Setup and Calibration of a Suite of State-of-the Art Microrheology Techniques

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ABSTRACT

Microrheology is the study of the flow and deformation of fluids on the micrometre scale. It has many benefits over the use of traditional rheomoeters to measure the mechanical properties of fluids. Microrheology has small sample sizes, can extract information about the underlying heterogeneities, often has a lower setup cost, can measure to higher frequencies and can measure the viscoelasticity of in-vivo samples. Work has been carried out to setup and calibrate four different microrheology techniques, namely: diffusing wave spectroscopy, dynamic light scattering, multiple particle tracking and probe laser tracking with a quadrant photodiode and optical traps. This resulted in the ability to measure the viscoelastic properties of a material over approximately eight orders of magnitude, with nanometre resolution on the most sensitive technique; diffusing wave spectroscopy. The link between free Brownian motion and a particle diffusing in a harmonic potential was used to calibrate the trap strength of the optical tweezers, enabling a comparison of three different trap calibration techniques. Calibration of the trap strength in optical tweezers resulted in a good agreement between different methods, although, the power spectral density method proved easier to implement and more accurate over the range of laser powers, making it the superior method to use. To illustrate the power of microrheology techniques, the mechanical properties of standard viscous and viscoelastic fluids were first compared. Also organelles in pollen tubes were tracked to simply and accurately measure properties of a complex biological system in-vivo.

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