

PULSE LASER ASSIST OPTICAL TWEEZERS FOR *in vivo* MANIPULATION

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KEY WORDS: optical tweezers, pulse laser beam, *in vivo* manipulation, optical surgery.

Optical tweezers is a technique to trap and to manipulate micron sized objects, such as polymer particles and cells, under a microscope by radiation pressure force exerted by a laser beam. This technique has been utilized for single-molecular measurements of force exerted by molecular interactions [1] and for cell palpation [2].

To extend applications of optical tweezers we have developed a new technique to get over various obstacles in a living cell. In this technique a pulsed laser (Q- switch Nd: YAG laser, wavelength of 1064 nm, pulse duration of 6 nsec) is utilized to assist manipulations by conventional optical tweezers achieved by a continues wave (CW) laser (Nd: YVO₄ laser, wavelength of 1064 nm). The pulsed laser beam is introduced into the same optics for conventional optical tweezers. In principle, instantaneous radiation force is proportional to instantaneous power of laser beam. As a result, pulsed laser beam generates strong instantaneous force on an object to be manipulated. If the radiation force becomes strong enough to get over an obstacle structure and/or to be released from adhesion, the object will be free from these difficulties. We have named this technique as Pulse Laser beam Assisted optical Tweezers (PLAT). We have successfully demonstrated to extract adsorbed particles (polystyrene, $\phi 1\mu\text{m}$, adhered on cover glass surface processed with aminosilane) for confirmation of this principle. We are aiming to apply this technique to manipulate objects inside a living cell for “*in vivo* manipulation”.

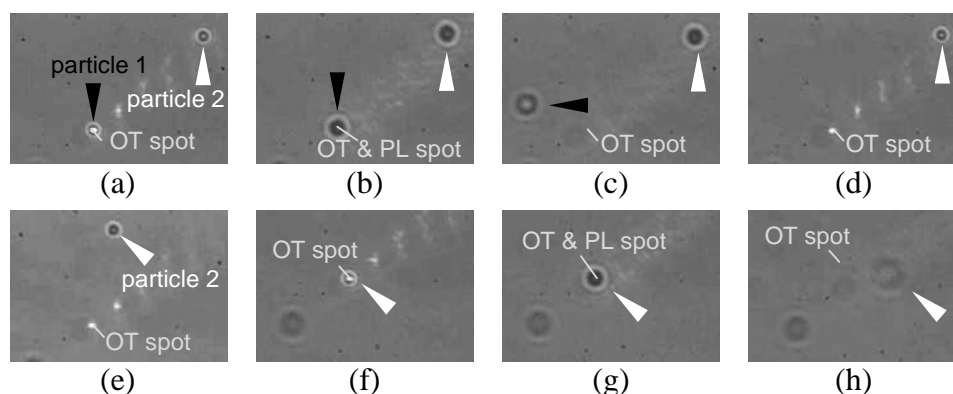


Figure 1: Particle extraction from APS processed glass surface by a pulse beam

- (a) Particle 1 cannot be moved by CW laser optical tweezers (OT).
- (b) ~ (d) Single shot of pulse laser beam (PL) is incident to the same particle, and then the particle is extracted.
- (e) ~ (h) Also particle 2 can be extracted by similar manner.

References;

- [1] K. Ritchie, A. Kusumi, “Single molecule probe scanning optical force imaging microscope for viewing live cells,” *J. Biol. Phys.* **28**, 619-626, (2002).
- [2] H. Miyoshi *et al.*, “Cell palpation system based on a force measurement by optical tweezers for investigation of local mechanical properties of a cell membrane,” *Jap. J. Appl. Phys.* **48**, 120223 (2009).