Correlation of Electron Tunneling and Plasmon Propagation in a Luttinger Liquid

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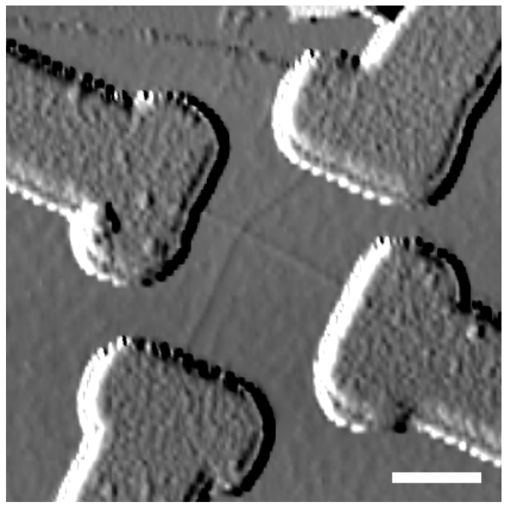
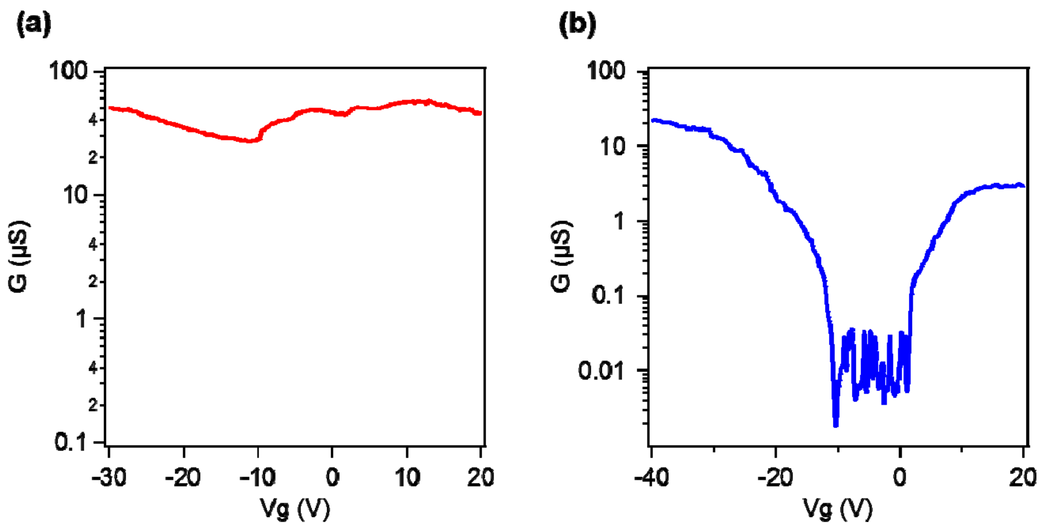
SM1.

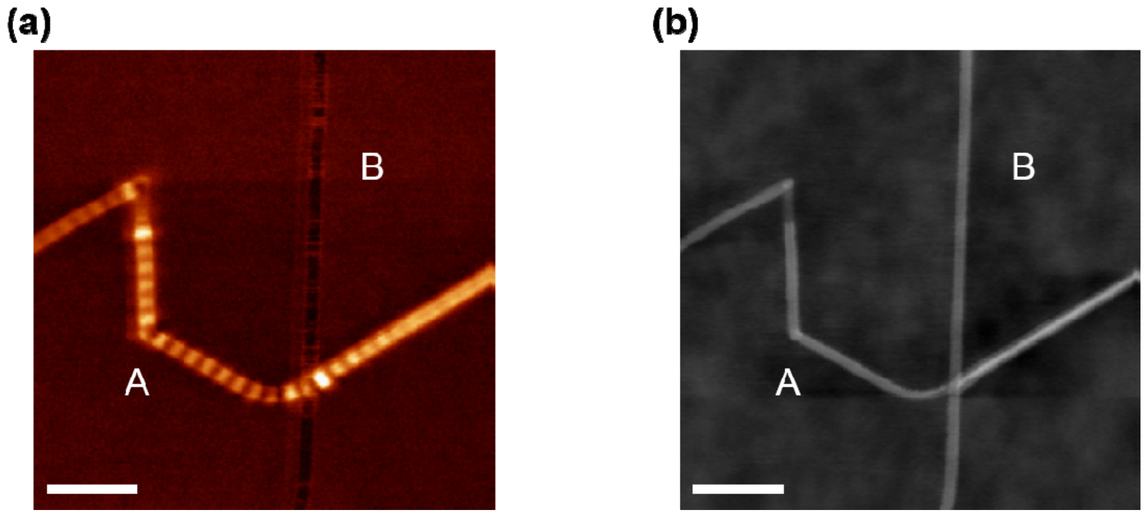


SM1. AFM image showing a representative SWNT cross junction device. Metal contacts are Pd/Au (10 nm/90 nm). The scale bar is 300 nm.



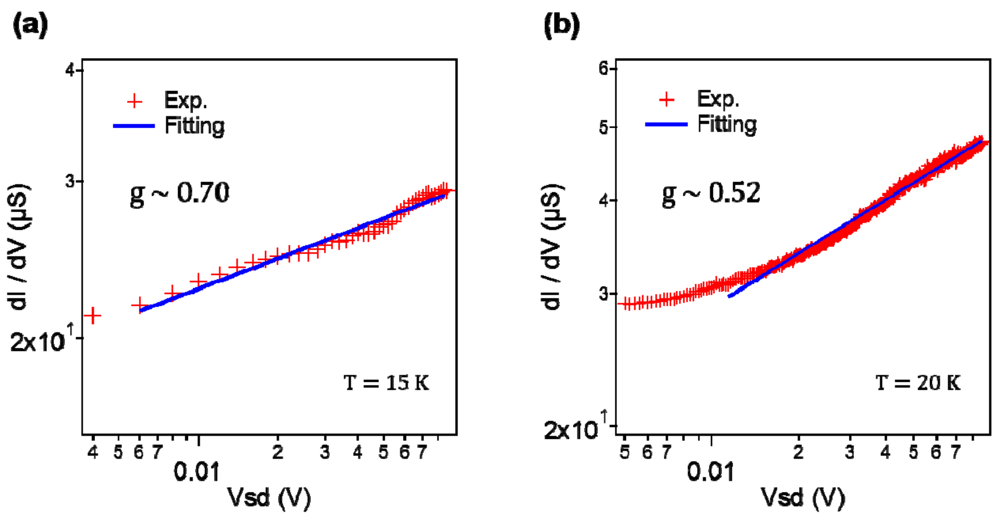
SM2. Transport data on individual metallic and semiconducting SWNTs characterized by near-field optical nanoscopy. (a) Transport data of an individual metallic SWNT (tube A in Fig. 2(c) in the main text) with weak dependence on backgate voltage (on/off < 5). (b) Transport data of an individual semiconducting SWNT (tube B in Fig. 2(c) in the main text) with strong dependence on backgate voltage (on/off > 1000). Measurements in (a) and (b) are carried out at room temperature in vacuum.

SM2.



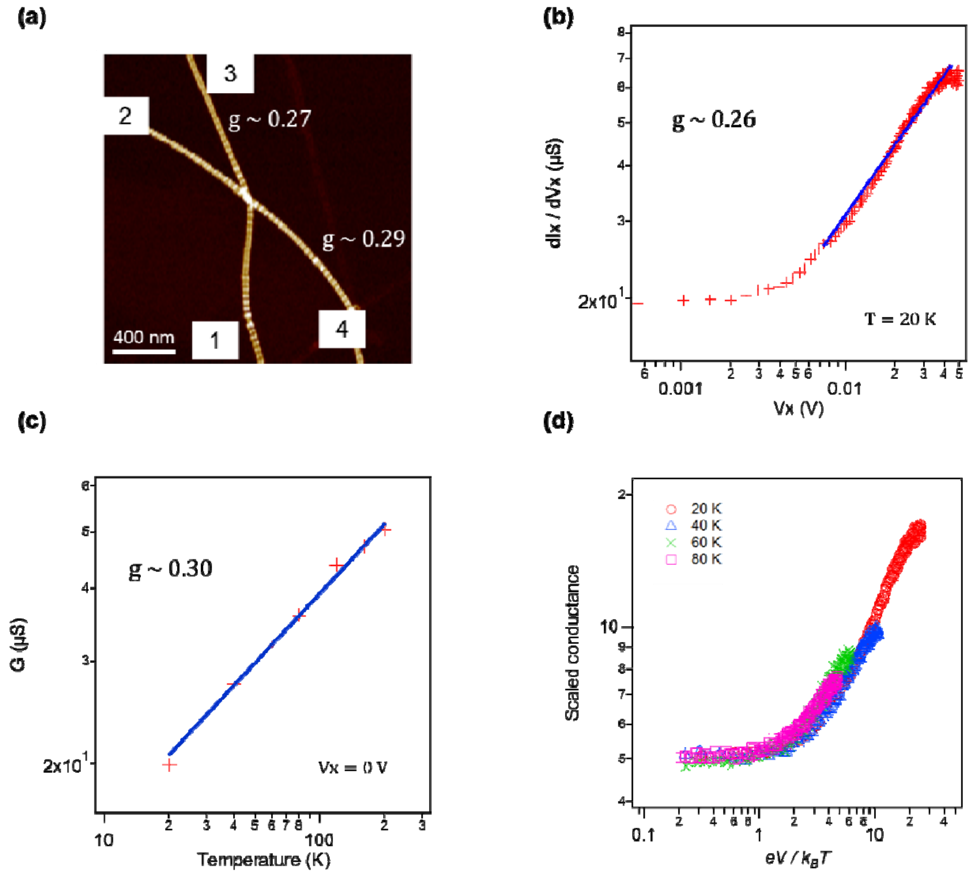
SM3. A SWNT cross junction with a metallic SWNT crossing a semiconducting SWNT characterized by near-filed optical nanoscopy. (a) Near-field optical nanoscopy image of a SWNT cross junction comprised of a metallic SWNT (tube A with pronounced Luttinger liquid plasmons) and a semiconducting SWNT (tube B with no plasmon oscillations). (b) The corresponding AFM topography image of the same SWNT cross junction. Note that tube A forms a bundle with another tube on the right-hand side of this image. The scale bars in (a) and (b) are 200 nm.

SM3.



SM4. Power-law scaling with electrical bias in individual metallic SWNTs. (a) dI/dV results for the constituent metallic SWNT (tube 1-3 in Fig. 3(a)) at 15 K with the same backgate voltage as that used in Fig. 3(b). The power index from our best fitting is $\alpha \sim 0.11$, which corresponds to $g \sim 0.70$ by using Eq. (2) in the main text. (b) dI/dV results for another isolated metallic SWNT measured at 20 K. The power index from our best fitting is $\alpha \sim 0.23$, which corresponds to $g \sim 0.52$ by using Eq. (2) in the main text. The power scaling indexes vary significantly in different single SWNTs.

SM4.



SM5. Correlation of electron tunneling and plasmon propagation in a Luttinger liquid in device #2. (a) Near-field optical nanoscopy characterization on a metallic SWNT cross junction. Luttinger parameters are determined to be g ~ 0.27 (tube 1-3) and g ~ 0.29 (tube 2-4) for each of two nanotubes from the measured Luttinger liquid plamons. Metal contacts are denoted by numbers. (b) Differential conductance (dIx/dVx) measurement of the electron tunneling probability across the Luttinger liquid junction as a function of voltage drop across the junction (Vx) at 20 K. Measurements are carried out in a four probe configuration where the electrical current is forced to flow through contacts 3 and 4 and voltage drop is measured through contacts 1 and 2. A power function fitting (blue line) yields g ~ 0.26. (c) The corresponding temperature-dependent electron tunneling data (zero Vx), which yields g ~ 0.30. (d) Scaled conductance (dIx/dVx) / T^{α} as a function of eV / k_BT at different temperatures, where α is the power component with bias scaling at each temperature. All data collapse onto a single curve reasonably well, which provides an independent verification of Luttinger liquid behavior.

SM5.