Scattering based bead-microrheology applied to biomaterials

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The quantitative stochastic description of Brownian motion of spherical micro- and nanobeads in complex fluids has laid the foundations for the invention of tracer microrheology, a powerful, noninvasive method that allows the measurement of mechanical properties over an extended range of frequencies using all optical instrumentation [1-3]. Over the last 20 years the method has been applied to a large range of materials ranging from foodstuff, dispersions, slurries to polymer solutions and surfactant based systems [1-4]. Since only small volumes are required the method is particularly well suited for applications in the field of biomaterials and bioactive substances [5-7].

The basic idea of optical microrheology is to study the response of small (colloidal) particles embedded in the system under study. The particle can be added as tracer particles or can be naturally present in the system (such as oil droplets in an emulsion or fat droplets and protein micelles in yoghurt). The motion of the embedded probe particles can either be controlled actively, e.g. using optical tweezers or one can analyze the thermal motion of the particles. Both approaches can provide quantitative information about the viscous and viscoelastic properties of the surrounding fluid. Scattering techniques such as diffusing wave spectroscopy (DWS) or dynamic light scattering (DLS) are some of the most popular techniques to probe passive (thermal) particle motion remotely. These laser-based techniques offer the advantage to provide an ensemble average of the probe particle motion within about one minute measurement time. Standard sample preparation protocols can be used and the samples are held in common cylindrical or rectangular glass cuvettes filled with fluid volumes of typically 0.2-1 ml. Moreover these methods can resolve extremely fast displacements on the order of microseconds with a sub-nanometer resolution.

Here I will briefly review the methodology and instrumentation and then discuss applications to biomaterials and foodstuff [5], for probing protein interactions/aggregation and for the study three-dimensional assemblies of cell clusters [6,7].

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