Coated Microspheres Tailored for Optimized Optical Trapping

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In an optical trap, micron-sized dielectric particles are held by a tightly focused laser beam. The optical force on the particle is composed of an attractive gradient force and a destabilizing scattering force. We hypothesized that using anti-reflection-coated microspheres would reduce scattering and lead to stronger trapping. Instead, we discovered that homogeneous spheres of a correct size demonstrated anti-reflective properties more effectively.

In addition, we found that homogeneous silica and polystyrene microspheres had a sharp maximum trapping stiffness at a diameter of around 800 nm---the trapping laser wavelength in the medium---and that a silica coating on a polystyrene microsphere was a substantial improvement only for larger diameters. Our measurements quantitatively agreed with Mie scattering calculations and served as a proof of principle.

We calculated that the use of higher-refractive index materials as cores will increase the maximum stiffness and broaden the range of optical tweezers applications in particular with respect to biophysical single-molecule experiments.