Using single nanoparticle tracking to simultaneously characterize nanoparticle size distribution and nanoparticle-surface interactions

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Measuring and understanding the interactions between nanoparticles (NPs) and cell surfaces, are of paramount interest for the developing specific targeting drug delivery complexes based on NPs. Experimentally, the direct measurement of the forces between nanoparticles (NPs) and surfaces by traditional methods (e.g. AFM) in realistic exposure conditions is challenging due to that these interaction occur in complex environments (usually under fluid flow conditions, at high salt concentrations, at room temperature, etc). As an alternative, in this work we present a novel technique to characterize NP-surface interaction in a microfluidic chamber. The proposed method is based on generating an optical potential to trap NPs close to a surface. A schematic representation of the experimental setup is shown in Fig. 1a. The main element of the device is a waveguide (WG) that transports light from a laser source through the experimental chamber. The propagated light generates an exponentially decaying field that extends above the waveguide. The NP will then go under Brownian motion and will scatter light. The closer to the WG the more light it will scatter (as the light intensity decays from the WG to the medium) and this effect is used to measure the fluctuations around the minimum of the potential well (Fig. 1c). Using a video camera, the position of the NP is recorded and a the full 3D trajectory is reconstructed as shown in Fig. 1b. Here we outline a further application of this technique to measure the size of single particles and based on these measurement build the distribution of a sample. We demonstrate its efficacy by comparing the size distribution obtained to established instruments, such as dynamic light scattering and differential centrifugal sedimentation. Our results were in good agreement to those observed with all other instruments. Furthermore, we demonstrate that the methodology developed in this work can be used to study complex particle mixtures and the surface alteration of materials. For all cases studied, we were able to obtain both the size and the interaction potential of the particles with a surface in a single measurement [1]. We also use the same methodology to study the effect of a coating layer on the diffusion silica NPs close to a surface [2].

References

[1] Hristov *et al.*, Nanoscale, 9 (2017) 4524 - 4535
[2] Lopez *et al.*, in preparation

Figures

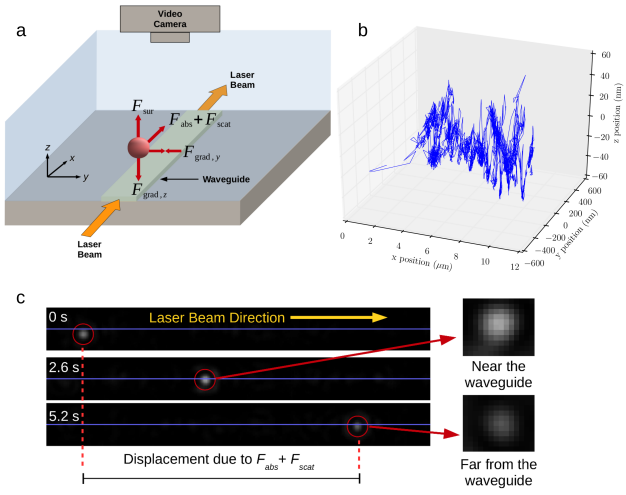

Figure 1. (a) Schematic representation of the experimental setup. (b) Full 3D trajectory of one NP. (c) Images of a NP traveling over the WG at different times. Due the exponential decay of the evanescent field, NPs closer to the surface scatter more light and are detected brighter. The direction of the light in the WG is from left to right and so is the movement of the NP.