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Research Interests

Scanning Ion conductance microscopy, Nanoscience, Nanofluidics, Solid-liquid Interfaces,

Education

2006	Doctor of Science, Graduate School Science and Technology, Niigata University

Professional Career

2006	JST-CREST Postdoctoral Fellow, Niigata University
2006 - 2007	JST- SORST Postdoctoral Fellow, Niigata University
2007	Assistant Professor, Department of Physics, Tohoku University
2007 - 2009	Assistant Professor, Center for the Advancement of Higher Education, Tohoku University
2009 - 2012	JST-ERATO Postdoctoral Fellow, Tohoku University
2012 - 2017	Assistant Professor, Bio-AFM Frontier Research Center, Kanazawa University
2017 - 2020	Assistant Professor, Nano Life Science Institute, Kanazawa University
2020 - present	Associate Professor, Nano Life Science Institute, Kanazawa University

Scientific Activities

2004 - 2012	Spin physics and quantum transport in strongly correlated electron systems.
2012 - present	Instrumentation and applications of scanning ion conductance microscopy.

Publications

1. K. Shigyou, L. Sun, R. Yajima, S. Takigaura, M. Tajima, H. Furusho, Y. Kikuchi, K. Miyazawa, T. Fukuma, A. Taoka, T. Ando, S. Watanabe, "Geometrical Characterization of Glass Nanopipettes with Sub-10-nm Pore Diameter by Transmission Electron Microscopy" Anal. Chem. accepted.
2. S. Watanabe, S. Kitazawa, L. Sun, N. Kodera, and T. Ando, "Development of High-Speed Ion Conductance Microscopy" Rev. Sci. Instrum. 90(12), 123704 (2019).
3. L. Sun, K. Shigyou, T. Ando, and S. Watanabe, "Thermally Driven Approach to Fill Sub-10-nm Pipettes with Batch Production" Anal. Chem. 91, 14080, (2019).
4. S. Watanabe, and T. Ando, "High-speed XYZ-nanopositioner for scanning ion conductance microscopy" Appl. Phys. Lett. 111, 113106, (2017).

Probing and characterizing nano-bio interfaces by scanning ion conductance microscopy

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Scanning probe techniques with a glass capillary have been widely exploited in the characterization of physical, chemical, and biological properties of nano-bio interfaces. Among these techniques, scanning ion conductance microscopy (SICM) has played an essential role in the visualization of live cell surfaces with nanometer-scale resolution. SICM uses an electrolyte-filled glass pipette as a probe to detect an ion current passing through an aperture of the pipette tip. The ion current variation depending on the distance between the pipette tip and sample surface reflects various local information of sample surfaces under a liquid environment, such as geometry, surface charge, and mechanical properties of the sample (Fig. 1). However, a longstanding drawback of SICM is an insufficient spatiotemporal resolution. We have devoted to improve the insufficiency of SICM to realize wide-range applicability of SICM for the investigation of nano-bio interfaces [1-4]. Here we show recent progress of our improvements and applications using our instrument. We developed a tip-scan-type high-speed SICM scanner with a large stroke [1], an active damping control method to reduce unwanted vibrations due to the driving of the scanner [2], and the signal enhancement method with an ion concentration gradient produced in the vicinity of the tip [2]. These improvements allow us not only to visualize dynamic biological processes occurring in soft cell surfaces with high roughness but also to map local mechanical properties of live cell surface.

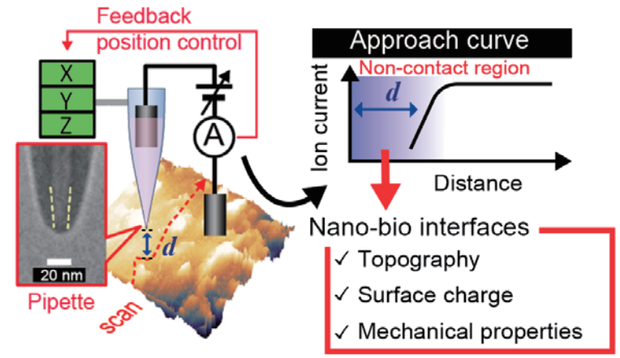

Fig. 1: Probing nano-bio interfaces by SICM

References

[1] S. Watanabe, and T. Ando, "High-speed XYZ-nanopositioner for scanning ion conductance microscopy" Appl. Phys. Lett. 111, 113106, (2017).

[2] S. Watanabe, S. Kitazawa, L. Sun, N. Kodera, and T. Ando, "Development of High-Speed Ion Conductance Microscopy" Rev. Sci. Instrum. 90(12), 123704 (2019).

[3] L. Sun, K. Shigyou, T. Ando, and S. Watanabe, "Thermally Driven Approach to Fill Sub-10-nm Pipettes with Batch Production" Anal. Chem. 91, 14080, (2019).

[4] K. Shigyou, L. Sun, R. Yajima, S. Takigaura, M. Tajima, H. Furusho, Y. Kikuchi, K. Miyazawa, T. Fukuma, A. Taoka, T. Ando, S. Watanabe, "Geometrical Characterization of Glass Nanopipettes with Sub-10-nm Pore Diameter by Transmission Electron Microscopy" Anal. Chem. *accepted*.