Evanescent wave spectroscopy

Let us consider the medium with lower index of refraction to be absorptive (e.g. atomic or molecular gas). Taking into account the nonzero imaginary component of the \( n_2 \) index one can see from the Fresnel equations (2) that the reflection coefficient for the total internal reflection becomes less than unity. This is the case of “attenuated total reflection (ATR)”. Total reflection from a resonant medium is therefore accompanied by resonant absorption of the evanescent wave. The penetration depth of the evanescent wave is of the order of a few hundred nanometers for visible spectral range. The ATR phenomenon can be used to perform spectroscopy of atoms or molecules in the vicinity of the surface and provides access to surface and interface processes. The interaction between particles in the gaseous medium and the surface changes their quantum and polarization states or velocity distributions. The optical response of the particles is therefore different in comparison with that inside a gas volume.

Exemplary references


Optogalvanic EW spectroscopy [7] [8]

When a discharge in a gas is illuminated by radiation resonant with an atomic or molecular transition of the elements within it, an increase or decrease in the conductivity of the discharge is observed. This phenomenon is known as the optogalvanic effect (OG). The optogalvanic effect is a convenient and sensitive technique for probing populations of the species in their excited states.

The change in the discharge conductivity rises from the change of number of charges (electrons and ions) creating the discharge and from the change of the free electron temperature. An interaction between an atom and resonant light leads to the variation of the population of both states involved in the optical transition. These variations induce the change
of number of charges because of the difference between the ionisation cross-sections $\sigma_1$ for these states.

We performed an optogalvanic spectroscopy experiment with the evanescent light to observe resonances from atoms located very close to the surface.

![Experimental setup for optogalvanic spectroscopy measurements with the evanescent light](image)

A radiofrequency oscillator (20 MHz) was capacitively coupled to the argon plasma by means of two flat external electrodes. A laser-induced change in plasma impedance was monitored through corresponding changes in the regime of the oscillator. Any oscillator adjusts its level of oscillation so that losses are balanced by regenerative amplification. If the losses are slightly increased, the oscillator amplitude is correspondingly decreased, and this produces an observable change in the oscillator's anode current. As the OG signal we took the voltage drop on the resistor $R$ inserted in the DC supply circuit of the oscillator. To improve signal-to-noise ratio the lock-in detection of the OG signal was applied by the amplitude laser beam modulation.
We used Ar 4s\(3/2\)\(_2\) (metastable) \(\rightarrow\) 4p\(5/2\)\(_2\) (\(\lambda=801.6\) nm) transition. The Ar pressure in the cell was 0.9 Tr in a room temperature.

References