**Optical Coherence Microscopy combined with Optical Tweezers   
for Cellular Mechanics Research**

**M A Sirotin, M N Romodina, E V Lyubin, I V Soboleva, A A Fedyanin**

*Faculty of Physics, Lomonosov Moscow State University, Moscow 119991, Russia*

Today the study of the micromechanical properties of single red blood cells is an urgent task. Deformation and aggregation properties of erythrocytes determine blood rheology in microvessels, so they significantly affect blood microcirculation, causing the occurrence of such pathologies as systemic lupus erythematosus, echinocytosis, as well as various forms of anemia and liver disease [1,2]. In this regard, the development of techniques allowing to determine the micromechanical properties of single living cells under conditions close to natural is of particular interest.

The main methods of studying the mechanics of erythrocytes are following: atomic force microscopy, the method of micropipette aspiration [3], cytometry with an alternating magnetic field [4], and also dynamic light scattering method [5]. However, these methods do not allow non-invasive examination of single living cells.

In our work, we combined two methods of studying micro-objects: optical tweezers and optical coherent microscopy (OCM). Optical tweezers allow us to control objects with submicron accuracy, and the OCM — to detect displacements with an accuracy of 10 nm and build three-dimensional images of the object [6,7].

The main advantage of combining these two methods is the ability to create mechanical excitation on the cell surface with tweezers, simultaneously detect the displacement of the membrane using phase OCM and study the three-dimensional structure of the cell. As a result, it becomes possible to non-invasively study the micromechanics of a living erythrocyte with high accuracy using external excitation with specified parameters.

The developed and assembled setup of optical coherent microscopy combined with optical tweezers allows us to obtain three-dimensional images of single biological cells with a lateral and axial accuracy of 1 micron (Fig. 1); to initiate non-invasive mechanical vibrations of the cell membrane and at the same time to register membrane movement in any point of cell with an accuracy of 10 nm (Fig. 2), which can give comprehensive data about the cell mechanics.

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**Figure 1.** The slice of the three-dimensional image of the erythrocyte obtained by the OCM method.



**Figure 2.** The erythrocyte membrane displacement signal is represented by blue line. Orange line shows schematically the periodic turning optical trap on and off.