

Multiple-probe Scanning Probe Microscope for Nanometer- and Micrometer-scale Transport Measurements on Nanomaterials

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Scanning probe microscopes (SPMs) have been widely used for investigating structures and properties of nanoscale structures and materials. Conventional SPM which equip a single probe has realized a variety of measurements depending on properties and/or functions of the probe. However, there have been practical difficulties in executing direct measurements of transport properties of individual objects [1]. In this paper, we present our multiple-probe SPM developed for single nanomaterials to extended nanosystems research.

In our MP-SPMs [1], we can use single, double, triple, or quadruple probes depending on the purpose of the measurements. Inter-probe distances down to 50 nm have been achieved with electrochemically etched metal probes so far, and the probes can achieve atomic resolution when imaging a target structure. When we use non-conductive substrates, multiple-probe atomic force microscope [2] can be used by setting specially designed tuning fork type probes [3]. More recently, newly designed MP-SPM has gained ability of non-contact potential mapping over nanomaterials and nanosystems under local current fields given by two or three contact SPM probes. Details of our MP-SPM together with several examples of MP-SPM characterization will be presented.

References

- [1] T. Nakayama, O. Kubo, Y. Shingaya, S. Higuchi, T. Hasegawa, C.-S. Jiang, T. Okuda, Y. Kuwahara, K. Takami and M. Aono, *Adv. Mater.* 24, 1675 (2012).
- [2] S. Higuchi, O. Kubo, H. Kuramochi, M. Aono and T. Nakayama, *Nanotechnology* 22, 285205 (2011).
- [3] S. Higuchi, H. Kuramochi, O. Kubo, S. Masuda, Y. Shingaya, M. Aono, and T. Nakayama, *Rev. Sci. Instrum.* 82, 043701 (2011).