Molecular Dynamics on Microbial Rhodopsins Probed by Time-resolved Vibrational Spectroscopy

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Microbial rhodopsins are light-driven proteins having various functions such as proton pump, ion channel and cation pump. For many microbial rhodopsins, the molecular dynamics in between picoseconds and microseconds after photon absorption is unclear. We apply time-resolved stimulated Raman and two-dimensional infrared spectroscopies to elucidate transient reactions in microbial rhodopsins.

Microbial rhodopsins with a retinal chromophore are widely found in microorganisms, utilizing light to their biological activities [1]. Notably, some of the microbial rhodopsins such as channelrhodopsins (ion channel) and sodium pump rhodopsins (sodium ion pump) are ones of the most important proteins for optogenetics [2,3]. The isomerization of the retinal occurs in femtosecond/picosecond time scales after photon absorption [4]. Following the isomerization, the light-driven functions are activated in microseconds after undergoing several intermediate states. Thus, observation of the molecular dynamics in between picosecond and microsecond is essential to understand the activation mechanisms of microbial rhodopsins. However, addressing the structural dynamics on those time region experimentally is challenging because of the difficulty to achieve both of structural resolution and picosecond-to-microsecond wide temporal window. We apply picosecond-to-microsecond time-resolved stimulated Raman and two-dimensional infrared spectroscopy for microbial rhodopsins to clarify the molecular mechanisms on the activation processes.

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