DECLARATION

I, hereby, declare that the thesis entitled ***"Study of wettability features of natural superhydrophobic surfaces, biomimicking aspect, and electrowetting on dielectric surfaces"***, submitted to the School of Sciences, Tezpur University (TU), in partial fulfillment of the requirements for the award of the Doctor of Philosophy in Physics, has been carried out by me at the Department of Physics, TU, Assam, India-784028, under the supervision of ***Prof. Dambarudhar Mohanta*** (Supervisor). The contents of this work is original except where specific reference is made to the works of others and has not been submitted in whole or in part for consideration for any other degree or qualification in this or any other university or institute.

महेश चन्द्र दुबे

Mahesh Chandra Dubey

13/05/2025

Date

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Mahesh Chandra Dubey

Date

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CERTIFICATE OF THE PRINCIPAL SUPERVISOR

This is to certify that the thesis entitled ***"Study of wettability features of natural superhydrophobic surfaces, biomimicking aspect, and electrowetting on dielectric surfaces"***, submitted to the School of Sciences, Tezpur University in partial fulfillment for the award of degree of Doctor of Philosophy in Physics, is a record of research work carried out by **Mr. Mahesh Chandra Dubey** under my guidance and supervision.

All help received by his from various sources have been duly acknowledged. No part of this thesis has been submitted elsewhere for award of any other degree.

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Do philosophical questions remain the same at all time? Is there a 'Universal reason' or 'Universal law' driving everything that happens in nature? I would like to thank nature, made of eternal energies and mysterious arts, closest to God and the source of human spiritual energy. I express my gratitude to all the scientists, teachers, gurus, and philosophers who inspired the pursuit of understanding and learning the laws of nature in human civilization.

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(*Mahesh Chandra Dubey*)

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List of abbreviations and symbols

2D	Two-dimensional
3D	Three-dimensional
CA	Contact angle
WCA	Water contact angle
WCAs	Water contact angles
TCL	Three phase contact line
CAH	Contact angle hysteresis
T.A.	Tilting angle
CAS	Contact angle saturation
CB	Cassie-Baxter
CC	Cassie-Cassie
γ_{LA}	Liquid-air surface tension
γ_{SL}	Solid-liquid surface tension
γ_{SA}	Solid-air surface tension
θ_Y	Young's contact angle
r_ϕ	Wenzel roughness
r_M	Wenzel roughness for microstructure
r_N	Wenzel roughness for nanostructure
f	Water-solid fraction
f_M	Micro texture water-solid fraction
f_N	Nano texture water-solid fraction
D_{TCL}	Diameter of TCL
θ_w	Wenzel angle
θ_{CB}	Cassie-Baxter contact angle
θ_{CC}	Cassie-Cassie contact angle
θ_{CW}	Cassie-Wenzel contact angle
θ_{WC}	Wenzel-Cassie contact angle
θ_{WW}	Wenzel-Wenzel contact angle
θ_{adv}	Advancing angle
θ_{rec}	Receding angle
$\theta_\parallel$	CA along parallel direction
$\theta_\perp$	CA along perpendicular direction
$\theta(V_{\mathrm{app}})$	CA function of applied voltage
θ_V	CA function of voltage
θ_{sat}	CA saturation
φ	Spreading angle

α	Surface inclination/tilting/rolling angle
μm	Micrometer
We	Weber number
Re	Reynolds number
F_r	Froude number
Bo	Bond number
Ca	Capillary number
M_c	Mach number
l_c	Capillary length
u_i	Droplet impact velocity
D_o	Impacting droplet diameter
e	Restitution coefficient
N_F	Number of fibers
R_d	Drop radius
l_S	Segment length
L_P	Persistence length
σ_θ	Standard deviation
$P(\theta(l))$	Gaussian probability distribution function
p	Pressure field
p_a	Atmospheric pressure
$p_{\mathrm{a}'}$	Entrapped air pressure
τ	Viscous stress tensor
τ_c	Contact time
$\beta_{\max}$	Maximum spreading parameter
μ	Dynamic viscosity
ν	Kinematic viscosity
S	Spreading parameter
g	Gravitational acceleration
ρ_w	Density of water
ρ	Density of liquid
σ_{SL}	Surface charge density at solid-liquid interface
C	Capacitance
V_{app}	Applied voltage
ε_0	Permittivity of vacuum
ε_r	Relative permittivity of the dielectric (medium)
η	Electrowetting number
n_1, n_2	Refractive index of liquids
f	Focal length

Dedicated to the visionary scientists and enlightened gurus who ignited the eternal flame of pioneering discovery, shaping the path of human civilization with wisdom and moral integrity