Optical tweezing with coupled nanobeams

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Abstract

We will show here experimental achievements of optical trapping, assembly and manipulation of dielectrics microspheres by the evanescent fields of coupled nanocavities integrated on a silicon optofluidic chip. This silicon optofluidic chip could be used for sensors applications.

1- Introduction

Silicon On Insulator (SOI) nanocavities confine the electromagnetic fields in very small volumes at the surface of a silicon chip [1-3]. The resulting field gradient provides optical forces large enough to envisage the development of on-chip integrated optical tweezers [4,5]. As reported earlier [6,7], coupling nanocavities together gives rise to addressable electromagnetic field distributions. We will report here optical trapping and assembly experiments of micrometer-sized dielectric particles (1µm in diameter) leaning on different system of coupled nanocavities. It is demonstrated that coupled nanocavities behaves as addressable optical tweezers which can be used to control dynamically the trapping sites, their auto-organization as well as their motion.

2- Discussion

In the reported experiments, the nanocavities are embedded in optofluidic cells allowing *in operando* monitoring of the optical transmittance while observing the particles motion above the photonic structures with an optical microscope (Fig.1).

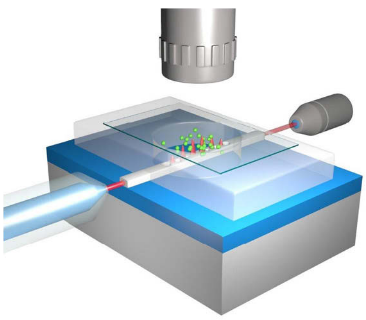

Fig. 1: Scheme of the nanocavity embedded in a fluidic cell allowing in operando monitoring of the optical transmittance as well as the particles motion over the structure.

A laser source is injected inside the photonic structures and the operating wavelength is tuned to study how dielectric microparticles behave inside the electromagnetic field of coupled nanocavities (Fig.2).

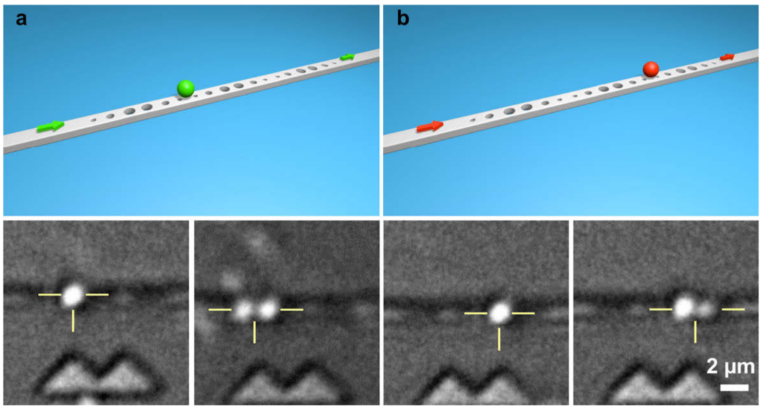

Fig. 2: a) Scheme of the coupled nanocavity lightened at the lower resonance peak, with examples of experimental snapshots of the particles position in respect to the field distribution. b) Scheme of the coupled nanocavity lightened at the higher resonance peak, with examples of experimental snapshots of the particles position in respect to the field distribution.

Depending on the cavity assembly on the silicon chip (lateral or longitudinal coupling for instance), mono- or multi- particles sensing, trapping as well as particles translation and rotation are observed experimentally. All these effects are obtained by properly tuning the operating wavelength in regards to the near-field properties of coupled cavities determined earlier by Scanning Near-field Optical Microscopy.

3- Conclusion

We studied microspheres optical manipulation in solution with on-chip integrated silicon nanocavities. We have shown proof-on-principles of optofluidics functionalities such as microparticles sensing, trapping or moving. By using different nanocavity organization we create different manipulation scheme like particles translation or rotation.

References

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