Principle of SPR detection: Intensity profile and shift of the SPR angle

(SPR basics video here)

When a light beam impinges onto a sensor (made from metal film coated on a glass slide) at a specific angle (resonance angle), the electrons in the metal film (called surface plasmons) are set to resonate with the light wave. The resonance results in the absorption of light. In a typical SPR detection setup a beam is focused onto a sensor. The focused light provides a range of incident angles, and the reflected beam will cover the same range of the angles and the projection of the beam forms a rectangular shaped band of light. When the SPR angle occurs within the spread angles, a dark line will appear in the band. An intensity profile of this band is plotted against the range of angles as shown in Figure 1.

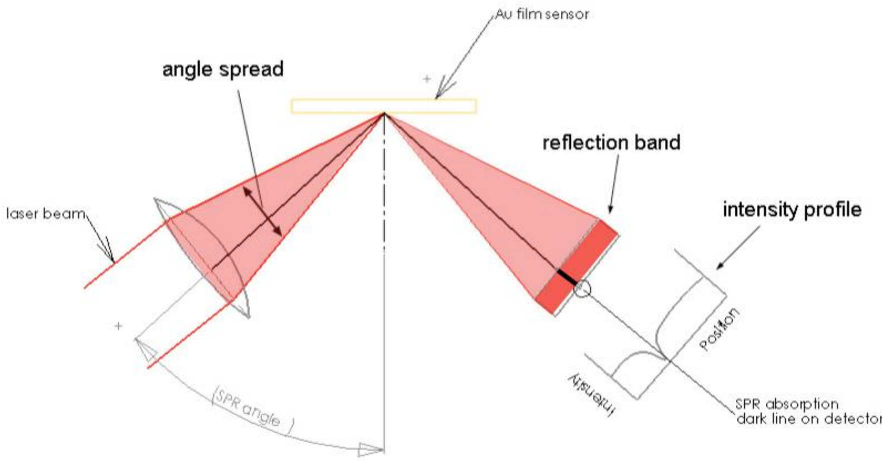

Figure 1. Principle of SPR detection in the mode of measuring the SPR angular shift.

This profile is often used in a typical SPR experiment to indicate that the metal film (or the solution above the metal film) matches the SPR resonance condition, and that the apparatus is set up properly. However, the actual measurement of molecular adsorption kinetics is only related to the shift of the absorption dip in the intensity profile corresponding to the SPR angle change (Figure 2). One has to sacrifice the resolution of the measurement to acquire the whole intensity profile curves and compare them to find the shift of the dip (minimum).

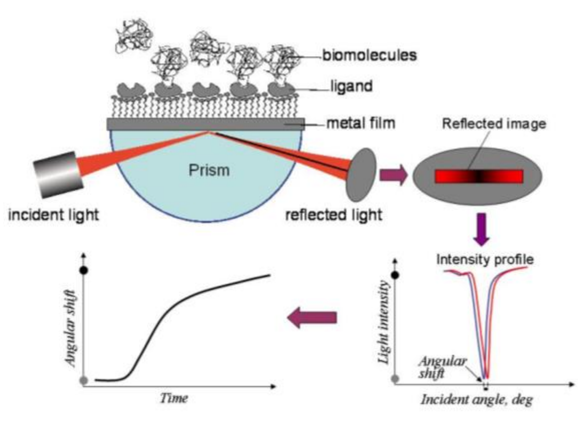

Figure 2. A laser is beamed upon a metal film through a prism and the reflected beam image shows a dark line due to SPR. The intensity profile of the reflected beam exhibits a dip or minimal intensity at the resonance angle. An SPR experiment measures the position shift of the dip (the angle shift) upon molecular adsorption, and this shift represents the adsorption kinetics when plotted as a function of time.

Biosensing Instrument (BI) uses a different approach to detect the SPR angle change by using an enhanced position-sensitive device with advanced algorithm to detect the SPR absorption dip shift. Since it only measures the position shift of the dip, it offers a highly sensitive detection scheme to measure extremely small angle changes of the SPR. As long as the SPR angle resides inside the angle spread, the system delivers exceptionally high angular resolution in its measurement.

Even though intensity profile is commonly used for demonstrating the proper alignment and the setup of an SPR system, it only offers limited status check of a metal film at a single position. For a multi-channel detection scheme used in the BI SPR system, a single intensity profile check is not sufficient to ensure that the system is in proper SPR detection condition. One has to ensure that all the illuminated areas of the metal film are in good condition. BI SPR provides a simple but sufficient solution by giving the user a visualized image of the SPR absorption dip. By examining the quality of the dark line in this way (as shown in figure 3-5), one could ensure that all conditions of the SPR are met and a successful experiment can be conducted.

Figure 3. A good metal film gives a clean and straight SPR dark line in air (left) and solution (right).

As illustrated in Figure 3, a good metal film gives a well-defined, clean, and straight dark line. This guarantees a good intensity profile at any point along the dark line.

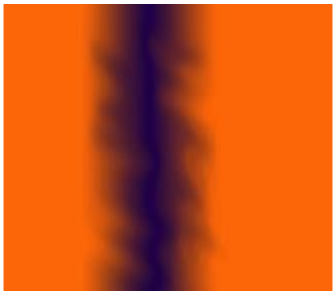

Figure 4. A contaminated film gives fuzzy and indistinct dark line.

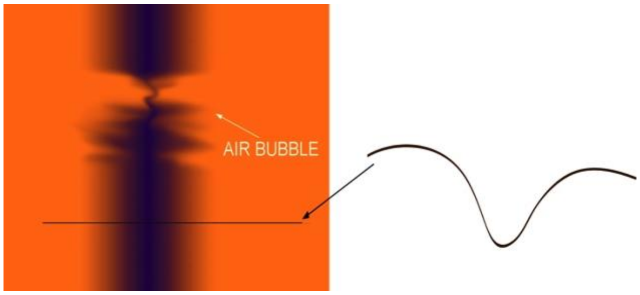

Figure 5. A trapped air bubble underneath of the metal film sensor will break the dark line. However, at the drawn line, dark line will still gives a good intensity profile of the SPR.

Figure 4 and 5 demonstrates that a partially contaminated metal film can still give a reasonable intensity profile of SPR at a given point. However, it will not lead to a reliable measurement, since the film quality across a large area is bad.