Supporting Information

CNT wire synthesis on the AFM probe

A suspension of single-wall nanotubes (SWNTs), which were manufactured via an arc discharge process, was prepared via the sonication of 10 mg of SWNTs with 100 mL of H_2SO_4/HNO_3 (3:1) for 2 h followed by centrifugation at 12000 rpm for 10 min and two successive washing processes with deionized water. A SWNT solution droplet was loaded onto the end of a plastic hub needle with a 290-μm-inner diameter to form a hemispherical surface. The SWNT solution droplet and an AFM tip were manually aligned so that only the end of the AFM tip was dipped into the SWNT suspension; an AC electric field with a frequency of 1 MHz and an amplitude of 1 V_{p-p} was then applied between the droplet and the AFM tip. Under the AC field, the SWNTs were aligned along the electric field and were formed a CNT-bundle wire due to a combination of the effect of dielectrophoresis (DEP) and the surface tension of the CNT suspension meniscus. The CNT-bundle wire formed using DEP comprises a tangle of SWNT fragments, as shown in Fig. S1.

SEMC-AFM performance of the L-shaped nanoprobes

The L-shaped probe produced two duplicate profiles of the CNT network sample during topological imaging. This artifact is caused by an additional contact between the tip and the sample surface at the disk plateau edge. The effective distance between the probe electrode and the sample surface during AFM scanning, d_{eff}, is reduced in the second profile, which is produced by the contact between the disk plateau edge and the substrate, compared to the first profile, which is produced by the initial contact of the protrusive peak to the substrate, as described in Fig. S2a. The difference in the effective distances between the first profile and the second profile was 10–15 nm

in the topographical images shown in Fig. S2b and S3a. This difference is smaller than the ideal Z_{shift} value, which is the distance between contact points 1 and 2 of the L-shaped nanoprobe in the z-direction when the nanowire tip end is cut parallel to the AFM cantilever, as described in Fig. S2a. The calculated value of Z_{shift} is approximately 50 nm; this value is based on the geometry of the fabricated L-shaped nanoprobes and the tip-end tilting angle, θ. The difference between the height difference of the two duplicate profiles and the ideal Z_{shift} value might have been induced by additional inclination of the tip end. The disk plateau that should be parallel to the cantilever can become nonparallel to the cantilever because of cantilever bending that can occur owing to the intrinsic stress induced by the insulation layer deposition process or imperfect alignment of the probe during electrode exposure via the FIB milling process. Fig. S4 shows a topographical image and an EC image of rectangular gold electrodes by the L-shaped nanoprobe. The gold electrodes were step-like feature, and the resolution of the L-shaped nanoprobes was estimated to ~300nm from the step-like feature.

Supporting Information Figures

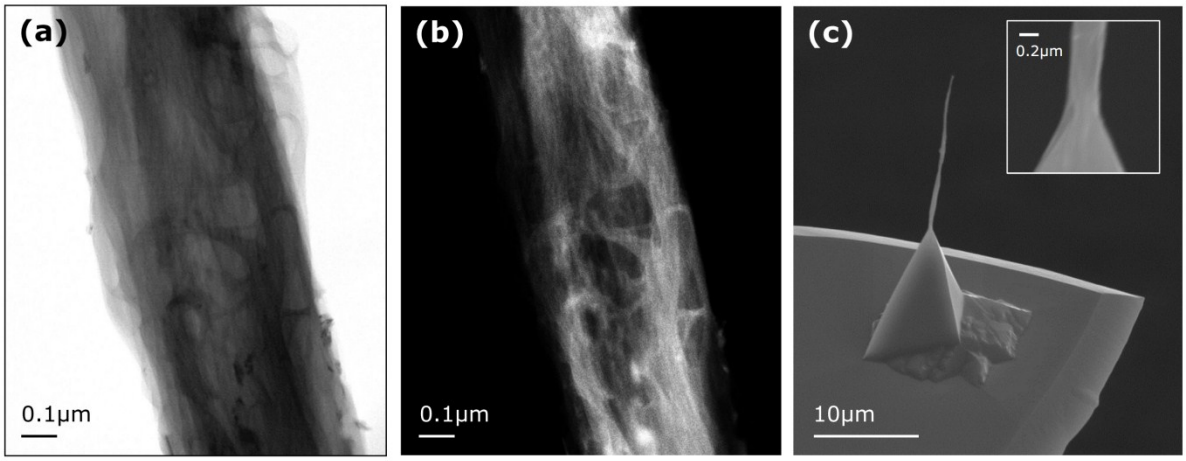

Fig. S1. (a) A bright field image and (b) a high angle annular dark field image of a CNT-bundle wire obtained via scanning transmission electron microscopy. (c) An FESEM image of an AFM probe with an integrated CNT-bundle wire (inset image: the pyramidal AFM tip end holding the CNT-bundle wire).

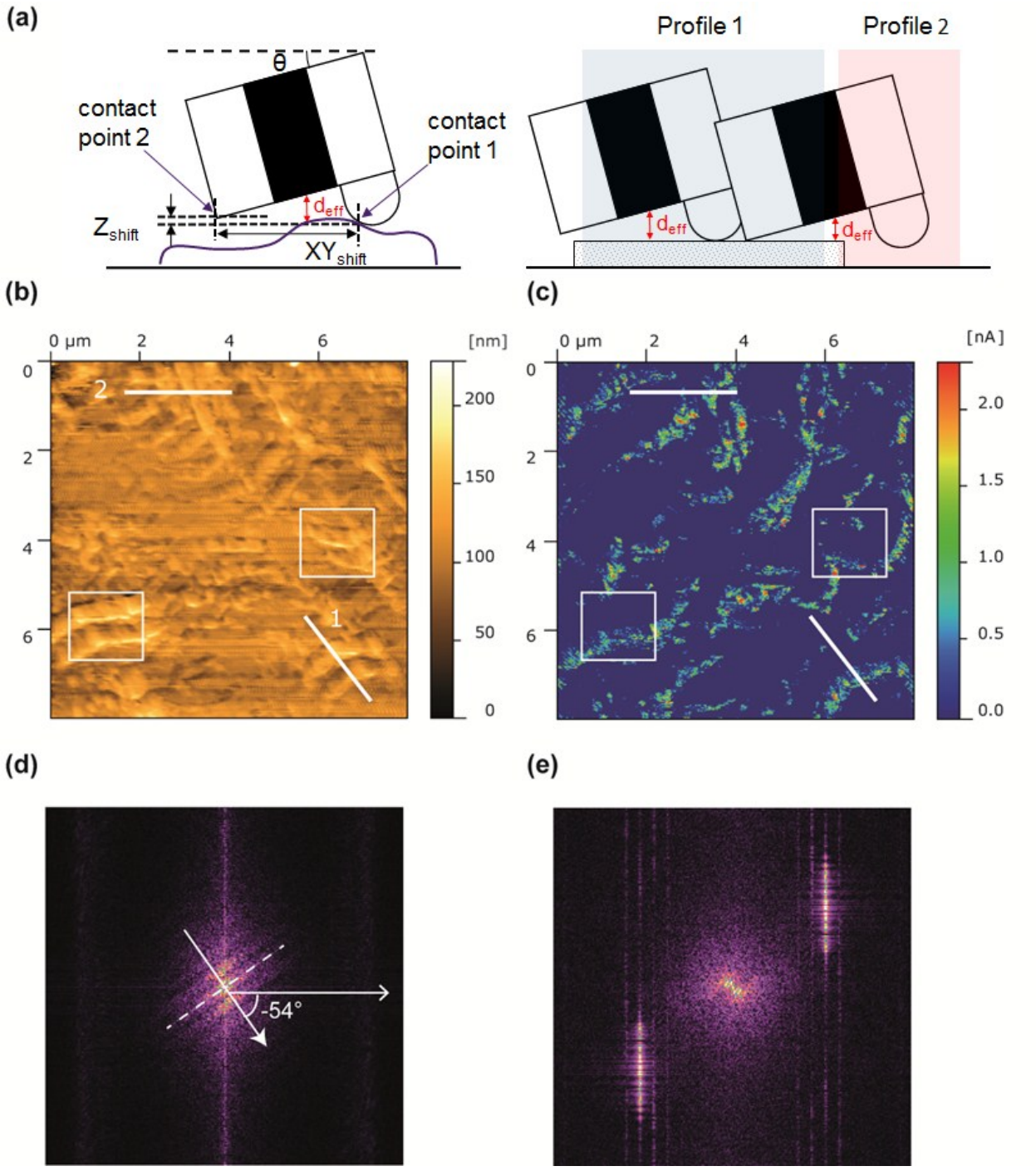

Fig. S2. (a) Schematic diagrams of surface scanning using the L-shaped nanoprobe. (b) Topographical and (c) electrochemical current images of CNT networks (8 µm × 8 µm area). Frequency responses of (d) the topographical and (e) current images corresponding to (b) and (c), respectively.

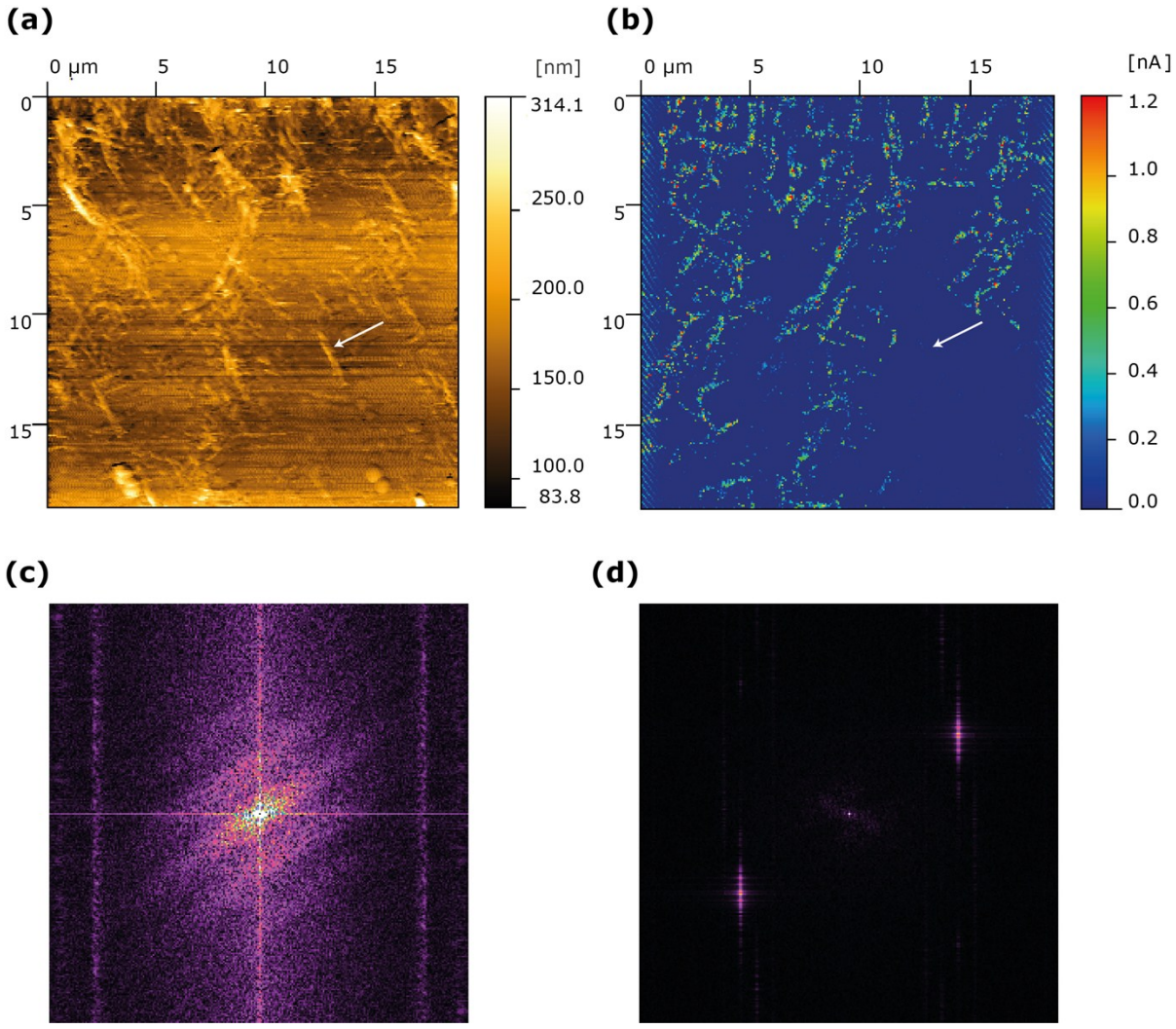

Fig. S3. (a) A topographical image and (b) an EC image of a 19 µm × 19 µm area of a CNT network at –0.1 V vs. a Pt reference electrode with a 0.5 Hz scan rate. Frequency responses of (c) topographical and (d) EC images.

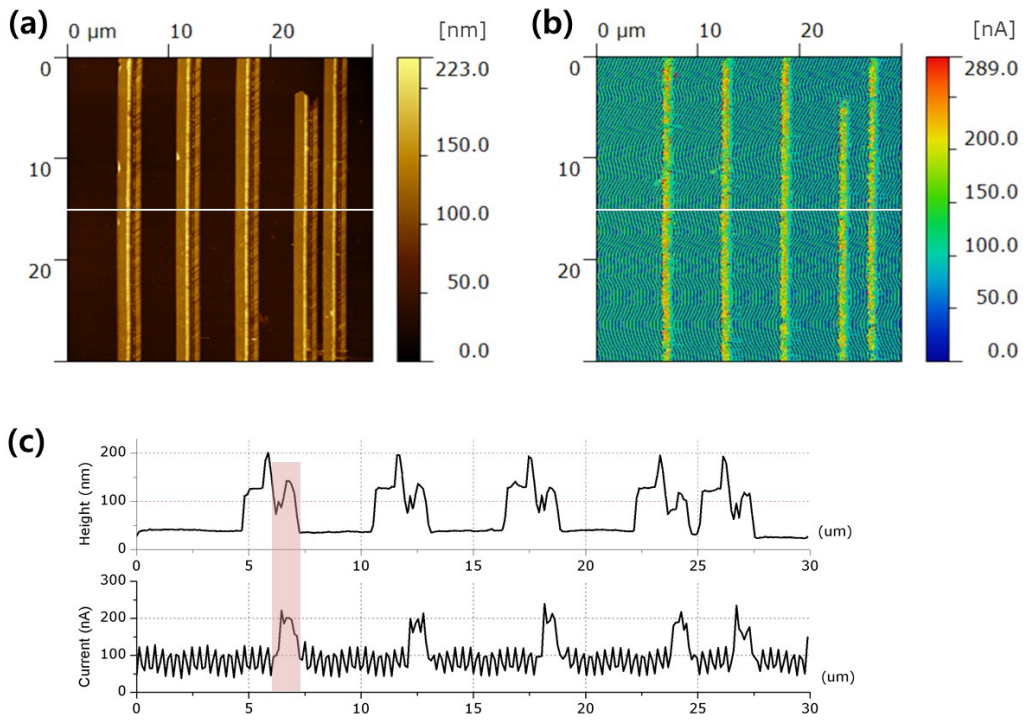

Fig. S4. SECM-AFM scanning data of a gold microelectrode array with an L-shaped nanoprobe. (a) Topographical and (b) current images of 30 µm × 30 µm range with -0.15V vs a Pt reference electrode. Scan rate is 0.2Hz. (c) Profiles of topographical and current image at white lines in (a), (b).