Azimuthally Resolved Scattering Morphology Resolved Total Internal Reflection Microscopy (SMR-TIRM) of Colloidal Ellipsoids

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Micrometer scale 'colloidal' particles are widely found in applications including chemical and consumer products, coatings, and human health. These particles interact with nearby boundaries and neighbors via weak, kT scale, conservative and non-conservative interactions. Further, suspension structure and flow will often be dictated by such interactions. A collection of experimental apparatus have been developed to measure these interactions, including the Atomic Force Microscope (AFM), Surface Force Apparatus (SFA), and Total Internal Reflection Micrscopy (TIRM) [1]. Although robust, these techniques do have limitations. In the case of AFM and SFA, the sensitivity of measurement is limited by the mechanical manipulation of two surfaces as they approach, whereas TIRM has only been conducted for isotropic colloidal particles. We're seeking to extend TIRM to anisotropic particles using Scattering Morphology Resolved Total Internal Reflection (SMR-TIRM) [4]. SMR-TIRM work via collection and analysis of the morphology of scattered light, rather than the integrated intensity as with classic TIRM. Herein, this talk will summarize experiments in which we collected and analyzed the orientationally dependent scattering from an anisotropic colloidal ellipsoid.

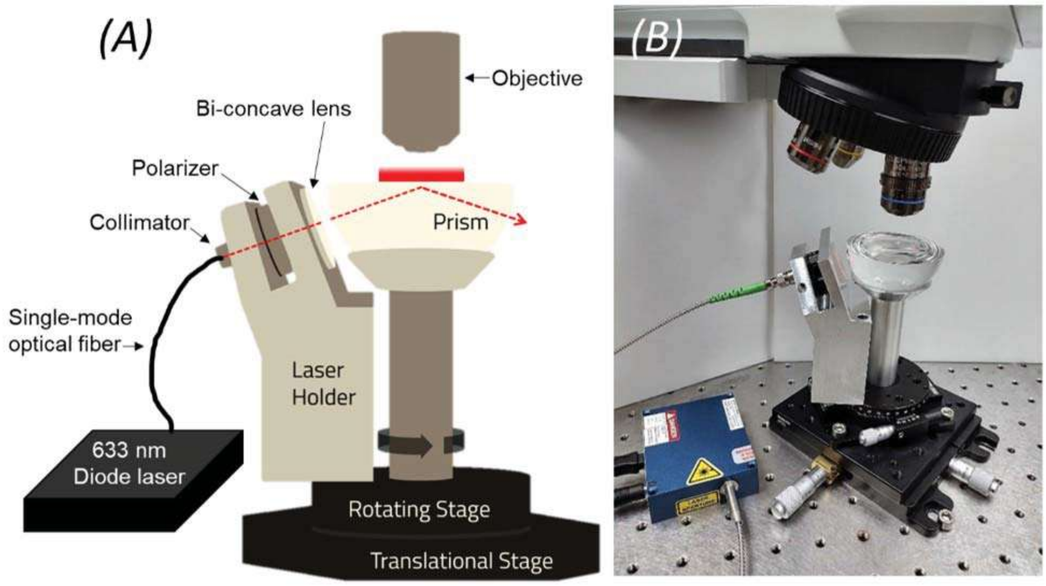

Figure 1: Scattering Morphology Resolved Total Internal Reflection Microscopy (SMR-TIRM) apparatus designed with variable azimuthal angle incident beam. (A) The apparatus consists of custom mounts for both the hemispherical prism and fiber optic laser, a rotatable stage to position the incident beam at any azimuthal angle, a collimator, polarizer, and bi-concave lens each needed to shape the beam appropriately for the experiment. (B) Image of the apparatus. Light is collected via a microscope coupled to a digital camera.

Azimuthally resolved scattering was collected from a colloidal ellipsoid with an apparatus designed to systematically adjust the rotational position of the incident beam (see Figure 1) [2] . Scattering morphology was collected from a single, fixed particle to experimentally determine the orientational dependence of scattering from the particle. The scattering morphology was analyzed for single particles via a two-dimensional (2D) Gaussian fitting method, which parameterizes the scattering morphology with orientation angle M_ϕ and aspect ratio M_{AR}. Previous theoretical and simulation work has shown these quantities to be sensitive reporters of the particle's orientation and position.

Experimental measurements compared well with an analytical expression that was developed based on the geometry of the particle. Further, the experimental data compared well with results from the simulation tool that has been developed in recent years [3]. Taken together, we now have a clear picture of how scattering depends on orientation for an ellipsoidal particle. The expression was then utilized in an experimental measurement of the potential energy landscape of an ellipsoid undergoing Brownian fluctuations. These expressions were then used to assemble a potential energy landscape for the colloidal ellipsoid.

References

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