Biochimica et Biophysica Acta 1847 (2015) 1

Contents lists available at ScienceDirect

Biochimica et Biophysica Acta

journal homepage: www.elsevier.com/locate/bbabio

Editorial

Vibrational spectroscopies and bioenergetic systems

Infrared and Raman spectroscopies are sensitive methods for the study of the chemical composition and the architecture of molecules. The high information content in infrared and Raman spectra was carried over from classical approaches in analytical chemistry to the study on biological systems and became an important tool for the study of proteins that are in focus of the field of molecular bioenergetics. The full potential of vibrational spectroscopies unfolds when isotopic labeling and site-directed mutagenesis are used to allow an unequivocal assignment of absorption bands or when the high structural information content are used in combination with high time resolution. The techniques are thus ideally suited to study the molecular mechanism of protein reactions.

In this Special Issue of BBA Bioenergetics, a variety of timely topics related the study of bioenergetic systems by means of vibrational spectroscopies is reviewed. This issue aims to present a collection of many, but certainly not all, applications of the techniques in the field. The topics of the articles range from key aspects of the core structure–function relationships through the molecular mechanisms of catalytic sites in enzymes from photosynthesis and respiration. Studies are presented which give insight into the proton pump mechanisms of proteins, coupled electron and proton transfer and ligand binding to the active sites in enzymes or in biomimetic models. They also highlight the strength of vibrational spectroscopic techniques when it comes to monitor the reaction or the structural environment of specific molecules like protonatable amino acid side chains, tyrosines, quinones or carotenoids. Ultrafast vibrational spectroscopies, studies at equilibrium, reaction induced FTIR difference spectroscopies, resonance Raman and Fluorescence Line-Narrowing, are presented in this Special Issue, giving an impressing insight into the opportunities vibrational spectroscopies will also provide in the future for the study of the complex and fascinating systems that rule respiration and photosynthesis.

It has been my great pleasure to act as a guest editor for this Special Issue on Vibrational Spectroscopies and Bioenergetic Systems. I am privileged to have been invited by BBA—Bioenergetics and must admit that I really enjoyed to participate in this project together with all contributors. I would like to thank all the authors for their excellent writing as well as the reviewers for their help and expertise. I would also like to thank the editorial staff of BBA Bioenergetics, in particular Andy Deelen whose help greatly eased the preparation of this issue.

Petra Hellwig is a professor in the Faculty of Chemistry at the University of Strasbourg in France. Her interest in vibrational spectroscopies on bioenergetics systems started with her master thesis prepared in 1995 under the guidance of Professor Werner Mäntele at the Friedrich Alexander University in Erlangen, Germany. Her PhD thesis at the same university (1998) described electrochemical and infrared spectroscopic studies on cytochrome c oxidases. In 1999 she was awarded a stipend from the DFG to study in the group of Professor Robert B Gennis at the University of Illinois at Urbana Champaign, USA, the quinone binding site in bo3 oxidase from E. coli. In 2001 she was appointed researcher in the Biophysics Department of the Johan Wolfgang Goethe University in Frankfurt, Germany. Her habilitation in 2002 focused on spectroscopic studies of the structure to function relation of membrane proteins from the respiratory chain. In 2005 she was appointed associated professor at the university in Strasbourg and since 2006 she is full professor for physical chemistry. In 2007 she was awarded a Chair d'excellence and since 2010 she is member of the Institut Universitaire de France (IUF). Her research aims at the understanding of the molecular mechanisms of ion translocating membrane proteins in respiration but also of other complex interactions in large molecular ensembles, as for example the study of protein–protein / protein–lipid interactions or the identification of specific proteins in native tissues. The experimental approach combines biochemical and biophysical methods with emphasis on vibrational spectroscopies (Infrared, Far Infrared, Raman-Microscopy) and bio-electrochemical techniques.

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http://dx.doi.org/10.1016/j.bbabio.2014.10.003
0005-2728/