Laser trapping for measuring viscosities of liquids and mechanical properties of the biological cells

（課程博士・様式７）（Doctoral qualification by coursework,　Form 7）

学 位 論 文 要 旨

Abstract of Doctoral Thesis

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論文題目：
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Abstract：

We propose a method for measuring viscosities of unknown liquids and probing cell elasticity. For these investigations, the optical setup combining laser trapping with optical microscopy was designed. The NIR laser (Nd:YVO_4) with a wavelength of 1064 nm was used to reduce damage from the optical trap because the optical absorbance of biological tissues and cells is lower at wavelengths higher than the visible wavelengths.

To determine the method for measuring viscosities, first, we trapped 1-μm particles in various water–glycerin mixtures and analyzed the dependence of the motion on viscosity. We found the dependence of displacement on the viscosity at chosen frequencies. Then by knowing how the displacement of the trapped particle changes with increase in the frequency of movement, we can estimate the viscosity of the liquid in which the particle is trapped. Based on our calibration with various water–glycerin mixtures, we propose a method for determination of viscosities of unknown liquids with high accuracy. The proposed method can be applied to measure the viscosity of liquids that are available only in small quantities or which have the limited

access. This non-invasive method of studying viscosities could be especially applicable in investigations of biological samples.

Probing cell elasticity determines cell functions, intra cellar changes and other cell parameters. The cell functions are determined by cell structure, any mechanical changes correspond to changes of cell functions. Investigations on mechanical cell parameters will help to understand cell processes for detecting and treating cellular diseases. For investigating the mechanical properties of the cells, we have indented the cells by fluorescent trapped polymer spheres. Cancer HeLa cells were cultured in Dulbecco's Modified Eagle Medium (DMEM) with 10% of Fetal Bovine Serum (FBS), then 0.5-micron fluorescent polymer spheres were added to the medium with cells. Reflected and fluorescent image were observed simultaneously, allowing observing trapped florescent polymer spheres and HeLa cells without dyeing cells which prevents cells from the damage. The trapped sphere was manipulated with known amplitude and trajectory and the stage with sample was moved till the trapped manipulated sphere could indent the cell. Thus, that resulted in the distortion of the detected positions of trapped polymer spheres. The precise detection of the displacements of trapped manipulated spheres was provided using back focal plane interferometry technique. Finally, by analyzing the distortion of the displacements of the trapped manipulated polymer spheres, elasticity of the HeLa cells was obtained.