

ME 6125 Mechanics of Viscous Fluid

Lecture 1

Dr. Abdul Aziz Shuvo

Assistant Professor

Department of Mechanical Engineering, BUET

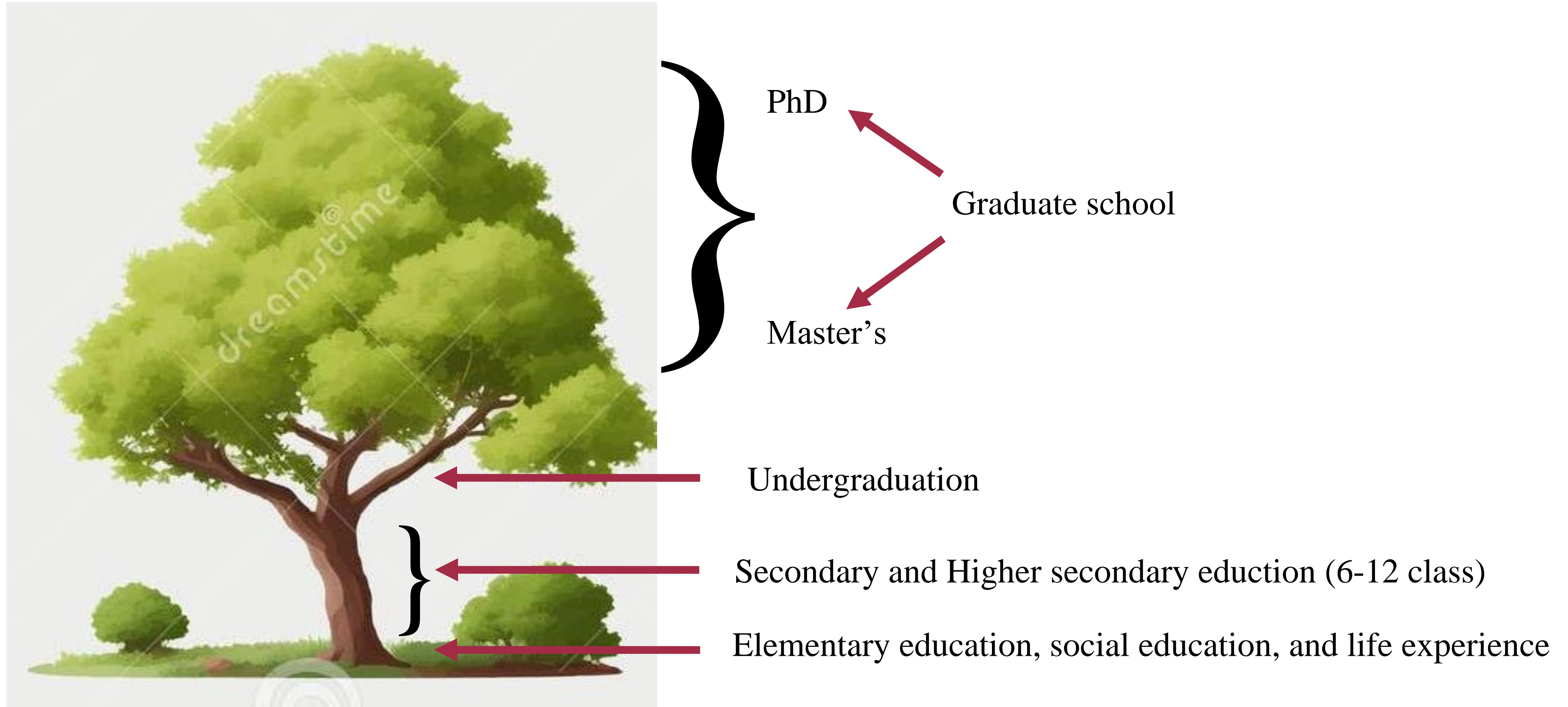


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IMPACT Lab
Interfacial Multiscale
Physics and Transport

Steps of education



Dr. Abdul Aziz Shuvo

• Education:

- Ph.D. - The Pennsylvania State University, USA (2025)
- M.Sc. - BUET (2022)
- B.Sc. - BUET (2019)

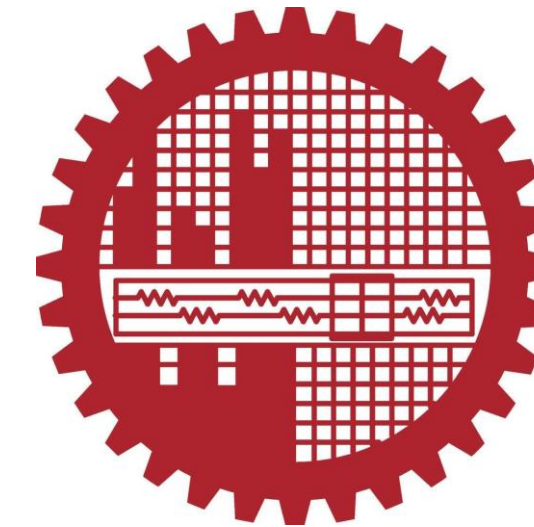


PennState
College of Engineering

**MECHANICAL
ENGINEERING**

• Professional Affiliation:

- Assistant Professor, ME, BUET (2022-present)
- Lecturer, ME, BUET (2019-2022)
- Principal Investigator, Interfacial Multiscale Physics and Transport (IMPACT) Lab at BUET

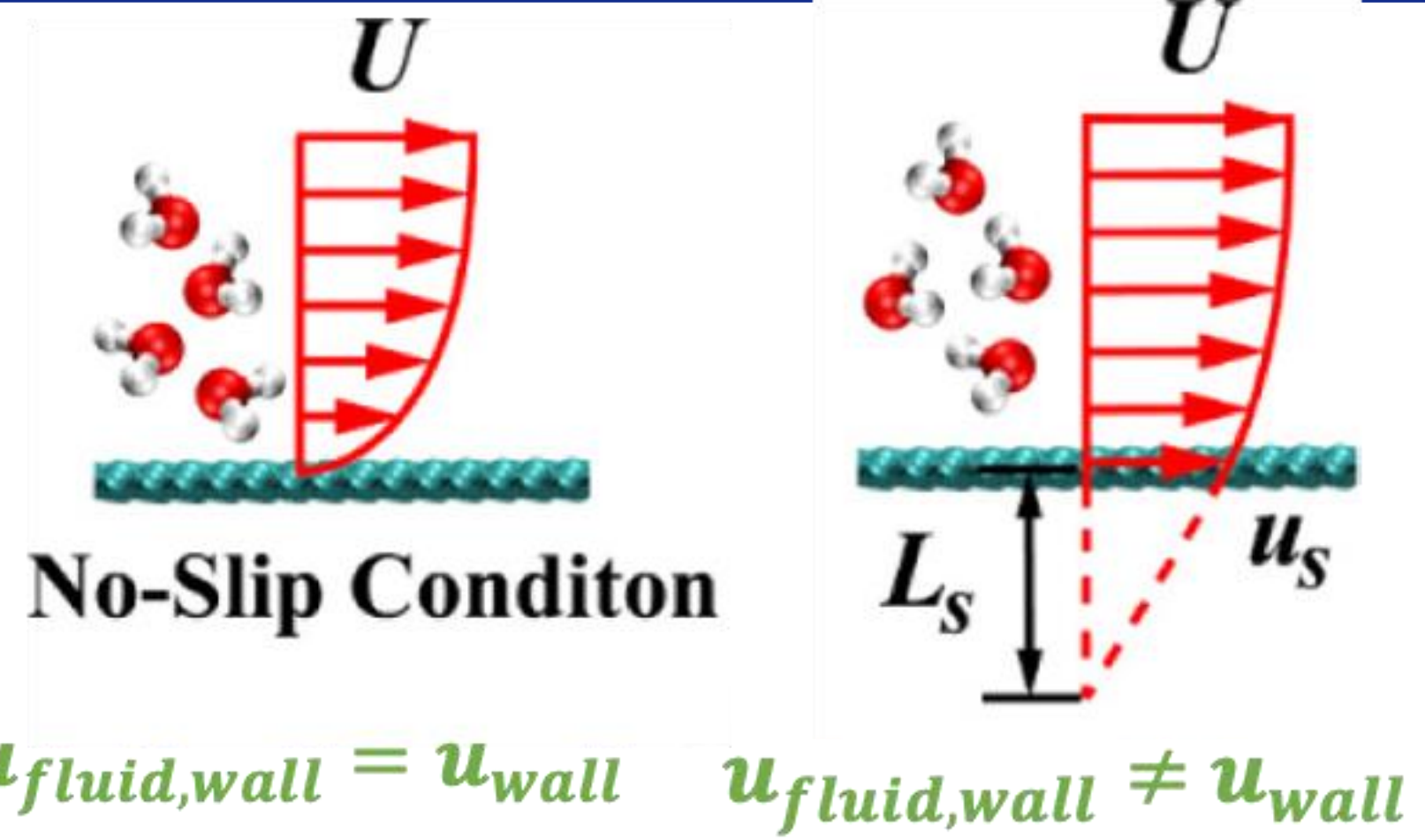


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Physics and Transport

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Motivation for my research

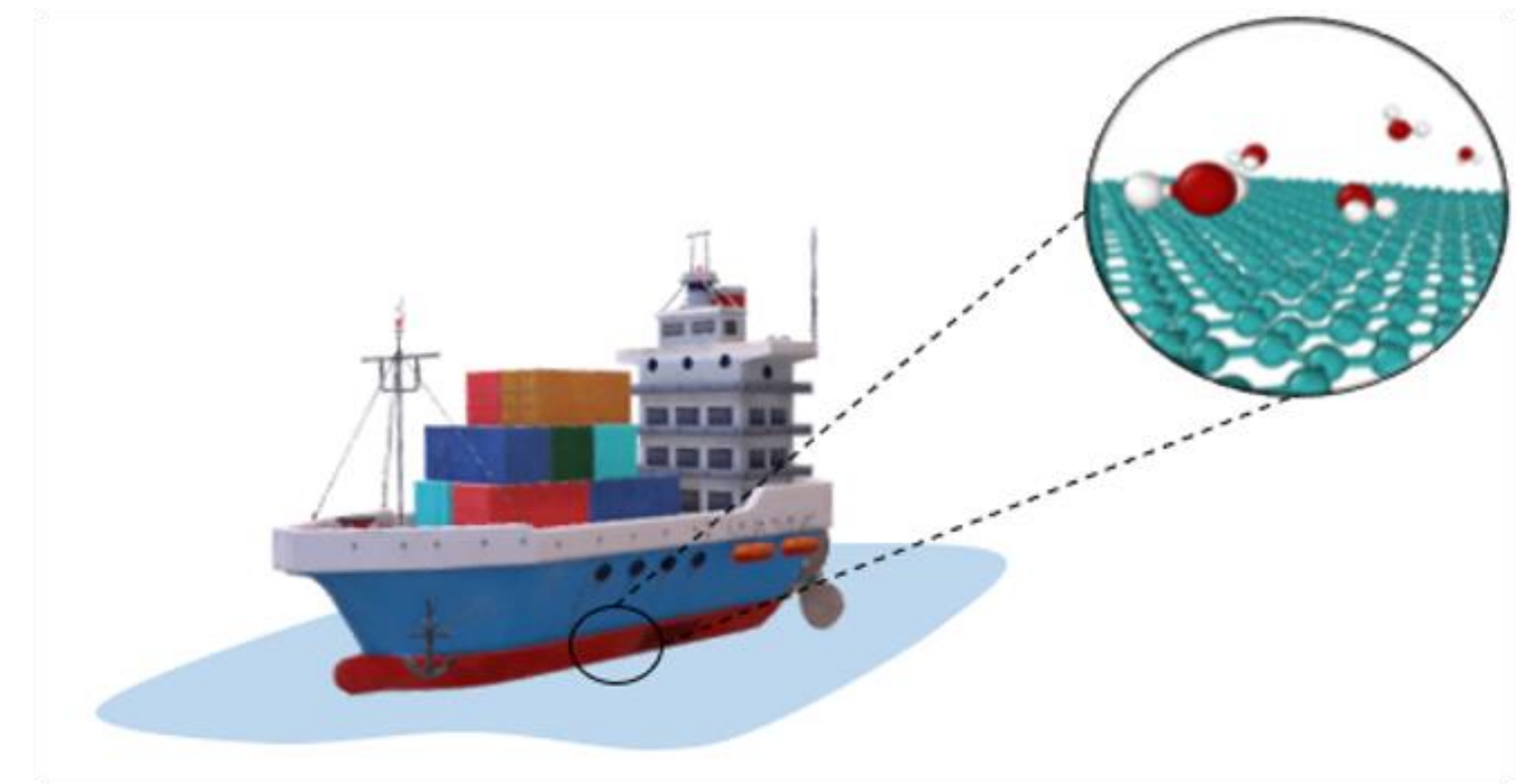
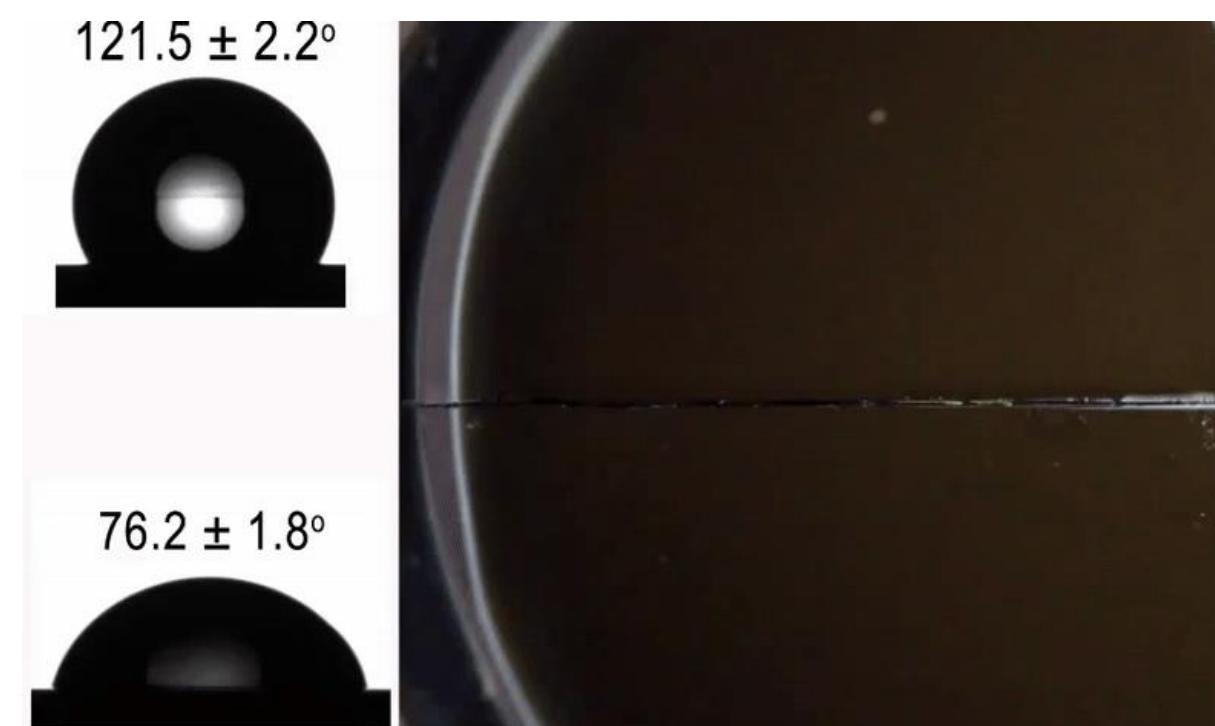


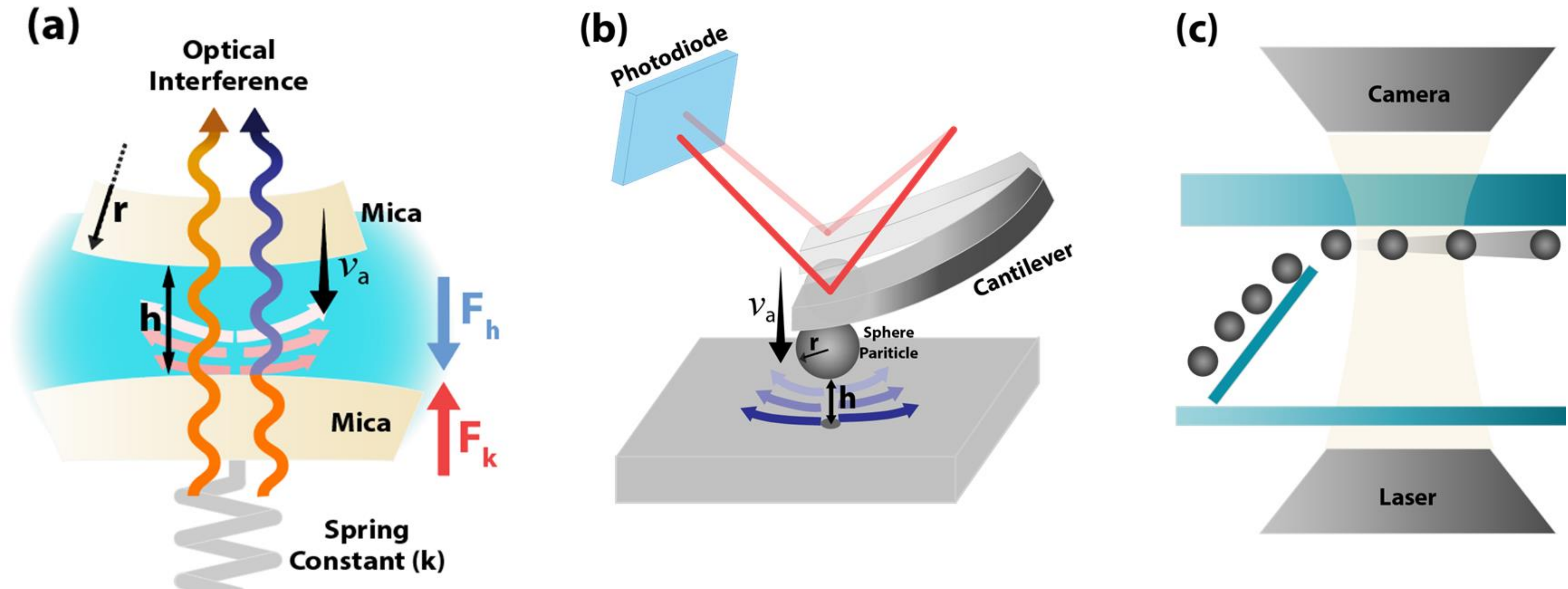
- Hydrodynamic slip is quantified by slip length (L_s).
- Frictional drag is a dominant source of hydrodynamic energy loss.
- In naval industry, it can account for as much as 80% of total energy losses.
- **30% drag reduction** can save up to **USD 38 billion** per year in ship industry.

Hydrophobic surface in nature

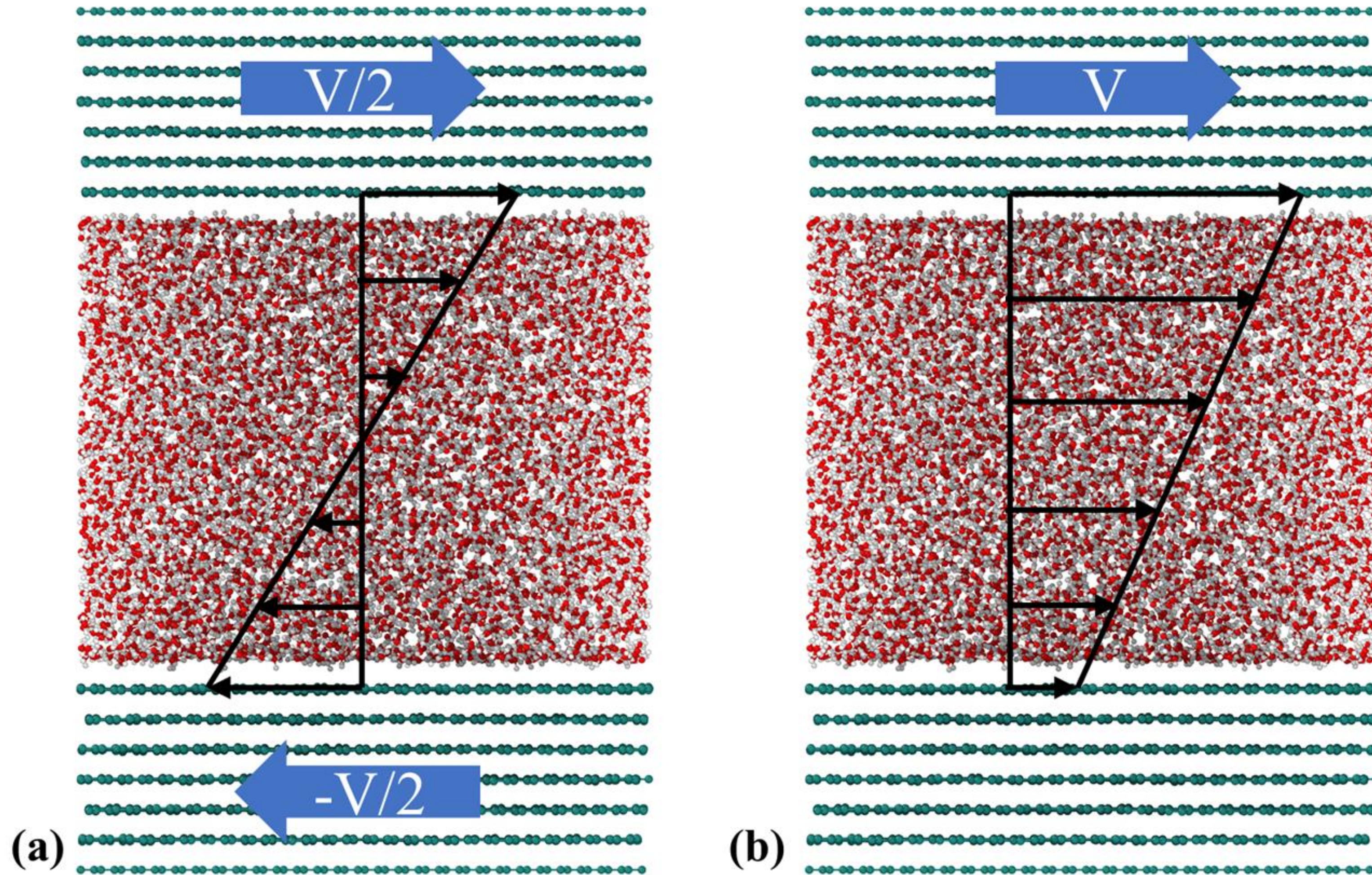


Engineered surface to facilitate hydrodynamic slip

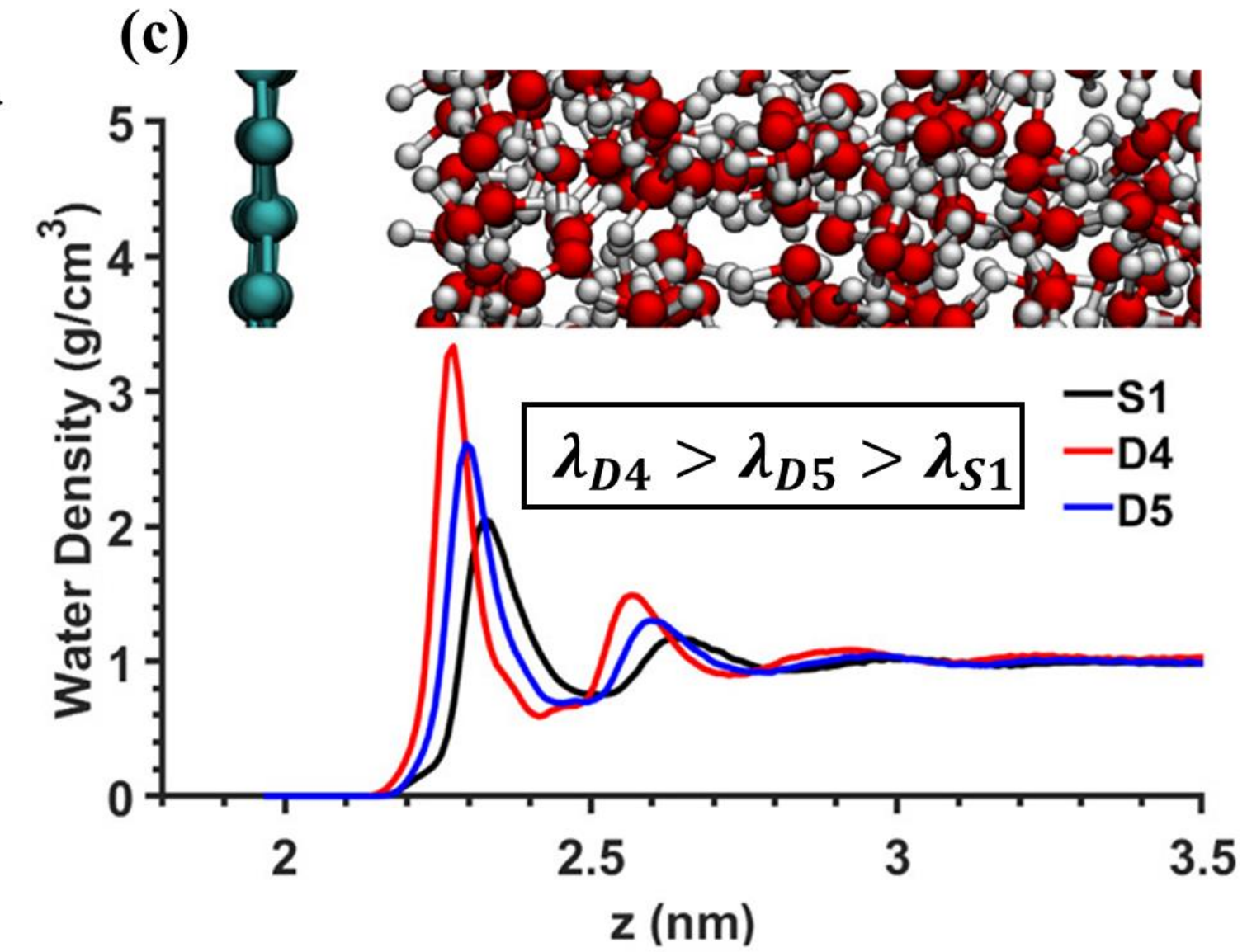
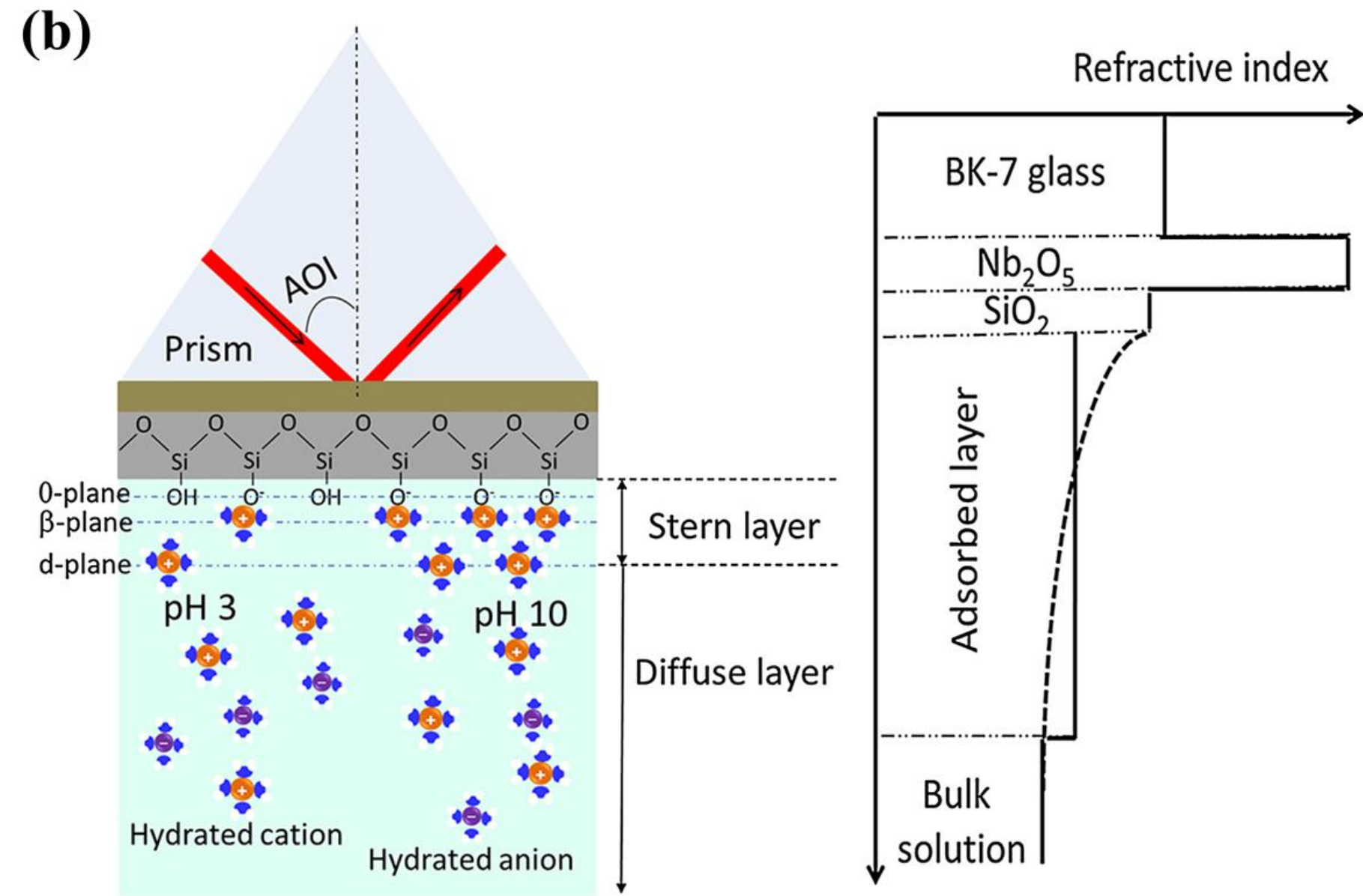
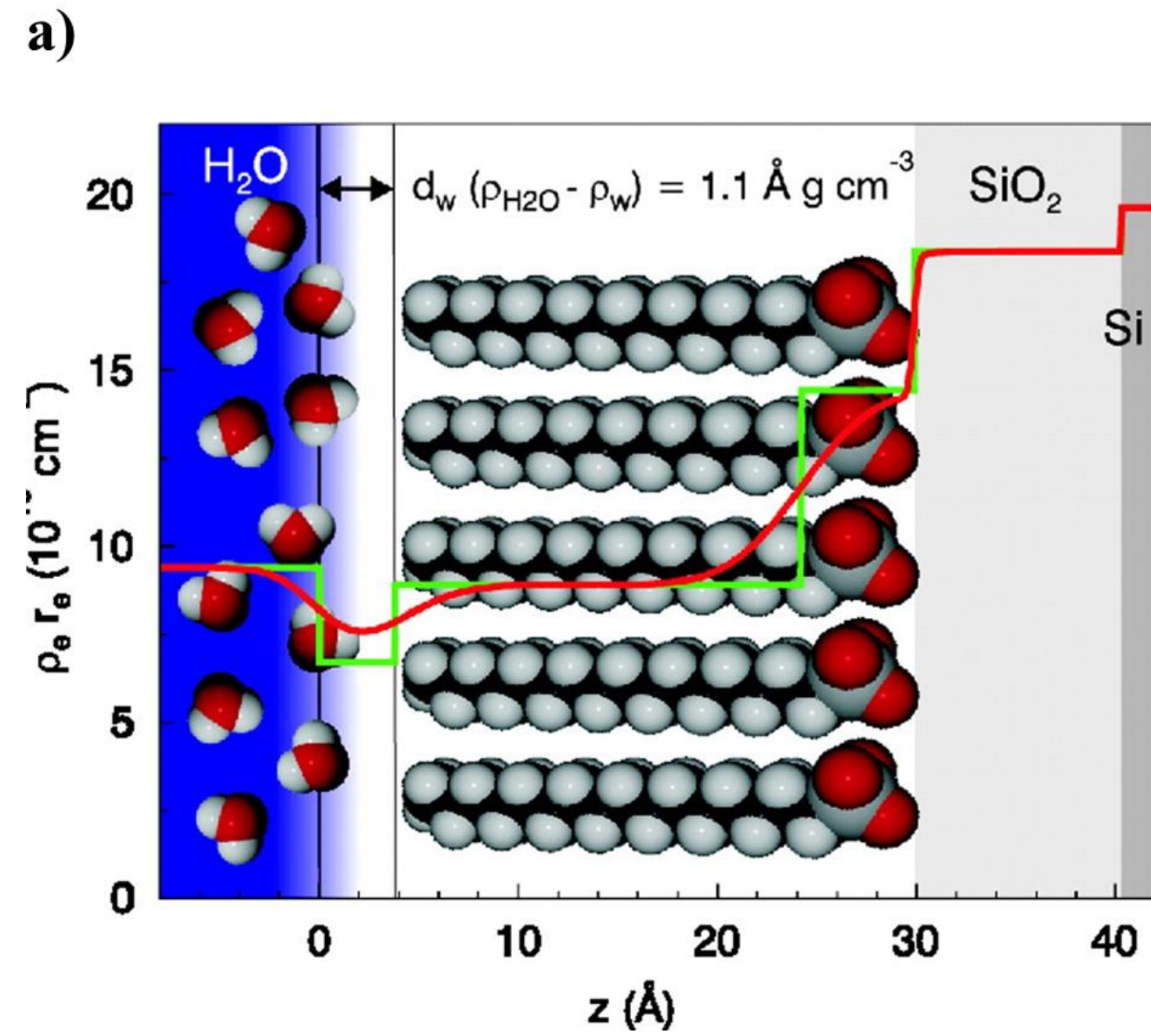




Molecular modeling

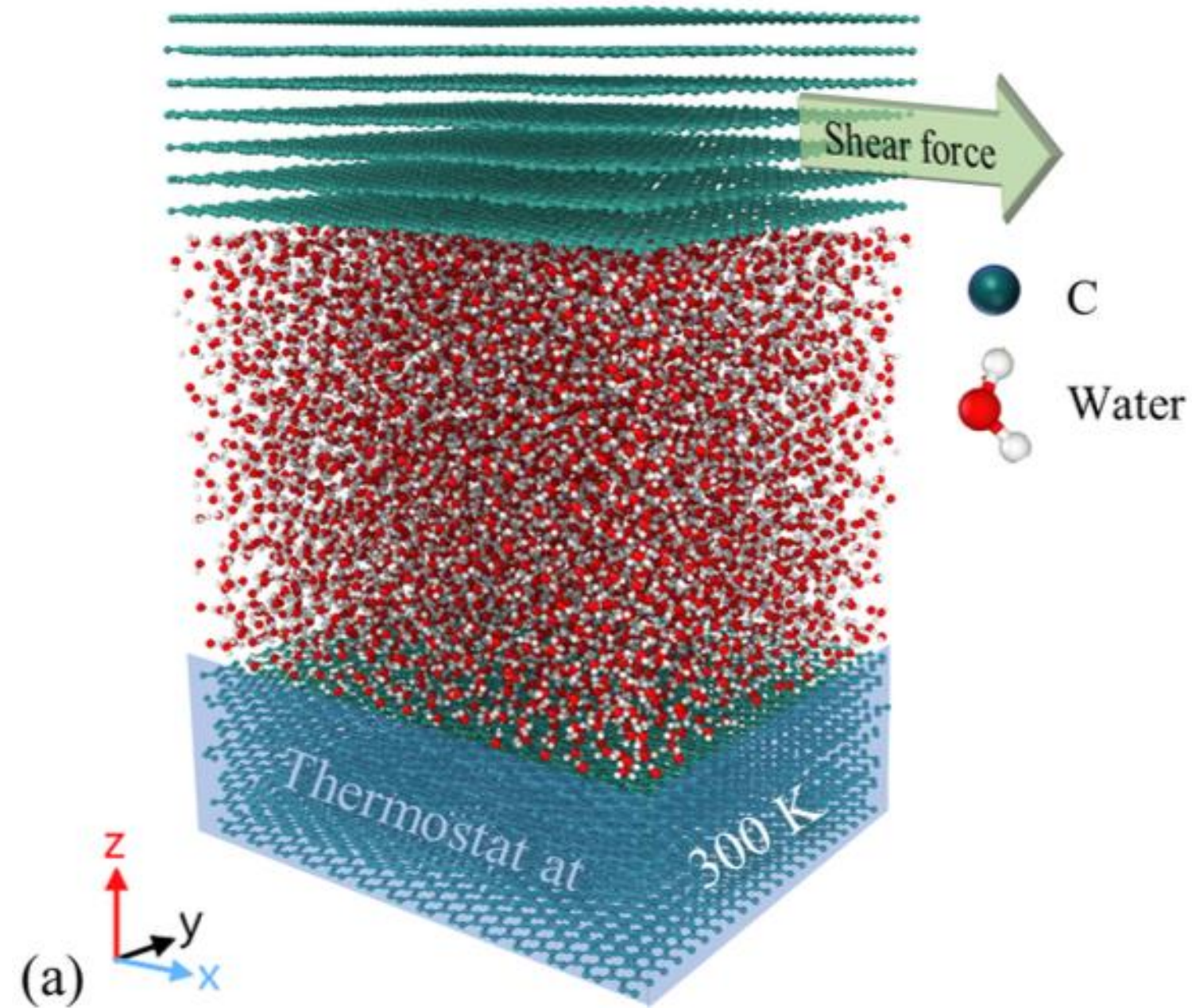


Revealing science

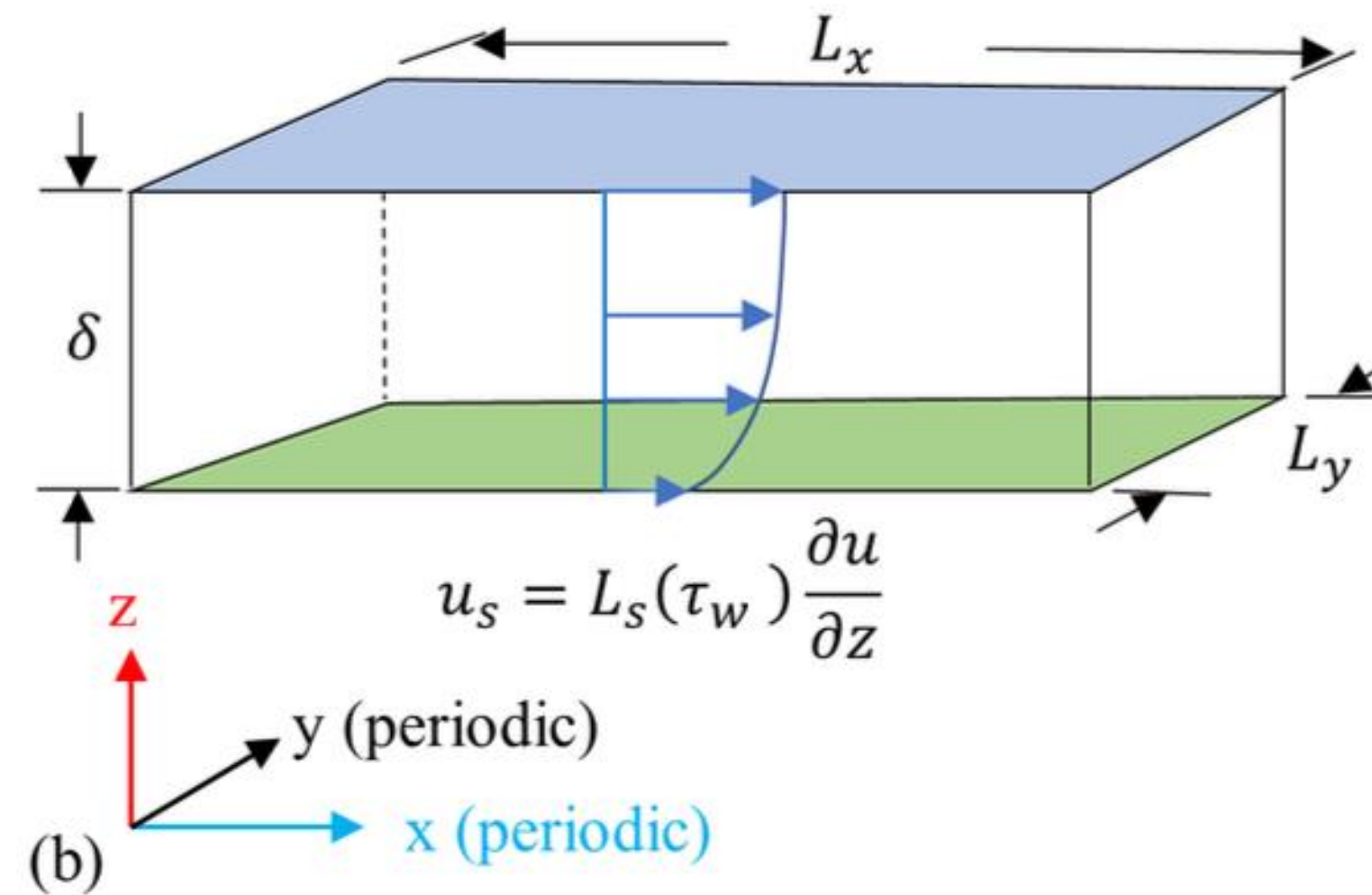


Applied in Macroscale

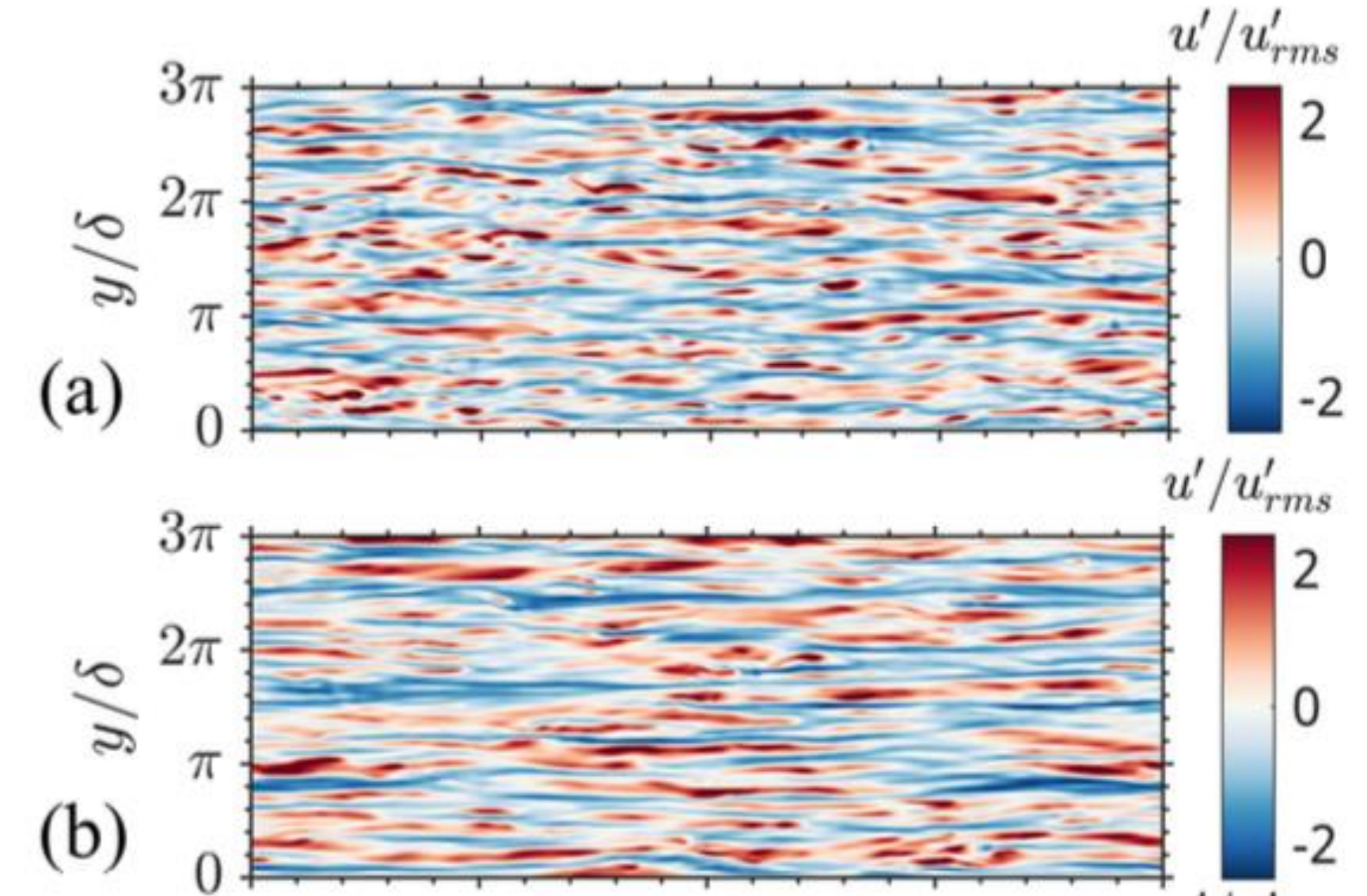
Atomistic model



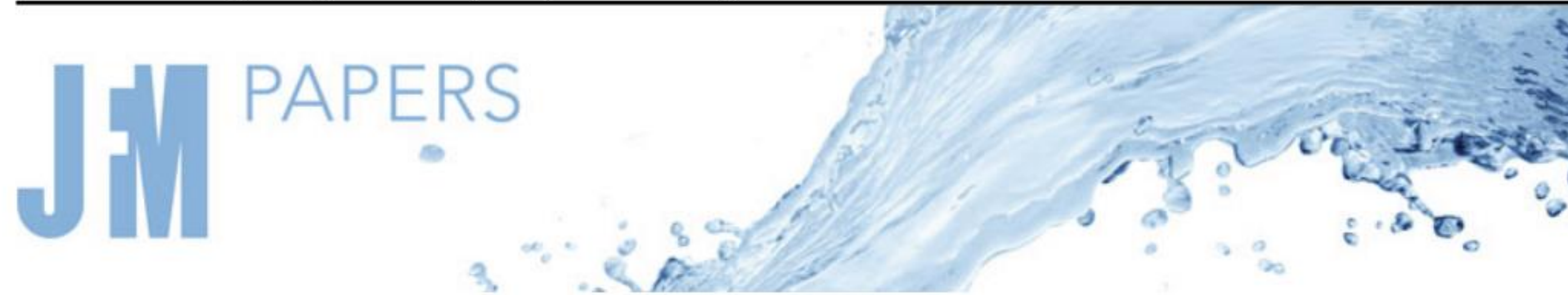
CFD Domain



Flow field at the wall



J. Fluid Mech. (2026), vol. 1030, A65, doi:10.1017/jfm.2026.11309



Direct numerical simulations of channel flow with a molecular-dynamics-informed wall slip boundary condition

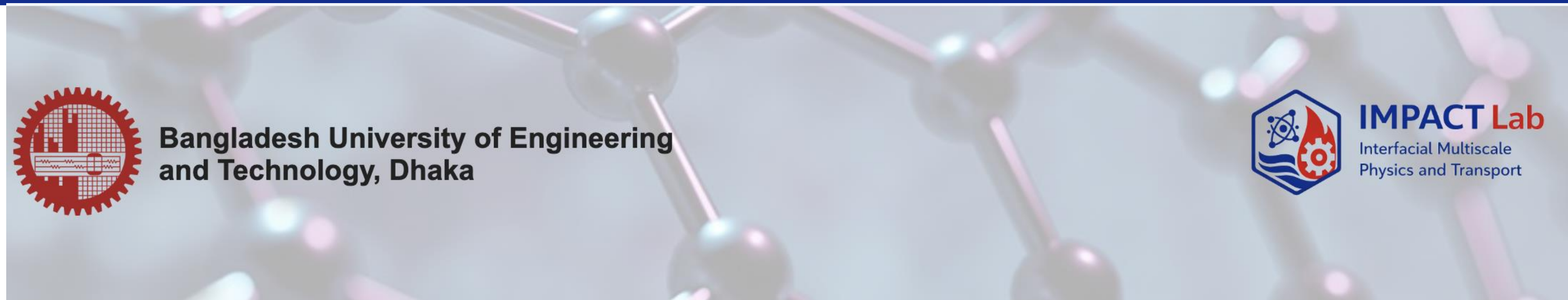
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IMPACT Lab Research

The **Interfacial Multiscale Physics and Transport (IMPACT) Lab** focuses on understanding and modeling transport phenomena across length scales—from atomistic interfaces to continuum and turbulent flows. Our goal is to develop **physics-informed models** and **machine-learning-assisted approaches** that enable predictive simulations for advanced thermal and fluid systems.

Research Themes

- **Interfacial Transport (Solid–Liquid Interfaces):** Thermal and momentum transport, surface chemistry effects, interfacial structure, and electric double layer (EDL) influences.
- **Slip and Drag Reduction:** Molecular-scale origins of hydrodynamic slip and friction and their translation to continuum-scale boundary conditions.
- **Turbulence and Wall Models:** CFD studies of turbulent wall-bounded flows with physics-informed and shear-dependent slip boundary conditions.
- **Multiscale & Multiphysics Modeling:** Bridging molecular dynamics (MD) and continuum simulations for predictive modeling across scales.
- **Machine Learning for Transport Modeling:** ML-assisted surrogate models, data-driven closure relations, and physics-informed learning for interface-aware CFD.

Methods and Tools



Dr. Abdul Aziz Shuvo

Ph.D. (The Pennsylvania State University, USA)

M.Sc. Engg (ME, BUET)

B.Sc. Engg (ME, BUET)

Assistant Professor

Mechanical Engineering
BUET, Dhaka-1000, Bangladesh



- We will meet **twice** (3 hrs) in a week.
 - Lectures, video/animations, class discussion
 - Class note will be available in my website: <http://shuvo.buet.ac.bd/>
- **Do's**: interact with me, attentive to your class, keep happy.
- **Don'ts**: don't get late in the class, no talking to each other during lecture, no cheating in the exams, assignments.
- **Office hours**: Every Monday **4pm- 5pm** at ME 215. Please **email me** to schedule a meeting.



- Introduction: Review of UG, Kinematics, Conservation laws, Differential Analysis: NS equations, Laminar boundary, Turbulence: introduction, RANS,
- Grading policy:

| | |
|--------------------|------|
| Assignments | 30% |
| Presentation | 20% |
| Final Exam | 50% |
| Total | 100% |
| Attendance (bonus) | 5% |

Textbook (Suggested)

