Multiple-probe scanning probe microscopy: a potential application to bio-inspired materials research

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Abstract (Arial 10)

Multiple-probe scanning tunneling microscope (MP-STM) [1] enables us to investigate, at the nanometer scale, electrical properties of nanomaterials and functions of extended nanosystems as schematically illustrated in Figure 1. So far, MP-STM has been developed and used for characterizing electrical properties of nanomaterials, such as fullerene polymers, self-organized metal silicide nanowires, carbon nanotubes and so on [2]. However, our recent development to convert the MP-STM into MP-atomic force microscope (MP-AFM) [3] really opens possibilities to perform MP-scanning probe microscope (MP-SPM) measurements on a variety of materials, ranging from metal, semiconductor, insulator and even biomaterials.

One of the challenging and exciting research which can be done using MP-SPM would be the application of MP-SPM to biology. Since MP-SPM is, in principle, a device equipped with multiple inputs and outputs to/from materials and systems of interest, application of MP-SPM, for example, to a single cell would establish a signal processing cell system. Here, an important thing is to use appropriate probes for detecting signals in bio-systems, i.e., molecular signals. Therefore, we have developed a tungsten suboxide probe which greatly enhances Raman scattering from molecules in a solution. Another example of interesting research is a development of neuromorphic architecture for neural network computation with MP-SPM. One of the major tackles in creating neural network based on silicon technology lies on the difficulty in preparing highly cross-over interconnections between units (some equivalent circuits to mimic neuron cells and synapses). Recently, an inorganic metal compound system was found to form neuromorphic structures [4]. We discuss how our MP-SPM can contribute to the development of neuromorphic network research toward future computation, together with preliminary results in forming bio-inspired neuromorphic network using carbon-based nanomaterials.

References

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Figures

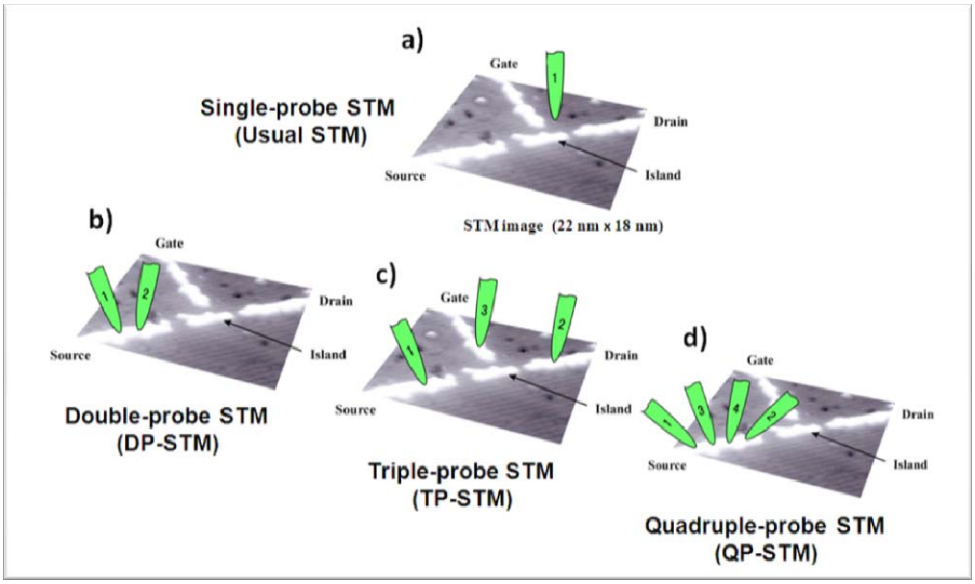

Figure 1. Possible measurements using scanning tunneling microscopes with (a) single, (b) double, (c) triple, and (d) quadruple probes.