Optical manipulation and sorting of sub-100nm nanodiamonds inside a tapered glass capillary

北海道大学電子科学研究所 [1] 〇パン クリストフ [1], (M2) 大塚 涼平 [1], 笹木 敬司 [1]

RIES, Hokkaido Univ. [1], ◦ Christophe Pin[1], Ryohei Otsuka[1], Keiji Sasaki[1]

E-mail: christophe.pin@es.hokudai.ac.jp

To discriminate and sort nanoparticles according to their optical properties, optical forces offer the unique advantage of directly controlling the motion of particles based on their interaction with the incident light. Nevertheless, the weak action of optical forces usually cannot overcome the fast Brownian diffusion of dielectric nanoparticles in liquid suspension. To optimize the optical sorting process, the motion of nanoparticles must be restricted to the volume of the light path. Efficient nanoparticle optical sorting could be achieved by setting solid boundaries to constrain both the liquid suspension and the light over a long distance in a narrow channel. For instance, tapered glass capillaries can be used to propel and sort nanoparticles such as carbon nanotubes [1] and fluorescent nanodiamonds [2].

In this work, we focus on two main issues: How to enhance the light guiding properties of narrow liquid-filled glass capillaries, and how to prevent undesired liquid flow from occurring inside a tapered capillary. First, nanodiamonds are dispersed in DMSO instead of water. DMSO's refractive index being larger than the one of fused silica (1.48 > 1.46 at 532nm), it makes it possible to design a liquid-core step-index waveguide with improved overlap between the guided light and the nanoparticle suspension. Second, tapered fiber tips are inserted at both ends of the tapered capillary to seal the microchannel and prevent any flow perturbation from occurring during the experiment. This technique may also enhance the coupling efficiency of the incident light from the fiber to the narrow liquid-core waveguide. Those recent technical development have made it possible to demonstrate the optical transport of fluorescent nanodiamonds with sub-100nm size (average size: 35nm) inside a tapered glass capillary.

REFERENCES:

[1] S. E. S. Spesyvtseva, S. Shoji, S. Kawata, Phys. Rev. Appl. **3**, 044003 (2015)

[2] C. Pin, R. Otsuka, K. Sasaki, ACS Appl. Nano Mater. **3**, 4127-4134 (2020)