133 - Using optical tweezers to measure pico Newton forces in nanoscopic systems

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Optical tweezers are a scientific instrument that uses light to trap micron sized dielectric particles, applying forces in the order of pico Newtons. They establish a non-invasive technique that allows the simultaneous nanopositioning of multiple objects and the measurement of the forces exerted on these trapped objects. These qualities make optical tweezers an excellent candidate as a technique to research a wide array of topics in both biology and physics, finding applications in the study of molecular motors (at the single-molecule level), the physics of colloids and mesoscopic systems, and the mechanical properties of biopolymers (the elasticity of DNA, for example), among others[1].

We have developed an optical tweezers system that is capable of trapping and moving multiple objects and measuring forces that are being exerted on these. It is possible to characterize the force exerted on a trapped particle by monitoring its position under the influence of a controlled oscillating force[2], which allows us to obtain the spectral density of the position.

This technique allows us to characterize forces exerted by the bead's medium that cause Brownian motion as well as forces that are exerted by individual elements such as chemical bonds. To eliminate noise associated to the instrumentation such as system drifts caused by vibrations or thermal oscillations, we have implemented a multi-trap system, that allows the monitoring of the relative positions of the trapped beads.

We will use these optical tweezers to directly measure the bonding forces in (and between) molecules of biological interest. To do this, the beads have to be functionalized to interact with the molecules to be studied and so, the beads can be used as handles to exert forces in places of interest. This will also allow the implementation of high-resolution sensors such as the nitrogen-vacancy defect in nanodiamond that can be used to measure magnetic fields and temperature.

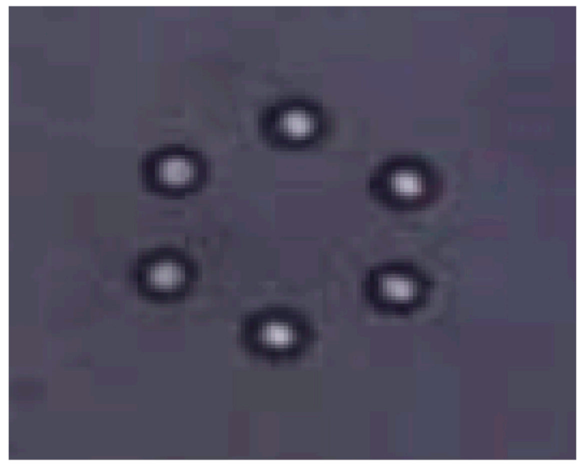

Fig. 1 *Six polystyrene beads with a diamater of* $3\mu m$ *being trapped in a hexagonal array. This image was taken in our optical tweezers at Pontificia Universidad Católica.*

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References

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