# Multi-probe Scanning Tunneling Potentiometry on a High Quality Graphite

**Hiroyuki Mogi**[1], Takafumi Bamba[1], Yuki Kawashima[2], Mutsuaki Murakami[2], Shoji Yoshida[1], Osamu Takeuchi[1], and Hidemi Shigekawa[1]

[1]Faculty of Pure and Applied Sciences, University of Tsukuba, Tsukuba, Ibaraki 305-8573, Japan. [2]Kaneka corporation, Kita, Osaka, 530-8288, Japan

Email: gimogimo1372546g@gmail.com, https://dora.bk.tsukuba.ac.jp/en/

Recently, miniaturization of electronic devices has been widely progressing and the development of the method for analyzing local conductivity has become extremely important. For this work, we have developed a four-probe measurement method including a tunneling junction with UHV four-probe STM (Unisoku corp.) which is integrated with optical zoom lens (VH-Z100T, WD=24mm, Keyence corp.). As shown in Fig. 1, we used a stiff electrochemically etched tungsten probe for STM and three Pt/Ir coated conductive cantilevers (spring constant: 0.2 N/m) for making soft mechanical contacts. Conventionally, stiff probes were used for mechanical contacts, where the measurements suffered from probe/sample destruction and deformation due to hard contact. We replaced them with AFM cantilevers, which allowed us to avoid the deformation of the probes and sample, and to realize the easy deformation-free probe approach.

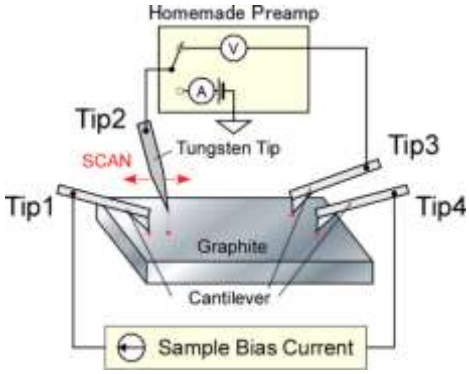


**Fig. 1:** Schematic diagram of the experimental setup

The potential mapping was well distributed over the STM topography image as shown in Fig.2. While STM topography measurement, scanning was interrupted on each grid point and measurement mode was switched between the current mode (STM) and the potential mode (STP) by using homemade preamplifier. Then, we swept the in-plane current value and obtained the slope of the lateral $I_{tip1\text{-}4}$-$V_{tip2\text{-}3}$ curve to eliminate the offset voltage of the system. In this study, the sample was a ~2 μm thick defect-free graphite sheet. From the potential gradient measured with the resolution of few tens microvolts, an ideal high conductivity for the sample was well confirmed. Details will be discussed at the conference.

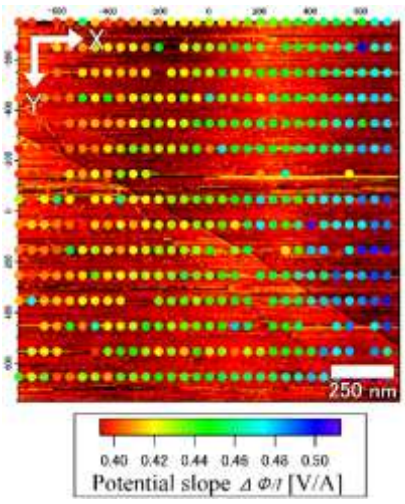


**Fig. 2:** Topographic image and mapping of potential difference between tip2 and tip3.