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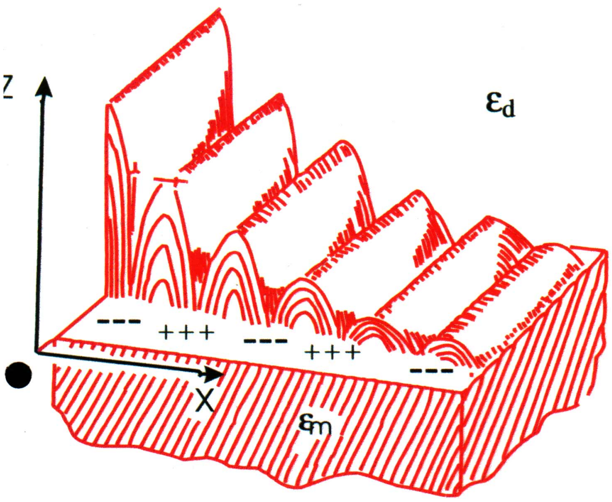
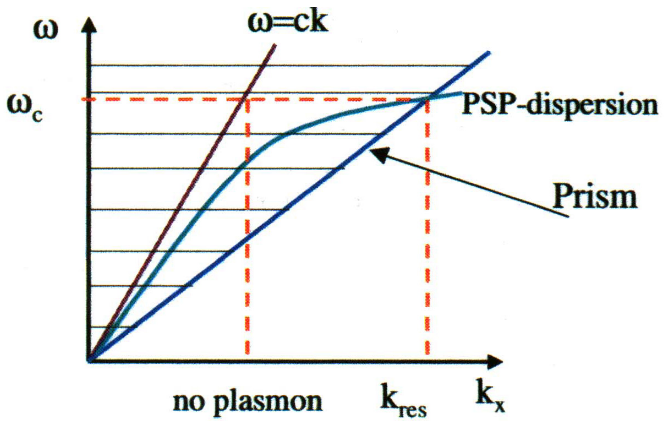
SURFACE PLASMONS

SPR spectroscopy is an optical reflection technique with a high sensitivity to the prevailing interfacial architecture. It has become a standard technique in the field of bio-sensing for studying binding events.

A surface plasmon is a charge-density oscillation that may exist at the interface of two media with dielectric constants of opposite signs, for instance, a metal and a dielectric. The charge density wave is associated with bound TM-polarized electromagnetic wave at the metal dielectric interface. The electric field of this wave has its maximum at the interface and decays evanescently into both media. Any change in refractive index of the bulk or the binding events lead to a shift in the SPR resonance.

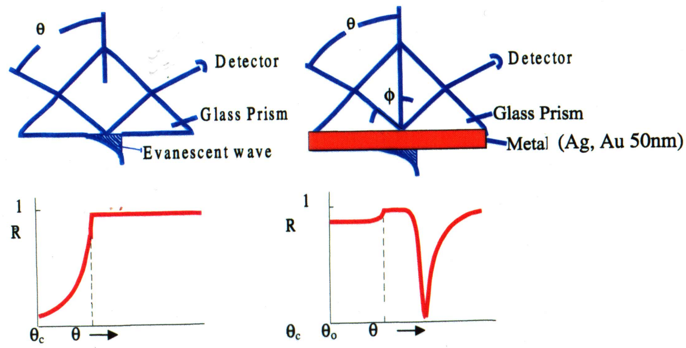


The excitation of a surface plasmon requires a special geometry. It turns out that is impossible to excite a surface plasmon within a simple reflection experiment. One of the mandatory condition for the excitation of SPR resonance is that the projection of the wave-vector k_x of light matches the one of the plasmon.



The dispersion relation of light in air $\omega(k)$ has no intersection with the corresponding curve of the plasmon. As a consequence the reflection of light at a metal-air interface does not lead to the excitation of a plasmon. A trick helps to fulfil the conditions. If light is incident in a media with a higher refractive index than air the slope of the straight line is decreased and a intersection between the plasmon dispersion relation may occur. This is utilized in the so-called Kretschmann configuration.

Angular resolved techniques using a prism in an ATR configuration are the most common arrangements. The metal layer is at the base of a prism and the reflected intensity is measured as a function of the angle of incidence Θ. The angle scan changes the projection of the wave-vector k_x onto the prism base in a similar fashion as wavelength change. For this reason the in a way misleading term Surface Plasmon spectroscopy is commonly used even if laser light with a single wavelength is incident on the sample.



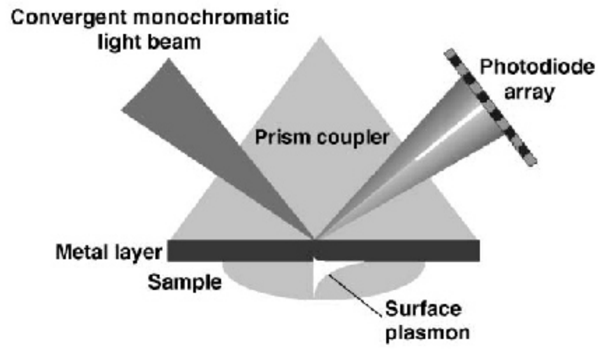
The excitation of the plasmon occurs in the total reflection regime. The exact position of the resonance bears information on the interfacial mass coverage or the thickness of an interfacial layer.

MULTISKOP - SPR MODULE

The aim of SPR instrumentation is to determine the resonance position as precisely as possible and with the best time resolution. This task is solved in the Multiskop in four different modes.

$\Theta - \Theta$ reflectivity scan The Kretschmann configuration is used and the intensity of the reflected light is measured as a function of the angular setting. The laser and detectorarm are synchronously moved and the reflected intensity is measured as a function of the angle of incidence.

Fast angle tracking in the kinetic mode Some commercial SPR instruments use a lens to focus the beam onto the prism base. Within the focus a variety of angle of incidence are covered. The angle range is given by the focal length of the lens and the beam diameter. The reflection curve is then monitored by a PSD or CCD array as sketched in the figure. These arrangement leads to a trade-off between the dynamic range and resolution of these sensors as a high number of elements have to be interrogated at once.



A more elegant and simple solution is based on the evaluation of the intensity reading of the individual segments of the four quadrant diode of the Multiskop. At the beginning of experiment the four quadrant diode is aligned in a fashion that the intensity in the upper segment A, B matches the reading of the lower segment C, D. The adsorption leads to a mismatch in the intensity reading of the segments. We could demonstrate that $(A+B-C-D)/(A+B+C+D)$ is proportional to the angular shift of the resonance. The relative sensitivity is extremely high and was found to be on the order of 10^{-5} degrees while the speed in the processing is only limited by the electronics. M. Schneider, A. Andersen, P. Koelsch, H. Motschmann Sensors and Actuators B 104 (2005) 276-281

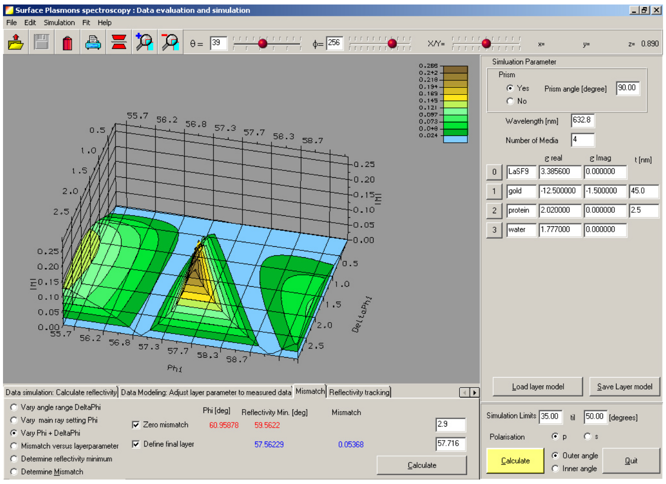
A further benefit of this algorithm is the elimination of laser intensity fluctuation due to the intrinsic normalization.

Reflectivity tracking: The reflectivity at a given angle of incidence is monitored as a function of the time. The data can also conveniently be used to follow studying fast kinetics

SPR Microscopy If the layer of interest is inhomogeneous an image of the surface can be obtained. SPR is then the contrast giving mechanism. A vertical resolution in the sub-nm range can be achieved.

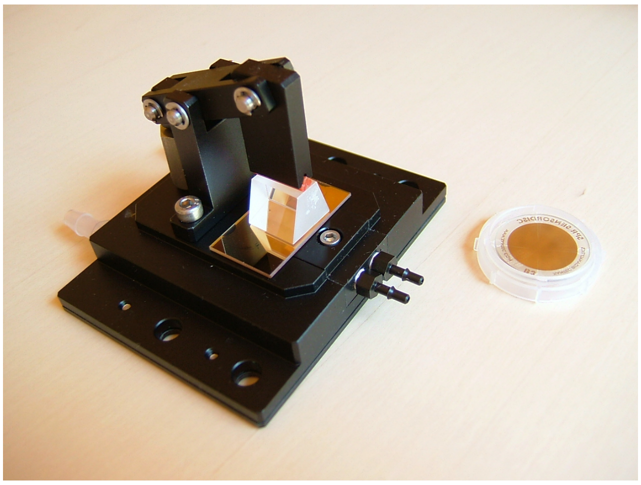
Software

The Multiskop comes with powerful software for data evaluation and acquisition. The data evaluation software is based on Fresnel theory of stratified media and different fitting algorithms have been implemented.



Acessories SPR flow cell

The SPR flow cell utilizes the Kretschmann configuration. The design of the holder host a variety of different prisms. The cell can be hooked up to a thermostat and to a peristaltic pump.



We have also a holder that is optimized for performing photochemsity.

SPR sensor discs

SPR requires gold surfaces with well defined thickness of about 45 nm. The gold layer is a very critical part of the experiment, here are the binding events translated in an optical signal. However, not all of the potential customers or users of the Multiskop have the possibility to manufacture the right sensing surface. For these customers we can offer SPR sensor discs of circular shape that are custom made for the Multiskop flow cell (lower image right hand side). The sensor discs can be ordered with a broad range of different surface modification such as thiols, hydrogels, specific binding sites such as biotin. We can offer also a broad range of prisms made out of various high index glasses such as LASFN9, SF11. Please contact us for further details. We would be delighted to discuss your experiment.