

The Controlled Twisting of Human Erythrocytes Trapped by a Near Infrared Optical Tweezer Using a Shutter

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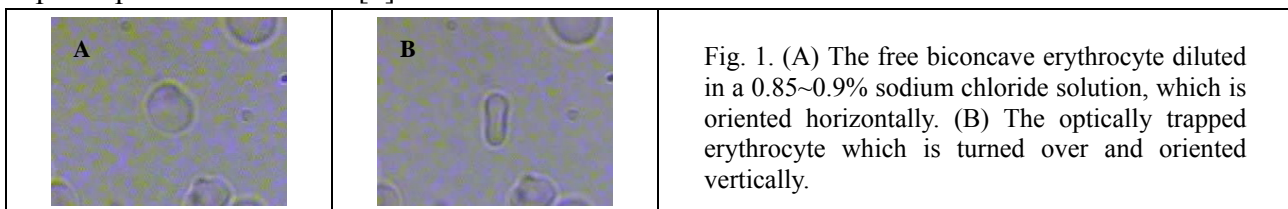
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Abstract: We have observed the twisting and untwisting processes of erythrocytes using a near infrared optical tweezer when the laser beam is modulated by a shutter.

Keywords: optical tweezer, erythrocyte, shutter, twisting

Summary

We have established an optical tweezer with a linearly polarized near infrared laser ($\lambda = 830$ nm) to trap human erythrocytes. The original shape of an erythrocyte is nearly circular in top view but with two concave surfaces in side view. The optical field of the focused laser will modify the shape of the trapped erythrocyte. The original disk-like erythrocyte whose diameter is about $7 \mu\text{m}$ [Fig. 1(A)] changes into a rod-like shape [Fig. 1(B)] by the gradient force action. The biconcave erythrocyte can be folded and twisted due to the polarization-induced optical forces at a higher optical power of ~ 30 mW [1].



Next, we blocked the laser beam periodically by a shutter (period ~ 400 ms) to see the dynamical twisting and untwisting processes of the shape evolution of an erythrocyte in an optical trap (Fig. 2). Due to elasticity of blood cells and conservation of angular momentum, the two semi-parts of the erythrocyte rotate in opposite directions and untwist back to the original rod-like shape within ~ 150 ms when the laser is blocked, and twist again when the laser is unblocked [2,3].

In conclusion, we have explored the twisting dynamics of optically trapped erythrocytes.

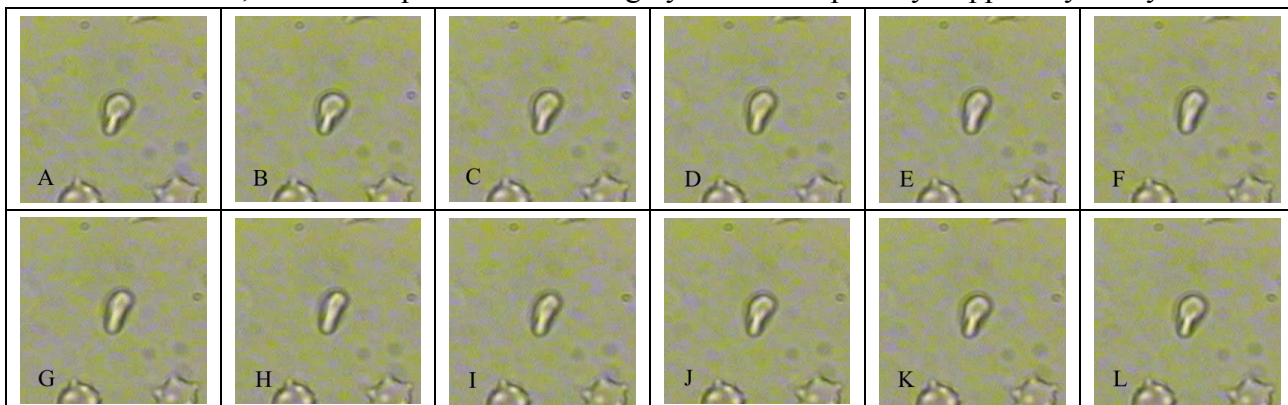


Fig. 2. The time evolution of the shape of an erythrocyte in a modulated optical trap. (A)-(F): The untwisting process when the laser beam is blocked. (G)-(L): The twisting process when the laser beam is unblocked. The temporal separation of each frame is about 30 ms.

References:

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