Coupling of proton and electron transfer in membrane proteins studied by electrochemistry and vibrational spectroscopies

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Energy supply mechanisms are central to life and living cells and are in focus of our research. Although the architectures of several membrane proteins in respiration and photosynthesis as well as the basic chemical reactions have been described, the interactions on molecular level, the curiously high diversity of mechanisms and their high efficiency, need to be clarified.
Conformational changes and protein dynamics play a central role in the catalytic efficiency of enzymes and are crucial to the biological function. Information on large-scale collective molecular motions and the internal hydrogen bonding structure of proteins can be observed in the far spectral region. We have probed the far IR spectral region from 0.06 THz (2 cm^{-1}) to 10 THz (333 cm-1) together with the low frequency region (333-1000 cm^{-1}) for the study of proteins and membranes and examples of these studies will be described. [1-3]
In order to understand the molecular basis of energy transduction, experiments have been developed which reveal how protons, other ions and water molecules are drawn through proteins and how they are coupled to electron transfer. A combined electrochemical, Raman and infrared spectroscopic approach was used for the determination of the pK value of crucial amino acid side chains and for the study of the structural, dynamic and energetic requirements for the proton transferring groups in the proton or sodium pumping enzymes and the cofactor sites that rule them. [4, 5] The technique enables the observation of protein action at the level of single functional groups within large proteins and thus provides essential knowledge's for the understanding of the mechanism of the studied enzymes. The identification of specific sites in proton and sodium pumping enzymes from respiration will be presented.
The reaction induced infrared spectroscopic approach was further developed for the far infrared spectral range giving access to information from metal ligand vibrations in a redox depended manner. [6]

Keywords: Infrared Spectroscopy, Electrochemistry, Proteins, collective vibrations and hydrogen bonds

References

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