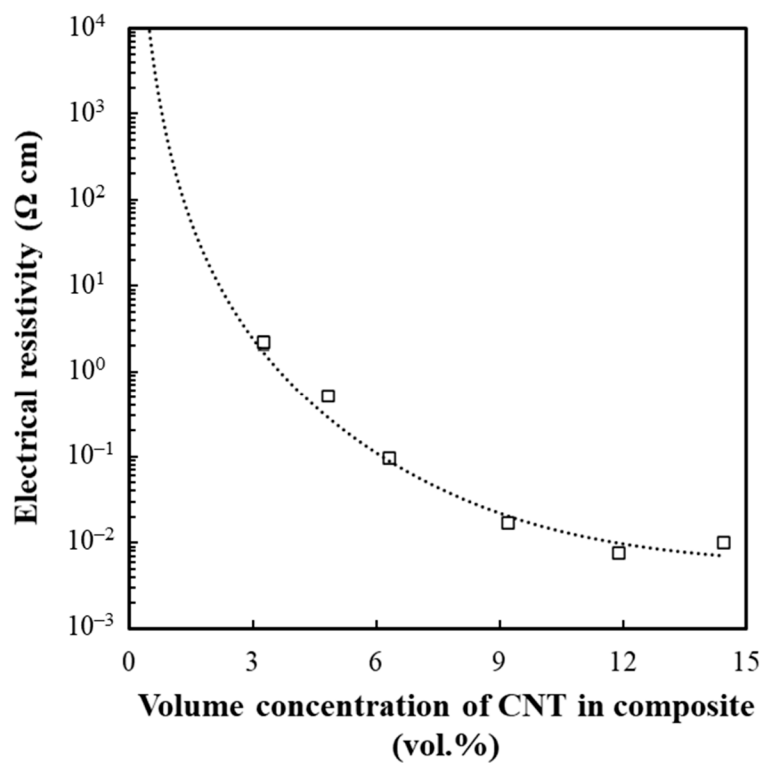
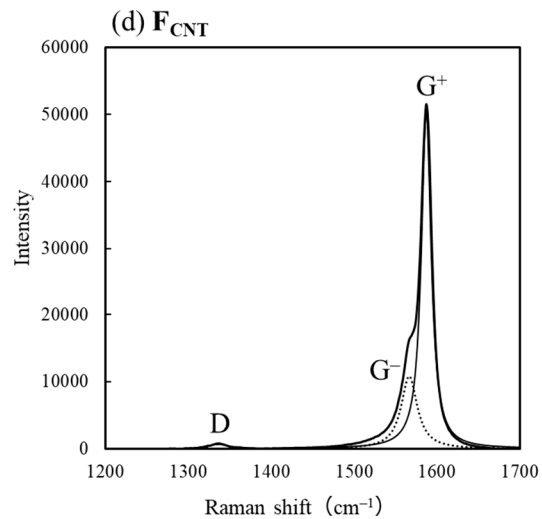
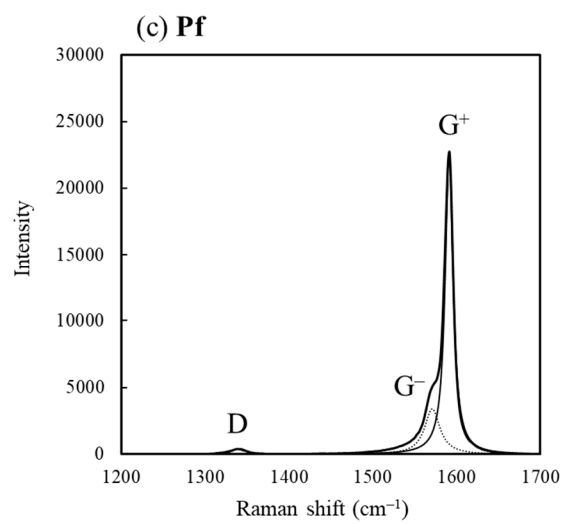
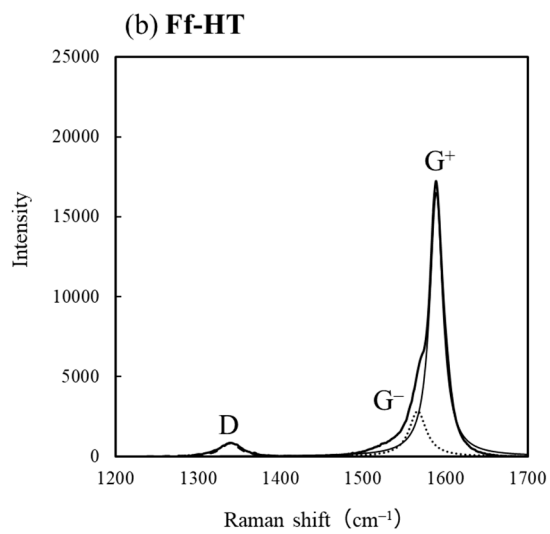
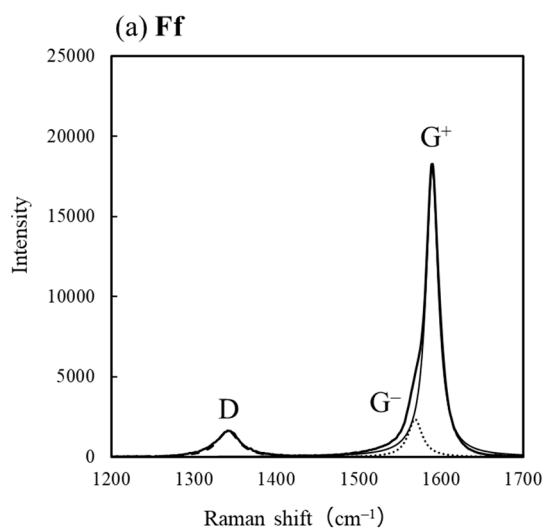
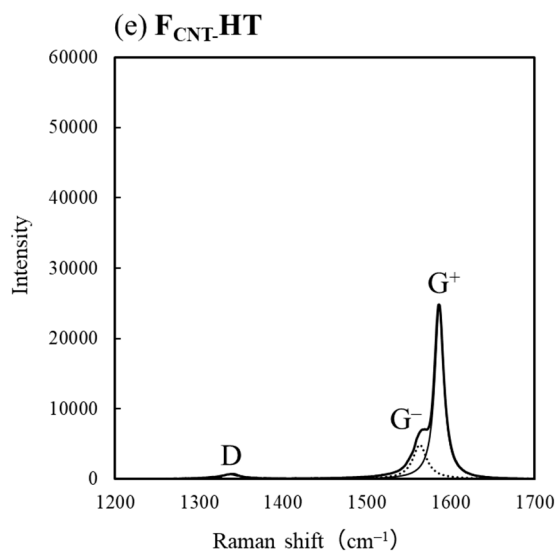


Supplementary Figure S1. Relationship between the film thickness of the SWCNT/SiO₂ composite thin films (**Fa–Fg**) and their volumetric fraction of SWCNT in each film. A stylus profilometer was used to measure the film thicknesses of **Fx**.

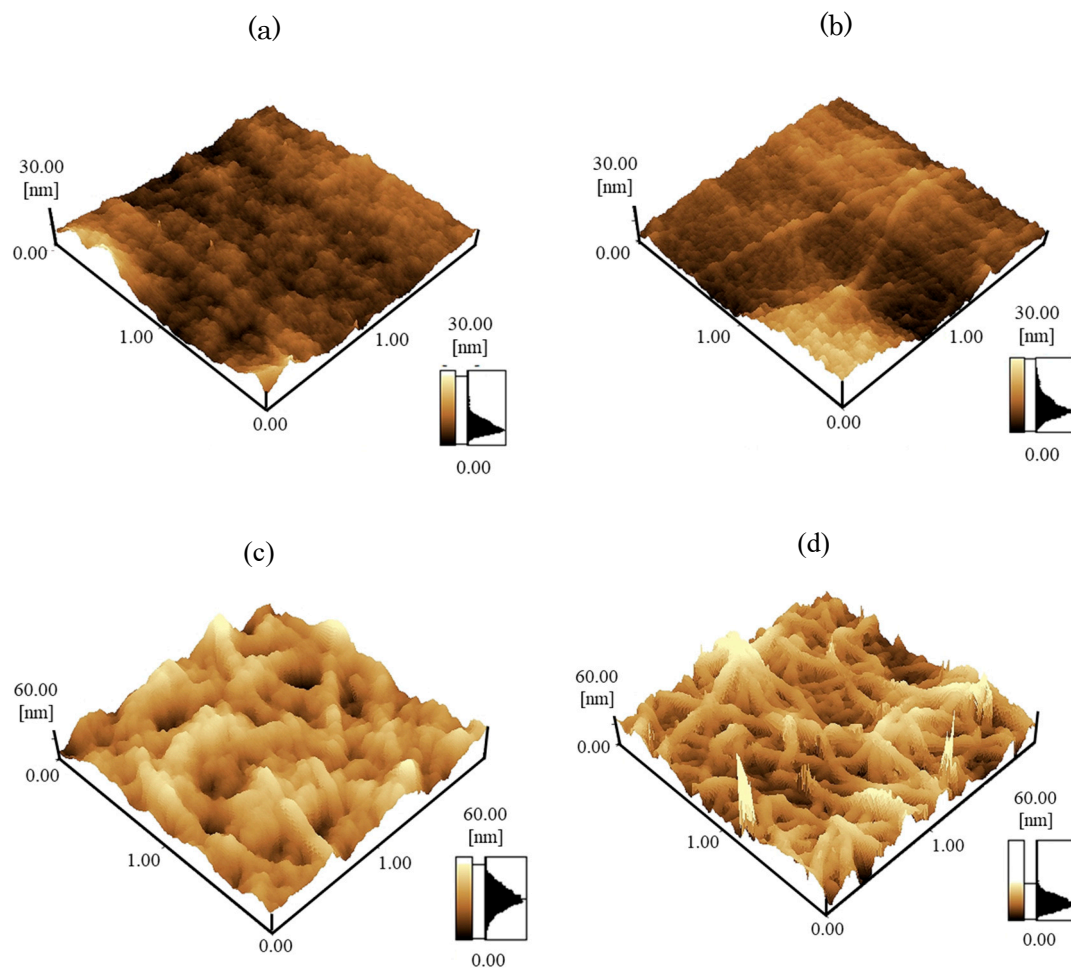


Supplementary Figure S2. Relationship between the electrical resistivity of the SWCNT/SiO₂ composite thin films (**Fb–Fg**) and their volumetric fraction of SWCNT in each film. The electrical resistivity of **Fb–Fg** at 25 °C was determined using four-probe method and film thickness. The plot of **Fa** was removed from the figure because the value is $>10^3 \Omega$ cm.





Supplementary Figure S3. Deconvoluted Raman peaks of the obtained thin films, (a) **Ff**, (b) **Ff-HT**, (c) **Pf**, (d), **F_{CNT}**, and (e) **F_{CNT-HT}**, along with each original spectrum in the range of 1200-1700 cm⁻¹. The thick line indicates the observed spectra, while three lines, (---), (•••), and (—) indicate the theoretically fitted curves assignable the D, G⁻, and G⁺ bands, respectively. All the calculated curves completely overlapped the corresponding observed curves.



Supplementary Figure S4. Three-dimensional (3D) AFM images of (a) **Ff**, (b) **Ff-HT**, (c) **FCNT**, and (d) **FCNT-HT** obtained by scanning each $2 \times 2 \mu\text{m}^2$ area.