Optical forces and applications

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Mechanical effects of light stem from conservation laws in light scattering. Optical tweezers (OT) [1], tools based on strongly focused light, enables optical trapping and manipulation of a wide range of microscopic and nanoscopic materials, as well as their characterization [2]. In the limiting cases of spherical particles either much smaller (dipole approximation) or much larger (ray optics) than the trapping wavelength, the force in OT separates into different contributions: a conservative *gradient force*, proportional to the light intensity gradient, responsible for trapping, and a non-conservative *scattering force,* proportional to the light intensity that generally is detrimental for trapping, but fundamental for optical manipulation and laser cooling. However, for non-spherical particles or at intermediate (meso)scale the situation is more complex and this traditional identification of gradient and scattering force is more elusive [1]. Moreover, shape and composition can have dramatic consequences for optically trapped particle dynamics.
Here, after an introduction to optical forces with a focus on the role of shape, aggregation, and composition, we give an overview of current applications to material science, plasmonics, soft-matter, and present some results on optical trapping, optical binding, and characterization of 1D and 2D materials, surface-enhanced spectroscopies in OT, and chiral particles.

References

[1] Jones, P. H., Maragò, O. M., and Volpe, G., 2015: *Optical Tweezers: Principles and Applications*, Cambridge University Press, Cambridge, UK.
[2] Maragò, O. M., Jones, P. H., Gucciardi, P. G., *et al.*, 2013: Optical trapping and manipulation of nanostructures. *Nat. Nanotechnol.* **8**, 807–819.