

SOFT MATTER IN CONFINEMENT AND UNDER POTENTIAL CONTROL

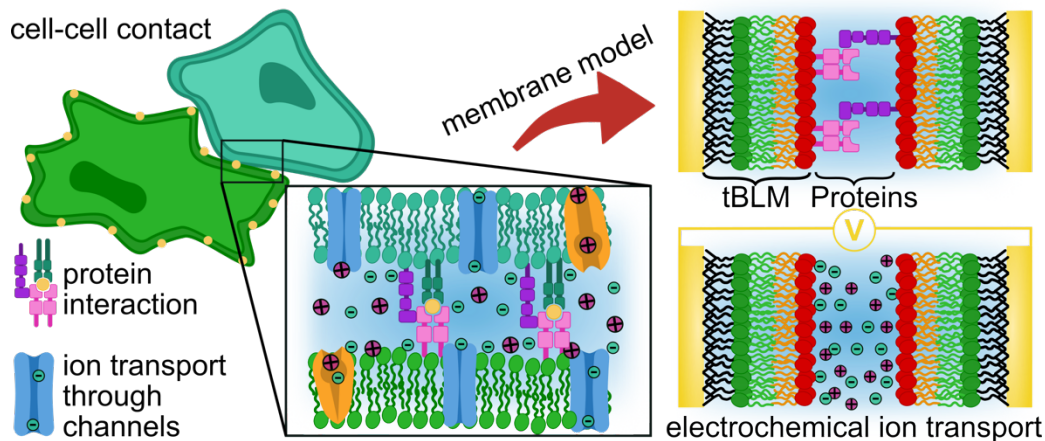


Figure 1. Cell membrane schematic of the interface of cells. The lipid bilayer incorporates proteins acting as channels and pores as well as receptors to sense other cells and bind to each other. In a recent work we developed this general structure for modelling a complex membrane system for measuring forces and interactions during approach and separation and during charging and recharging of membranes. In this work we will extend this to more complex and realistic systems.

Supervisory Team¹

Primary Supervisor: Markus Valtiner is full professor at the institute of applied physics at TU Wien. He did his PhD at the Max-Planck-Institute (MPI) in Düsseldorf in the department of Martin Stratmann (DE), and his post doc at University of California with Jacob Israelachvili in Santa Barbara (USA). His work is focused on measuring and steering molecular interaction forces in biologic systems, with a focus on membrane physics and physics and chemistry in confined spaces. In his work he uses instruments such as single molecule atomic force microscopy, the surface forces apparatus, or optical tweezers.

TU Wien project partners: Univ. Prof. Dr. Gerhard Kahl, Univ. Prof. Dr. Gerhard Schütz

External academic partners: Prof. Dr. Sapun Parekh, University of Texas (Austin) and/or Prof. Dr. Xavier Banquy, University of Montreal

External industry partners: CEST Center for Electrochemical and Surface Technology GmbH, Excellence Center of the Austrian Research Promotion Agency (FFG)

Project Description

Soft matter, in confinement and under variation of electrochemical surface potentials, is central to life as such. Precisely, biologic life is compartmentalized into confined spaces, and closely approaching cell membranes mediate forces that can steer genomic expression, drive intercellular communication and mediate adhesion. In this project we will measure and

¹ The Early Stage Researchers (ESRs) will be accompanied during their thesis by an individual “Thesis Advisory Committee” (TAC), which will guide the ESR through the graduate studies. The TAC will consist of the thesis primary supervisor, and two additional members of the Supervisory Team selected by the ESR.

simulate consequences of confinement and approach of two cell membranes, while varying their surface potential. We will evaluate structures and forces mediated by the assembly of polymeric model compounds that resemble typical plasma membrane structures. Specifically, we will use e.g. glycosylated lipids, protein binding lipids and we will, both experimentally and theoretically, study the close approach of such structures in symmetric and asymmetric systems and against polarizable surfaces. In the later stages of the work, we will apply the fundamental advances to studying realistic surfaces, aiming to uncover technologically exploitable features such as bacteriophobic surface coatings, or force mediated genomic expression in collaboration with external industrial experts.

Key Goals and Tasks

The primary aim of this PhD thesis is

- Working with atomic force microscopy, optical tweezers, and the surface forces apparatus to measure and characterize molecular level interactions
- Uncover new forces and interactions and interfacial design principles that are technologically exploitable
- Collaborate with theoreticians to simulate experimental data
- Visit an academic collaborator for 3-6 months to perform complementary spectroscopic measurements (to be decided during the work when will be an ideal timing)
- Collaboration with external industrial experts for evaluating commercial potential of discoveries made
- Preparation of scientific publications as first author.

Project-specific Requirements

- Completed master studies in physics, chemistry, biochemistry or a related field.
- Good knowledge of fundamental physics and chemistry
- Experience and skills in surface and interface physics are beneficial, but not a prerequisite.
- Interest in working with complex experimental setups, and their adaptation to new problems and questions.
- Enthusiasm for science and scientific discoveries, as well as scientific writing are appreciated
- Willingness to travel to project meetings, collaborators and scientific conferences
- Excellent command of English in speaking and writing
- Personal skills: Independence, ability to work in an international and diverse team, excellent communication, problem-solving skills.