LIPID AND PROTEIN STRUCTURES UNDER SHEAR AND PRESSURE MIMICKING SYNOVIAL FLUIDS CONDITIONS

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Life-long pain free articular joint movement is strongly depended on the understanding the tribology mechanisms, which can provide proper strategy of medical treatment in the case of joint diseases and on other hand will suggest the ways to decrease energy losses in mechanical devices via friction reduction. Information on the molecular structural organization of components of synovial fluids (proteins, biopolymers and lipids) in the joint area is required to explain selforganisation behaviour at low friction surfaces and thereby facilitate fine-tuning of friction [1]. Proteins and lipid molecules form lamellar like layers at the cartilage surface and significantly decrease the friction coefficients [2]. The determination of the structure of formed layers at conditions close to those found in the articular joint during movement (low and high pressure, different shear rates and influence of other molecules or ions) demands highly sensitive and non-destructive structural methods and dedicated sample environment. Modern synchrotron facilities are optimised for such complex studies via X-ray reflectivity and small angle scattering instruments. We varied the hydrostatic pressure up to 2000 bar and followed the structural variation of lamellar lipid layers in the presence of biopolymer (hyaluronan) and calcium ions at different temperatures. It was determined that both additives separately lead to an increased stability of the solid supported lipid layer against pressure via incorporation into the outer polar part of the lipid lamellar layer [3], and the combined action of hyaluronan and Ca^{2+} ions resulted in structural changes of the outer and inner lipid layers. Increasing of shear rates up to 1500 s^{-1} leads to the ordering of biopolymer and destabilization of protein clusters [4, 5]. The further addition of other components of synovial fluid (glycoproteins) into model solution will lead to a more delicate structural response to pressure, shear and temperature, which will require advanced experimental approaches.

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