~ Fresenius Lecture ~

Molecularly Imprinted Polymers:
What You Always Wanted to Know, But Never Dared to Ask!

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Abstract

Biomimetic recognition utilizing supramolecular chemistry and molecularly imprinted polymers (MIPs) has proven its potential by providing synthetic receptors for numerous analytical applications including liquid chromatography, solid phase extraction, biomimetic assays, and sensor systems. The inherent advantages of synthetic receptors and functionalized membranes in contrast to biochemical/biological recognition and immobilization schemes include their robustness, synthetic versatility, and potentially lower costs. In principle, molecularly imprinted (templated) materials are an ideal molecular capturing matrix tailorable for selective recognition or immobilization of a wide range of molecules. However, tailoring synthetic recognition elements to a target analyte requires thorough analysis and fundamental understanding of the governing molecular processes during the imprinting procedure, with the ultimate goal of rationally designing and predicting optimized synthetic pathways leading to molecular capture, recognition, and immobilization matrices with superior control on their physical geometry and molecular selectivity.

Fundamental understanding of the involved processes via analysis of the governing interactions at a molecular level providing complex stoichiometries, binding affinities, and facilitating pre-screening of optimized functional monomers and component ratios provides the basis for molecular dynamics simulations enabling modeling of the interactions of template molecules with functional monomers and cross-linkers in explicit solvent. While is anticipated that molecular templating based on rational synthetic design will significantly reduce the number of trial & error experiments currently required, it is evident that the complexity of simulating the generation of molecular imprints still requires extensive efforts toward rational design of next-generation synthetic receptors. Of particular interest is the development of synthetic alternatives for antibodies enabling biomimetic recognition, capturing, scavenging, and analysis of proteins and large biomolecules. Recent developments on this new frontier in molecular imprinting will be highlighted with selected examples and novel routes toward tailoring polymeric receptors for biomolecular recognition facilitating innovative approaches assisting molecular analysis.

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Short Biography

Dr. Boris Mizaikoff received his Ph.D. in Analytical Chemistry at the Vienna University of Technology in 1996. Heading the Chemical Sensor Laboratory (CSL) he has been responsible for numerous research projects in the field of chemical IR sensors, including 4 multinational projects funded by the European Union. In 1997, he has been with the University of Texas, Austin/USA as a postdoctoral fellow. In October 2000 he finalized his Habilitation (Assoc. Prof. for Analytical Chemistry) at the Vienna University of Technology. Since Fall 2000 he was faculty member at the Georgia Institute of Technology, School of Chemistry and Biochemistry, heading the Applied Sensors Laboratory (ASL). Since 2004 he was Director of the Focused Ion Beam Center (FIB^2 Center) at Georgia Tech, and since 2005 member of the Center for Cell and Molecular Signaling at Emory University, School of Physiology. In Fall 2007, he has joined the faculty at the University of Ulm, Germany, as a Chaired Professor heading the Institute of Analytical and Bioanalytical Chemistry. In 2013, he has been OCE Distinguished Visiting Scientist at CSIRO (Perth, Australia) and Distinguished Visiting Professor at INCTAA/UNICAMP (University of Campinas, Brazil). Today, his research interests focus on optical sensors, biosensors, and biomimetic sensors operating in the mid-infrared spectral range, applications of novel IR light sources (e.g., quantum cascade lasers), system miniaturization and integration based on micro- and nanofabrication, multifunctional scanning nanoprobes (e.g., combination AFM-IR and AFM-SECM-IR), scanning probe tip integrated nano(bio)sensors, focused ion beam (FIB) microscopy, development of chemical recognition interfaces for separation and sensing applications (e.g., molecularly templated materials), chemometric data evaluation, advanced vibrational spectroscopic techniques (e.g., SEIRA), environmental analytical chemistry, process analytical chemistry, and biomedical diagnostics. Dr. Mizaikoff is author/co-author approx. 200 peer-reviewed publications, 17 patents, and numerous invited contributions at scientific conferences; his current h-index is 32. Since 2010 he is Associate Editor Europe of *Analyst* published by the Royal Society of Chemistry (RSC), and since 2014 Editorial Advisory Board member of *Analytical Chemistry* published by the American Chemical Society (ACS). He has received a series of awards including the 2010 *Craver Award* (Coblentz Society), the 2005 *Pittsburgh Conference Achievement Award* (Society for Analytical Chemists of Pittsburgh), the 2004 *Fritz Feigl Award* (Austrian Society of Analytical Chemistry), and the 2004 *Meggers Award* (Society of Applied Spectroscopy). In 2005, he was elected *Fellow of the American Association for the Advancement of Science (AAAS)*, and in 2013 *Fellow of the Royal Society of Chemistry (RSC)*. In 2014, he has been named *Fresenius-Lecturer 2014* by the German Chemical Society (GDCh).