

Two-Stage Optical Trapping Mechanism of Protein at its Air/Solution Interface

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Optical trapping by a single focused laser beam is used as a tool to manipulate individual microparticles and living cells, while nanoparticles are trapped as a single small assembly in solution. However, the picture is completely different at interface.¹⁾ The nano- and micro-particles are gathered along the interface, giving a single extremely large disk-like assembly. Its size reaches a few ten micrometers, which is interpreted in terms of scattering and propagation of the trapping laser along the interface. Recently we reported that a similar behavior is induced for protein lysozyme solution and its assembly size is a sub-millimeter in diameter and a few ten micrometers in depth.²⁾

Here we apply simultaneous transmission and fluorescence imaging and elucidate non-linear assembling nature with respect to trapping laser power and protein concentration. Upon irradiation a “white ring” appears from the focus in the transmission image and expands to the outside over a few ten micrometers. The fluorescence imaging of a dye-bonded lysozyme directly reveals the assembling behavior, while it is visualized by monitoring the movement of added polystyrene microparticles. Based on these results, we propose a two-stage mechanism; 1) formation and widening of a shallow lysozyme layer and 2) the later trapping of lysozyme clusters expelling the lysozyme layer from the focus.

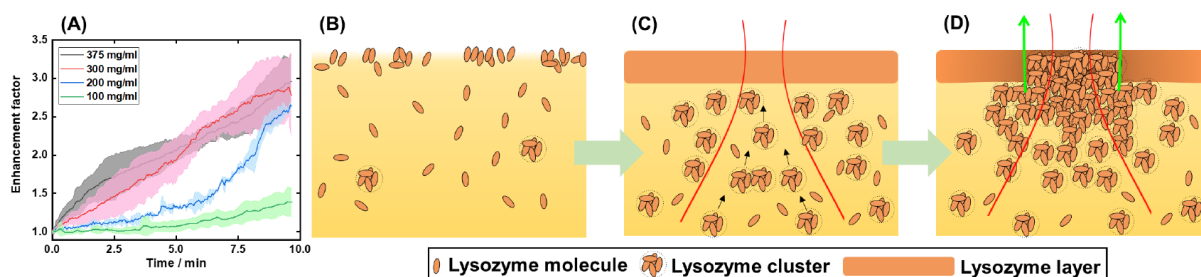


Figure 1. (A) Lysozyme concentration increase at the focus induced by the 1064 nm laser irradiation of 0.6 W. For the 200 mg/mL lysozyme solution, the slow rise is switched to fast at ~ 7 min irradiation. (B)~(D) The illustration of two-stage of optical trapping mechanism. The focused laser and the “white ring” are shown as red cone and green arrow, respectively.

References

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2. P.-W. Yi et al., *J. Phys. Chem. C*, 2021, 125, 18988-18999