DESIGN AND SIMULATION OF A WETTING LENS FOR THE PINHOLE CAMERASOF A TWO PHASE FLOW SYSTEM

Presented

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HAVE A BRIEF IDEA

Outline of the Presentation

- Introduction
- Software Tool Used
- Design Details
  - Geometry
  - Physical Interface
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  - Providing Inputs
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1.Introduction

- **MEMS** is a fabrication approach that conveys the advantages of **miniaturization**, **multiple components** and **microelectronics** to the design and construction of integrated electro-mechanical systems.

- With the emergence of nano technology, MEMS has been focused on development of new fabrication techniques to be used in various optoelectronic devices.

- In electro-wetting the **balance of forces at the contact point is modified by the application of a voltage** between a conducting fluid and the solid surface.

Software Tool used

- The software package selected for solvation this design was **COMSOL MultiPhysics** software of V4.3.b

- This software is very powerful interactive software with environment by reliability

- This software is also capable of providing facilitates for **physical interfaces** these analyses which is highly essential for present design

Design Details

- The lens has been designed by using COMSOL software followed by fundamental steps:

- ❑ Defining geometry
- ❑ Adding material for forming solid structure
- ❑ Adding physical interfaces
- ❑ Meshing, simulation of model with inputs provided.

Defining Geometry

- The solid structure of the electro-wetting lens is obtained by taking geometrical properties of **Rectangle** and **Bezier polygon**.
- The Bezier polygon is a set of polygon segment that has two sets of rows which are divided as row1 and row2 for easier approach of **control points** in the structure, with **R=1.5 mm** and **Z = 0.55 mm** respectively.

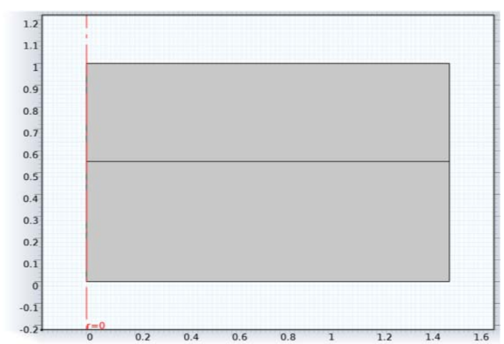

Figure1: Meshed Structure

Addition of materials

- A specific material is chosen from available database and properties are assigned in two forms of materials like material 1 (conducting fluid) and material 2 (insulating fluid) for clear modules for solid structure of the design with its respective domains in their field as below in table.

Material Properties

Property-I	**Expression**	**value**
Density	rho	1000
Dynamic Viscosity	mu	muoil
Property-II	**Expression**	**value**
Density	rho	1000
Dynamic Viscosity	mu	1.5

Physical Interfaces

- To obtain the conditions for the interfacing concept, we take two immiscible liquids for **fluid-fluid interface** and **wall-fluid interface**.
- As per young's equation the contact angle **before switching the voltage**:

  contact angle(θ_0): $\boldsymbol{\gamma s_1 * \sigma_{12} + \cos(\theta_{ew}) = \gamma s_2}$

- Here γs_1 is the surface energy per unit area between fluid 1 and the solid surface, γs_2 is the surface energy per unit area between fluid 2 and the solid surface, and σ_{12} is the surface tension at the interface between the two fluids.

Providing Inputs

Parameter	Expression	Value
Zero Voltage Contact Angle	theta0(θo)	140[deg]
Surface Tension	gamma(r)	0.05[N/m]
Insulating Fluid Viscosity	muoil	8 [Pa*s]
Relative Dielectric Constant	espr	2.65
Dielectric Constant	d_f	3[um]
Applied Voltage	Vapp	(0,120)[V]

Simulation

- The contact angle of a two-fluid interface with a solid surface is determined by the balance of the forces at the contact point.

- The equilibral finite quadrilateral elements are used for integrating the material elements for the meshing, as they are typically stiffer and form as webbed geometrical structure is plotted in side figure3.

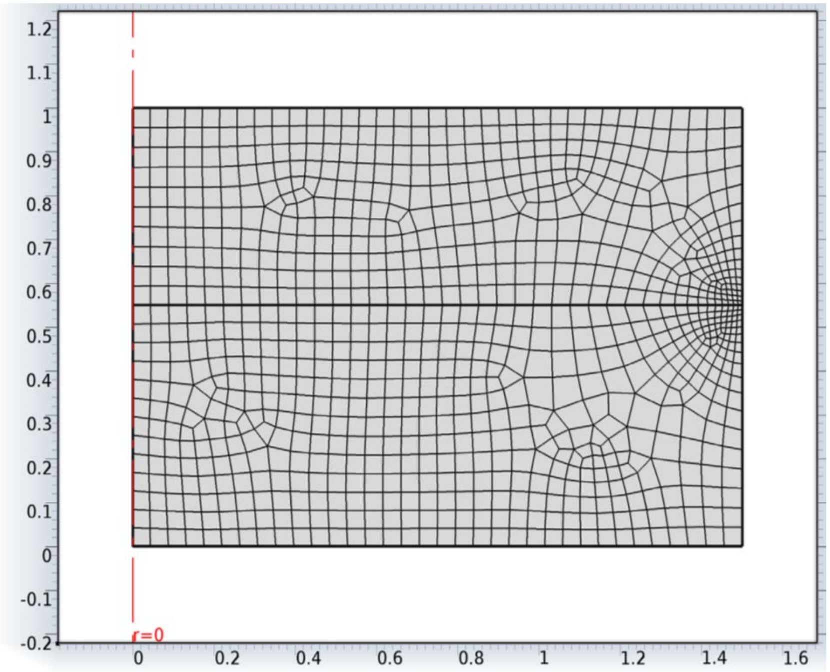

Figure3: Integrating the material elements

Experimental Results

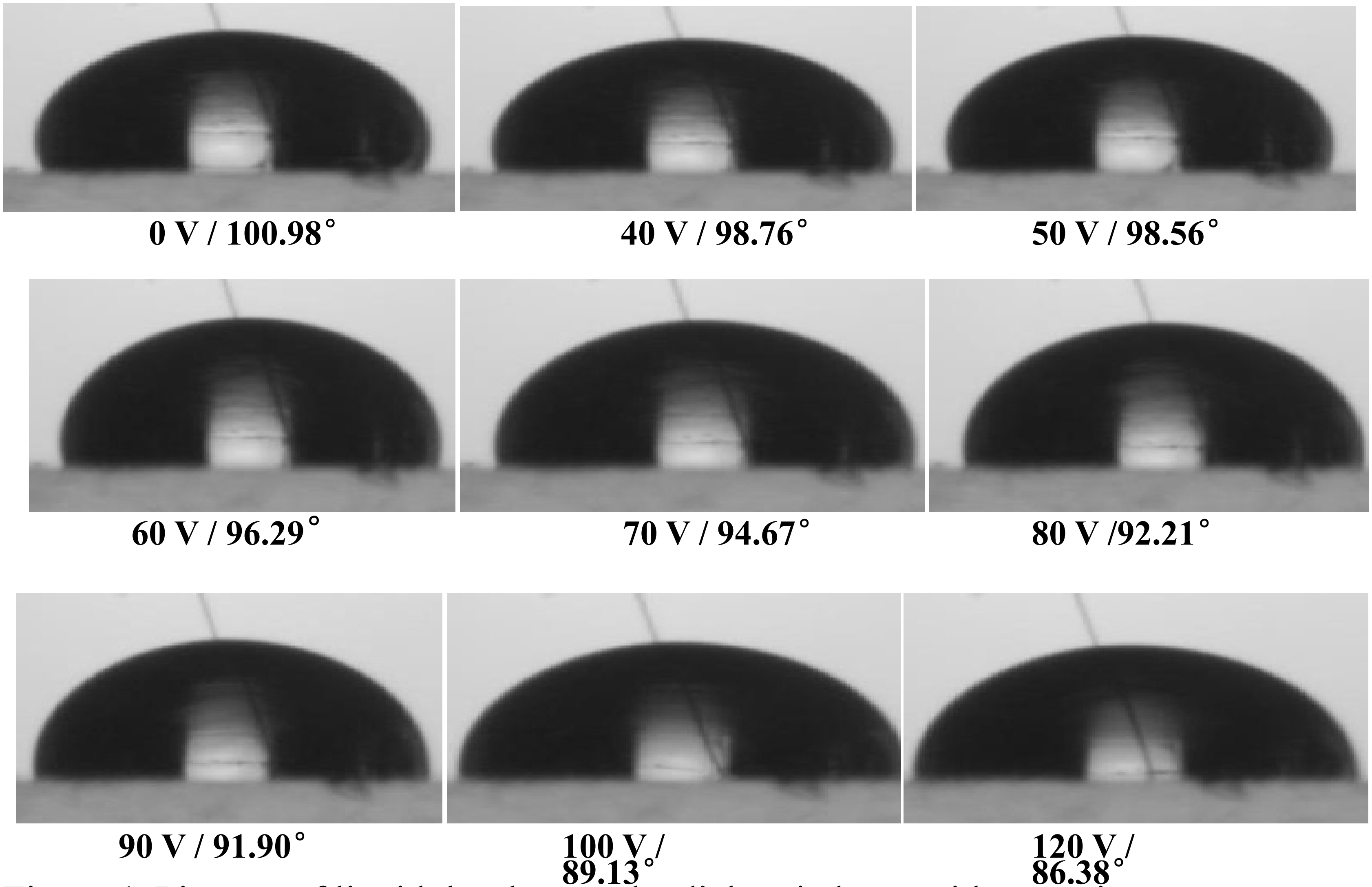

Figure 4: Pictures of liquid droplets on the dielectric layer with a continuous change voltage from 0 V ~ 120 V, applied by a DC power supply.

Experimental Results(Cont.)

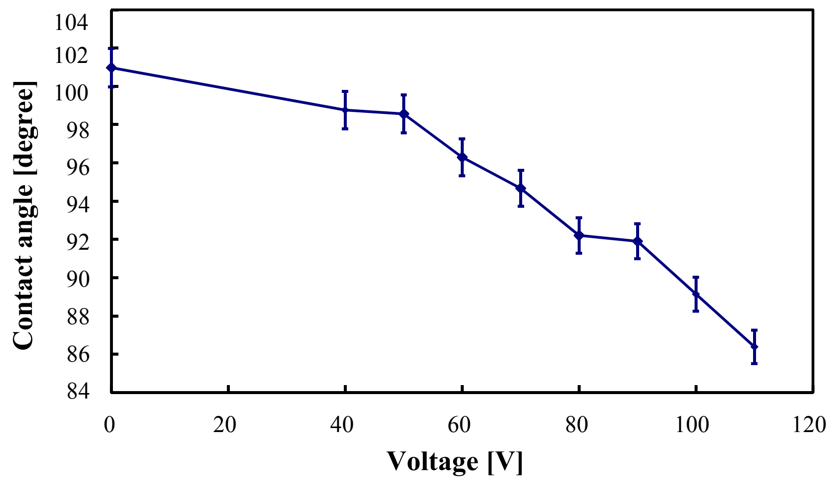

Figure 5: Measured contact angle versus the applied voltage. The conductive liquid droplet was 5 µl of 1% KCl solution.

In Figure 5, the voltage-contact angle curve of 5 µl volume of 1% KCl solution with the increased voltage is shown, based on the measurement in Figure 4. The contact angle decreased as the voltage increased from 0 V to 120 V. Saturation of the contact angle was observed for voltages higher than 120 V.

Conclusion & Future scope

- The concept shown in this work can be open to various designs. This electro-wetting lenses are highly recommended for the present emerging trends and mainly for bio medical applications.

- The key point is the application of gradients of wettability, which control the shape of the drop edge .

- In advanced version of these lenses can be used as filters with electro-wetting functionality has been suggested for cleaning oil spills and separating oil-water mixtures which are under construction stage.

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ANY QUERIES


Thank you!