

# **Report on Deep Learning Enhanced Background Oriented Schlieren for analysis of droplet Evaporation**

Based on Work done by Partha Dutta , & KIRAN RAJ M

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## **Introduction**

The work is done to analyse the droplet evaporation after impact . This phenomenon involves following multiphysics

1. Coupled Fluid Motion
2. Heat Transfer and Phase Change

the surrounding vapour cloud influences the evaporation rate and so on droplets lifetime and stability

## **Objectives**

### **BOS Technique**

in BOS technique , the fluid we want to study is placed between a random dot pattern and a camera ,then a picture is taken for reference . then we take another picture when fluid is under study and compare both pictures .

## **Setup and Methodology**

### **setup**

1. background pattern : 20mm × 20mm field of view with dot size of 0.01mm( 1pixel)

and 54% dot coverage

1. droplet generation and impact condition :
  1. dilute acetone-water solution (1:3) ratio
  2. diameter of droplet : 2.5mm
2. geometric Parameter of BOS
  1. Z\_grad : distance between background and heated substrate
  2. Z\_lens : distance between lens and background

### **Methodology**

1. Two BOS video at 2000fps were recorded for reference and distorted background
2. frames were extracted , merged and cropped to 512 x 512 pixels
3. displacement field were obtained using cross correlation and physics based CNN to improve the quality of BOS images

## **Mathematical Modeling**

Based on displacement field , required refractive index is found out

$$\frac{\partial n}{\partial x} = c \Delta x$$

$$\frac{\partial n}{\partial y} = c \Delta y$$

where  $c = \frac{n_0}{2z_{\text{grad}}\Delta x_p}$  , where  $n_0$  is the refractive index of air ,  $\Delta z_p$  is the half width of field of view obtained from image calibration .

Based on the boundary condition of refractive index of air around it refractive condition of mixture is calculated to find out the concentration of droplet after impact

## **Result Discussion and Conclusion**

### **Comparison of resultant displacement field**

Cross correlation captures the overall droplet evaporation structure, but spatial window averaging reduces the effective resolution and increases the noise robustness

### **Result and Conclusion**

1. transverse droplet oscillations is observed after impact as evident in resultant displacement field
1. these oscillation arise due to competition between initial impact inertial, surface tension recoil and heat induced non uniform evaporation near the contact line on heated substrate