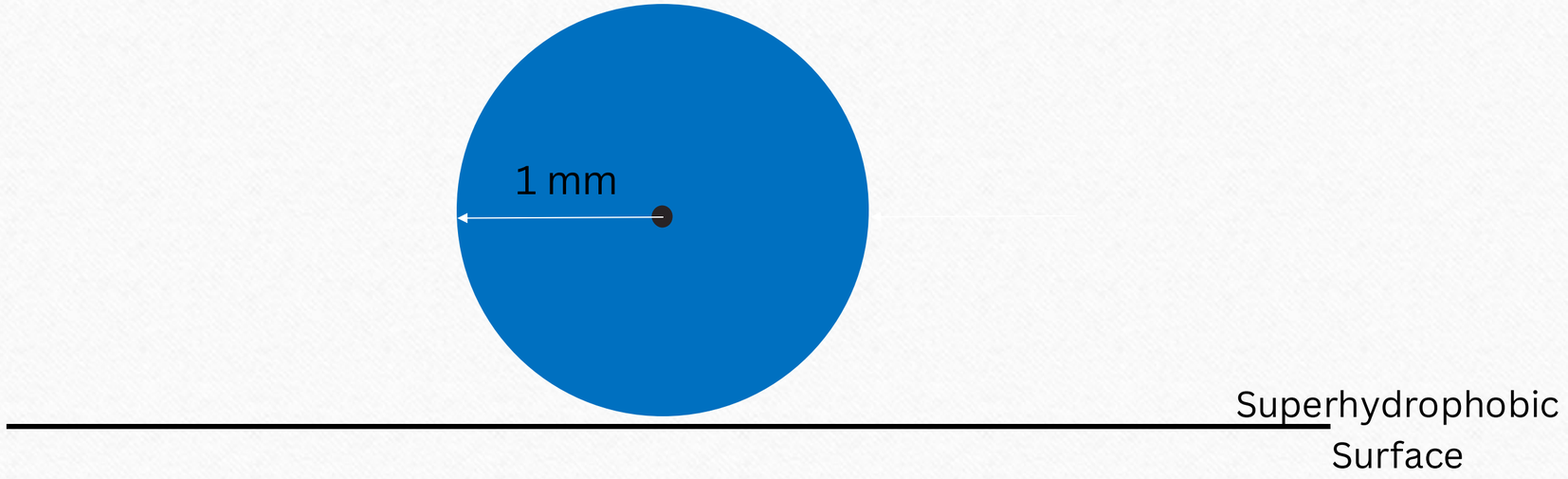
Problem Statement

This study investigates the impact dynamics of a **2 mm diameter droplet** on a **superhydrophobic surface**, comparing the spread factor evolution over time through **experiments and numerical simulations**. High-speed imaging will capture experimental data, while **VOF-based simulations in OpenFOAM** will provide numerical insights. The goal is to assess the accuracy of computational models in predicting droplet spreading behavior and understand the influence of superhydrophobicity on impact dynamics

Superhydrphobic Surface

Problem Statement

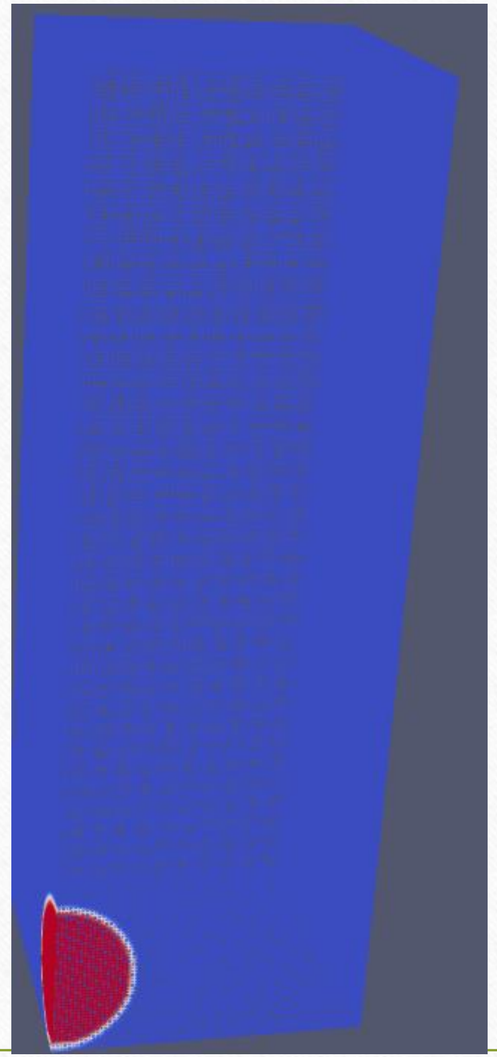
The droplet of diameter 2mm is kept just above the superhydrophobic surface and is released with the velocity of 0.96 m/s downward direction.

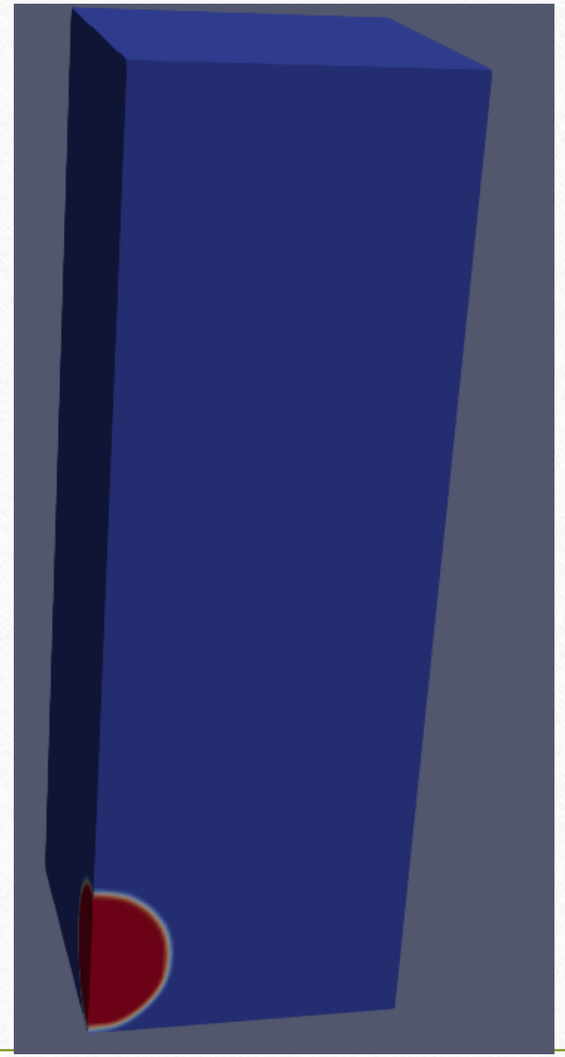


Diameter = 2mm
Velocity = 0.96 m/s

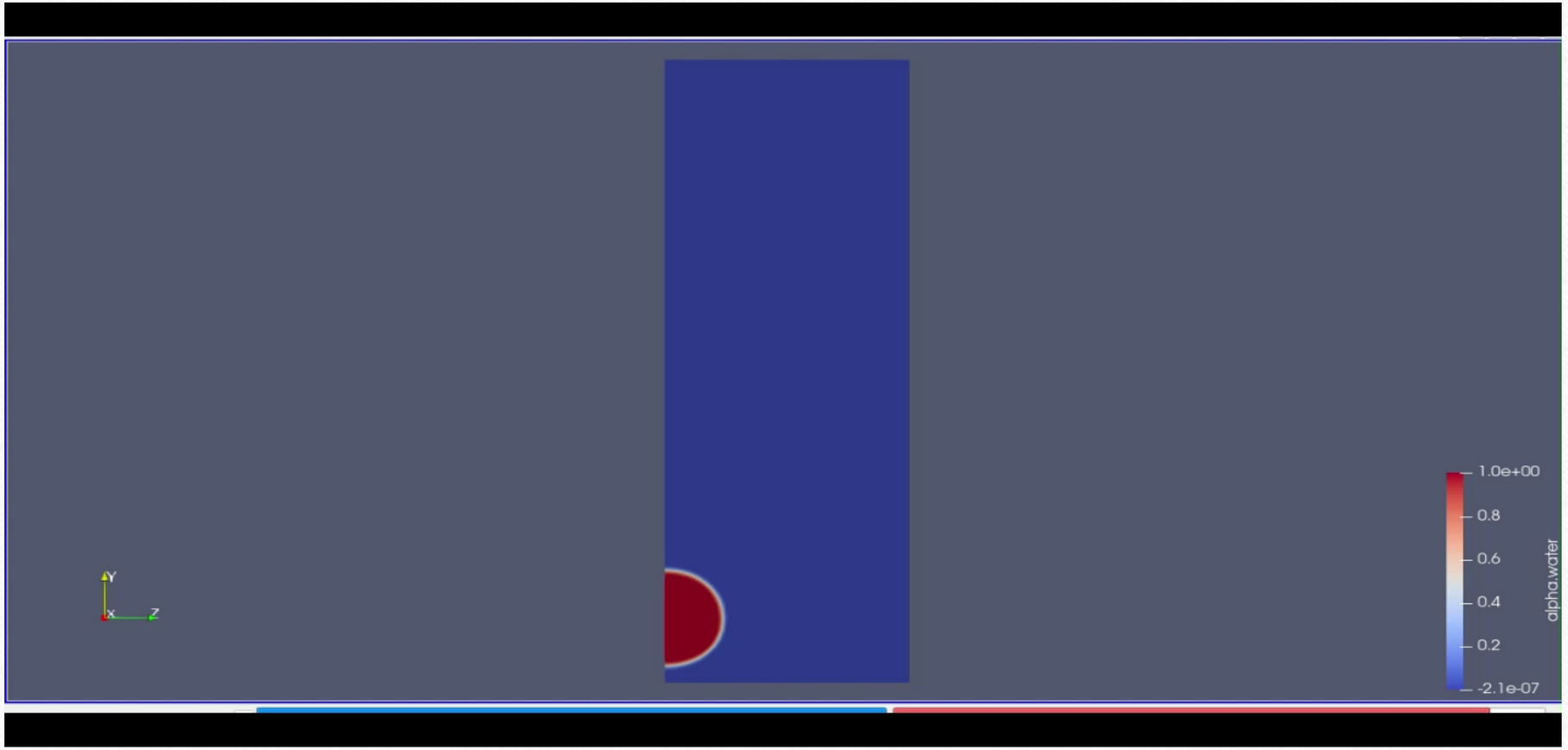
Computational Domain

- The domain is a quarter-symmetric block with half a droplet.
- Reflection generates a full droplets.
- Grid: 80×240×80.
- Domain size: 4mm X 12mm X 4mm

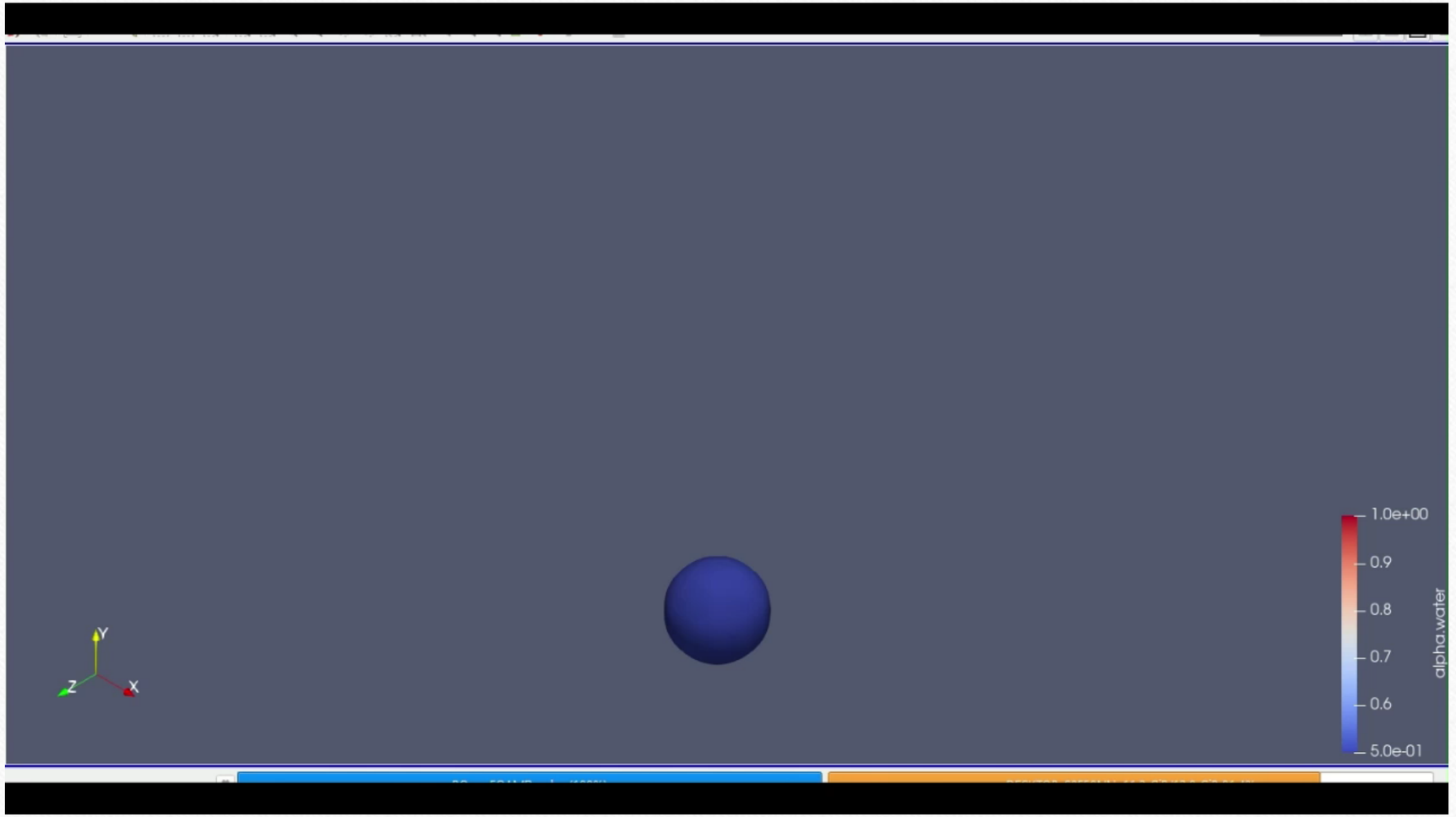




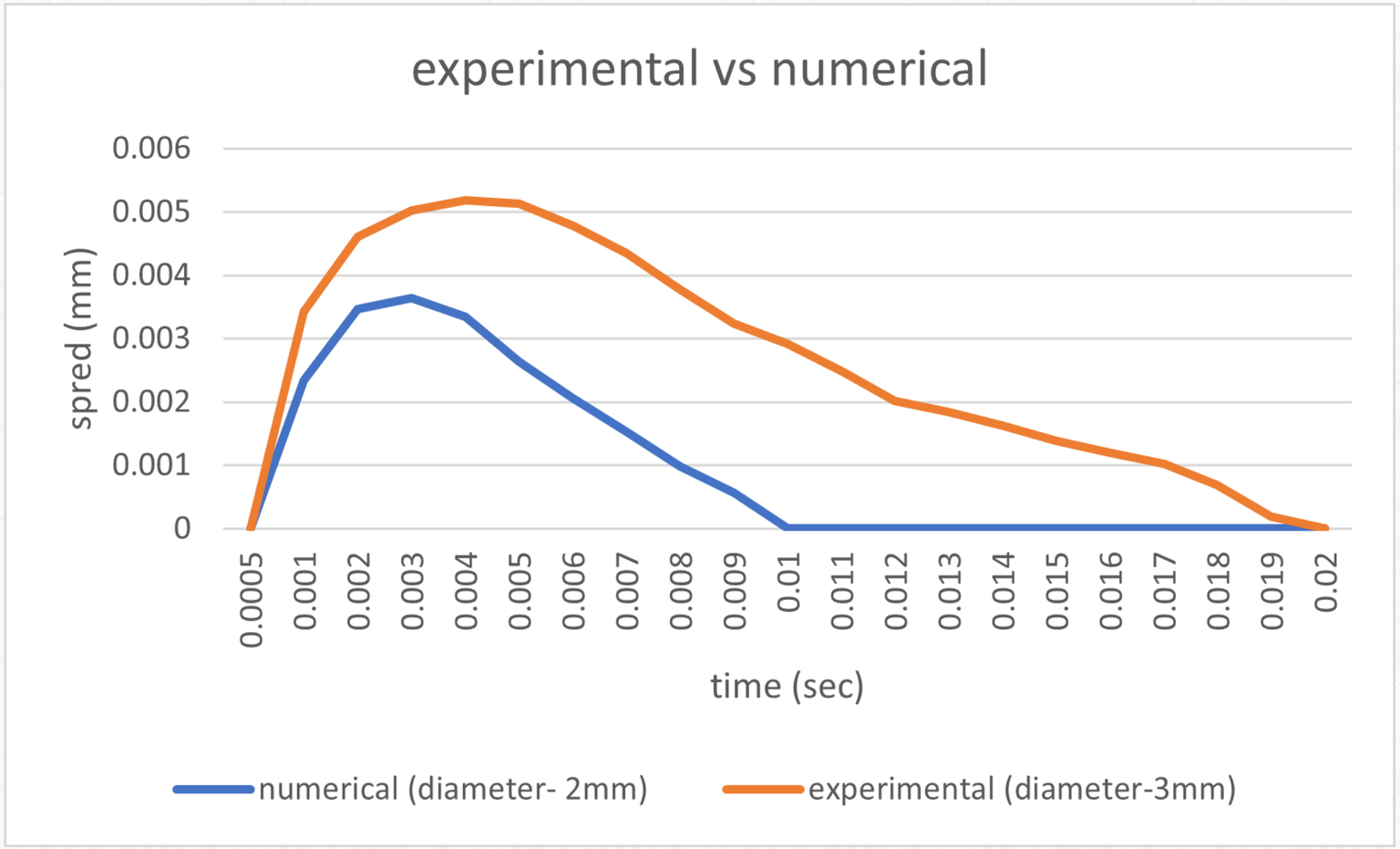
Simulation Results



Simulation Results



COM Graph


experimental vs numerical
spred (mm)
0.006
0.005
0.004
0.003
0.002
0.001
0
0.0005
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.01
0.011
0.012
0.013
0.014
0.015
0.016
0.017
0.018
0.019
0.02
time (sec)
numerical (diameter- 2mm)
experimental (diameter-3mm)