Most of biological molecules show their vital activities through conformational changes. It has been one of dreams in biological sciences to directly observe biological macromolecules at work under physiological conditions, because such observation is straightforward to understanding their dynamic behaviors and functional mechanisms. To realize this observation, our group has been improving the imaging speed of atomic force microscope (AFM) and currently established high-speed AFM. We currently focus on application of high-speed AFM to study molecular mechanism of proteins at single molecular level while developing novel techniques such as high-speed AFM system combined with fluorescence microscopy/optical trap techniques. In addition, by increasing the scanning speed of scanning ion-conductance microscope (SICM), that can observe the surface characteristics of cells and organelles in a noncontact manner, we are also promoting applications of the microscope into the biological sciences.

Master course: The first grade students start their research projects which include technical development and imaging study of biological samples using high-speed AFM and high-speed SICM under the supervision of the staff members. For the technical developments, the students are required to learn broad knowledges about mechanical design, electronic circuit, software development and so on. For the imaging study, students need to gain knowledge about sample preparations for cells and proteins in addition to the skills of AFM and SICM operation.

Doctor course: Students have own research project with high impact about either single-molecule imaging or developments for novel microscopy techniques. They are highly encouraged to attend international or domestic conferences to give presentations.

Our group has the laboratory meeting every week. In the meeting, we have two sessions; progress report and journal club given by the lab members.

Research subjects

- High-speed atomic force microscopy imaging of transmembrane proteins with Nanodiscs
- Improvement on concave/convex substrate for high-speed AFM observation and its biological applications
- Observation of nucleosome remodeling by ATP−dependent chromatin remodeler
- Structural dynamics of the intrinsically disordered protein CAMP studied by high-speed AFM
- Simultaneous observation of biomolecules and living cells using high-speed atomic force microscopy and fluorescence microscopy
- Study of assembly pathway of the proteasome α−ring by high-speed atomic force microscopy
- Development of 3D-patterned HS−AFM substrate using focused ion beam lithography
- Fine tuning of tip shape of nanopipette probe for high-resolution scanning ion conductance microscope
- Development of HS−AFM substrate with concave−convex shapes using nano−sphere imprinting method
- Development of Temperature Controlled High−Speed AFM and its application to FliI ATPase
- Development of tip-scanning HS−AFM combined with optical tweezers
- Structural dynamics of MukB and MukB−DNA complex studied by HS−AFM
- Study of assembly pathway of the proteasome α−ring by high-speed atomic force microscopy
- Development of 3D-patterned HS−AFM substrate using focused ion beam lithography
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