学位申請論文公開講演会

日　時：2023 年 1 月 26 日　10:30 ~ 11:30

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場　所：物理会議室 (C207)　(理学 C 館)

題　目：Development and Applications of Tip-Scan High-Speed Atomic Force Microscopy Combined with Substrate Stretching Device

基板の一軸伸張機構を有する探針走査型高速原子間力顕微鏡の開発

主論文の要旨

Nanometer-scale imaging technology with the air of atomic force microscopy (AFM) unveiled fruitful scientific insight into various areas, including biology, polymer, tribology, and metrology. Although dynamic imaging processes of both biological and non-biological processes have been long-standing challenging to the conventional apparatus, the emergence of high-speed AFM has allowed the direct observation of nanoscale dynamics processes of samples with sub-second temporal resolution and is very powerful in the analysis of single-molecule dynamics of various proteins. In addition, technological developments toward the multi-functionality of high-speed AFM, such as the combination with optical microscopy to enable more multifaceted analysis, have also been carried out.

One of the developments required to enhance the versatility of high-speed AFM is the mechanical manipulation of samples because the functions of proteins are often modulated by mechanical stress from an external environment. Thus, I developed a tip-scan-type high-speed AFM equipped with a uniaxial stretching mechanism for the substrate on which the sample is fixed to capture unprecedented dynamics under mechanical loads. As a demonstration of the application of the developed device to biological samples, I observed the stress-induced microtubule rupture process, the change in the affinity of actinin for the curvature of actin fibers, the curvature-sensitive binding affinity of BIN1 protein to the lipid membrane. Further, I applied the technique to non-living samples and observed morphological changes in latex films formed with polymer particles under an extreme strain of 140%.

These application studies effectively demonstrate that the high-speed AFM with uniaxial extension mechanism developed should be a versatile tool for analyzing nanometer-scale dynamics of samples under controlled mechanical stress and is expected to provide novel and innovative methods for life science and materials science.