

Imaging surface plasmon resonance

Olof Andersson

Akademisk avhandling

som för avläggande av teknologie doktorexamen vid Linköpings universitet kommer att offentligt försvaras i hörsal Planck, Fysikhuset, Linköpings universitet, fredagen den 26 september 2008, kl. 10.15. Opponent är Prof. Jiří Homola, Institute of Photonics and Electronics ASCR, Prague, Czech Republic.

Abstract

The central theme of this thesis is the use of imaging Surface Plasmon Resonance (iSPR) as a tool in the characterization of surfaces with laterally varying properties. Within the scope of this work, an instrument for iSPR analysis was designed and built. SPR is a very sensitive technique for monitoring changes in optical properties in the immediate vicinity of a sensor surface, which is very useful in biosensing and surface science research. We have employed SPR in the Kretschmann configuration, wherein surface plasmons are excited by means of an evanescent field arising from total internal reflection from the backside of the sensor surface. In iSPR, the signal is the reflectivity of TM-polarized light which is measured using an imaging detector, typically a CCD camera. Advantages of this technique include extreme surface sensitivity and, because detection is done from the backside, compatibility with complex samples. In addition, SPR is a non-labeling technique, and in imaging mode, a lateral resolution in the μm range can be attained.

The imaging SPR instrument could be operated in either wavelength interrogation mode or in intensity mode. In the former case, the objective is to find the SPR wavelength, λ_{SPR} , which is the wavelength at which the reflected intensity is at a minimum. In intensity mode, a snapshot of the intensity reflectance is taken at a fixed wavelength and incidence angle.

In biosensor science, the use of an imaging technique offers a major advantage by enabling parallelization and thereby increasing throughput. We have, for example, used iSPR in biochemical interaction analysis to monitor immobilization and specific binding to protein and synthetic polypeptide micro arrays. The primary interest has been the

study of soft matter surfaces that possess properties interesting in the field of biomimetics or for applications in biosensing. Specifically, the surfaces studied in this thesis include patterned self-assembled monolayers of thiolates on gold, a graft polymerized poly(ethylene glycol) (PEG) based hydrogel, a dextran hydrogel, and a polyelectrolyte charge gradient. Our results show that the PEG-based hydrogel is very well suited for use as a platform in protein immobilization in an array format, owing to the very low unspecific binding. In addition, well defined microarray templates were designed by patterning of hydrophobic barriers on dextran and monolayer surfaces. A polypeptide affinity microarray was further designed and immobilized on such a patterned monolayer substrate, in order to demonstrate the potential of analyte quantification with high sensitivity over a large dynamic range.

Furthermore, iSPR was combined with electrochemistry to enable laterally resolved studies of electrochemical surface reactions. Using this combination, the electrochemical properties of surfaces patterned with self assembled monolayers can be studied in parallel, with a spatial resolution in the μm regime. We have also employed electrochemistry and iSPR for the investigation of potential and current density gradients on bipolar electrodes. ■

Department of Physics, Chemistry and Biology
Linköpings universitet, SE-581 83 Linköping, Sweden

Linköping 2008

ISBN 978-91-7393-820-4

ISSN 0345-7524