Interfaces are very important for function. In the simplest case a single lipid bilayer membrane separates the exterior of a cell from its interior volume. Cell membranes are certainly more complex and host many different functional units comprised of proteins, peptides and surfactants, but also simple lipid bilayer membranes can be functionalized as model bio-membranes under load. In that context high pressure is an important feature, in particular for marine biotopes where also cold denaturation and pressure induced unfolding of proteins is of outmost importance [1]. Another important aspect is bio-lubrication and the search for advanced implant materials that mimic natural conditions [2]. Here, sustainability under applied shear at physiological conditions is a very relevant parameter.

With this contribution we demonstrate that we are able to address above aspects by combined in-situ studies of immobilised oligolamellar lipid bilayer films and polymer brush systems without and with immobilised proteins at soft solid-liquid interfaces against excess aqueous phases under (a) applied hydrostatic pressure of up to 100 MPa and (b) applied shear of up to 5 Hz at physiological temperatures. We utilize neutron reflectivity (NR) in combination with surface sensitive infrared spectroscopy (ATR-FTIR) and dedicated sample environments for that purpose. This way we achieve structural insight into our systems under varied environmental conditions on the nanometre scale.