Evanescent Wave Dynamic Light scattering

EWDLS

P. R. Lang
Institut für Festkörperforschung
Forschungszentrum Jülich GmbH
1 Basic Principles

In EWDLS–experiments an evanescent wave is created upon total reflection of a laser beam from the flat interface between a glass body and the sample solution. This evanescent wave is used as the incident radiation for a dynamic light scattering experiment, as sketched in Figure 1. The near-wall dynamics of Brownian particles can be studied by EWDLS, if the intensity which is scattered off the evanescent wave by an ensemble of particles is correlated. The scattered field at a given time \( t \) from an ensemble of \( N \) identical particles is,

\[
E_S \propto \sum_j^N \exp \left\{ -\frac{\Lambda}{2} z_j \right\} \exp \{ i \mathbf{Q} \cdot \mathbf{r}_j \}.
\]  

(1)

Here the scattering vector is the difference between the wave vector of the scattered and the evanescent wave, \( \mathbf{Q} = \mathbf{k}_S - \mathbf{k}_e \), \( \mathbf{r}_j \) defines the position of the \( j \)th particle and \( \Lambda \) is the \( 1/e \)–penetration depth of the evanescent field intensity. The time auto correlation of the scattered field can be expanded in a cumulant series as

\[
g_1(t) = \exp \left\{ -\Gamma t + \mathcal{O}(t^2) \right\}
\]  

(2)

where the initial decay rate depends on the scattering vector components as

\[
\Gamma = \langle D_\parallel \rangle Q_\parallel^2 + \langle D_\perp \rangle (Q_\perp^2 + 4/\Lambda^2),
\]  

(3)

With our instrumental design it is possible to vary the amount of the normal, \( Q_\perp \), and the parallel, \( Q_\parallel \), component, of the scattering vector independently. By this means it becomes possible to distinguish between the particle mobility parallel and normal to the interface.
2 Experimental Setup

The mechanical setup is based on a three axis x-ray spectrometer by Huber, which is shown in Figure 2. This instrument allows for a three dimensional access of the detector to the scattering volume. As a light source we use alternatively a 15 mW HeNe Laser with a wavelength of 632 nm or a Verdi II system from Coherent with a wavelength of 512 nm. The scattered light is collected with a mono-mode fiber attached to a splitter with a splitting ratio of approximately 50:50. From this the light is guided by two mono–mode fibers to two avalanche diode (Perkin Elmer) detecting units, which can be operated in a single photon counting mode. The diodes’ TTL outputs are cross correlated using an ALV 6000 multiple tau correlator.