Masterarbeit

Spectroscopic studies of reversible structural changes in forisomes mechanoproteins

Forisomes are protein polymers found in some plants. They have a remarkable ability to undergo reversible structural changes in the presence of divalent cations (Ca^{2+}), at extreme pH environment (pH < 4.5 and pH >11) and upon the application of electrical impulses. These structural changes resemble muscle contractions and lead to a contraction of the protein length and increase in the protein width. Due to reversible changes of the protein structure forisomes have large application potential for example as valves in microfluidic systems, motor proteins, sensor devices or artificial muscles.

The secondary structure of the protein is not yet known. The peptide chains of forisomes form coiled hundreds of nm long fibrils with a diameter of 9-12 nm. The fibrils arrange into larger elongated forms called filaments. The condensed conformation of the fibril is stabilized by the charge-charge interactions at amino acids present on the polypeptide chains. Addition of divalent cations, change of the pH value or application of electrical potentials destabilize the charge-charge interactions between the polypeptide chains and lead to widening of the fibril and its disintegration. Interestingly, this process is reversible and removal of the external impulse leads to a reestablishment of the native protein structure.

In this work the forisme protein will be adsorbed on the gold electrode surface in the absence of Ca^{2+} ions in the electrolyte solution. Electrochemistry will be used to determine potential range of the protein adsorption and to indicate any changes in the structure of the adsorbed film. Alternative current voltammetry will be used to determine the capacitance of the protein film and surface coverage of the electrode surface by the protein. In the next step Ca^{2+} ions will be added to the electrolyte solution. Electrochemical characterization of the protein film upon interaction with the divalent ion will be performed.

Infrared spectroscopy is one of the most often used techniques to study in situ changes in the structure of proteins. The amide I mode is of a particularly large importance for the monitoring of structural changes in the protein structure. In the second part of this work in situ Polarization Modulation Infrared Reflection-Absorption Spectroscopy will be used to monitor changes in the secondary structure of the protein as a function of the electrode potential in the presence and absence of Ca^{2+} ions.

This project is realized in cooperation with Dr. G. Noll, University of Münster

Supervision: PD Dr. Izabella Brand