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# High-speed atomic force microscopy for video imaging of functioning biological molecules

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## Abstract

Biological molecules (protein molecules in particular) function by changing their structure. Thus, the direct observation of their structure dynamics is a straightforward approach to understanding how they operate to function. However, this observation has long been infeasible because of a lack of techniques that can meet all conditions required for it: single-nanometer resolution, high temporal resolution, aqueous environment, and low-invasiveness. To make the observation possible, we have been developing high-speed atomic force microscopy (HS-AFM), which has now reached its maturity [T. Ando, *Nanotechnology* **23** (2012)]. HS-AFM opens up a new opportunity to directly visualizing the dynamic structure changes and processes of functioning biological molecules in physiological solutions at sub-second to sub-100 ms temporal and submolecular spatial resolution. Recently, the powerfulness of HS-AFM has continuously been demonstrated by the observations of several proteins, including myosin V walking along actin filament [N. Kodera *et al., Nature* **72** (2010)], bacteriorhodopsin response to light illumination [M. Shibata *et al., Nature Nanotechnology* **5** (2010)], rotary catalysis of rotor-less $F_1$-ATPase [T. Uchihashi and R. Iino *et al., Science* **333** (2011)]. Unlike fluorescence microscopy, dynamic molecular events unselectively appear in detail in the AFM movies, facilitating our understanding of how they function. Furthermore, this technique would be applicable not only biological science but also many scientific fields occurring at the solid-liquid interfaces, including electrochemical reactions, corrosions, catalytic reactions, cleaning with detergents and so on. Thus, this new microscopy will facilitate creation of new "wet nanotechnology". In the presentation, we will briefly overview the principle and performance of HS-AFM and then show interesting movies captured by HS-AFM.

## Biography

Noriyuki Kodera has completed his Ph.D in Biophysics at the age of 27 years from Kanazawa University (Toshio Ando's lab). He has been continuously developing and improving the high-speed atomic force microscope (HS-AFM) since 2000. He is one of staffs of Bio-AFM Frontier Research Center. In 2010, he published a paper showing a walking myosin V along actin filament. After that, he has been applying HS-AFM to various biological phenomena for understanding their functional mechanism.