Supplementary Information

S1: Photocurrent in D1

At zero source-drain bias, the a.c. current image for D1 (Fig. S1, standard lock-in) shows strong localized spots of opposite polarity at the nanotube-metal junctions. These are a result of a local electric field created by the electronic band-bending at the interface of the dissimilar materials.

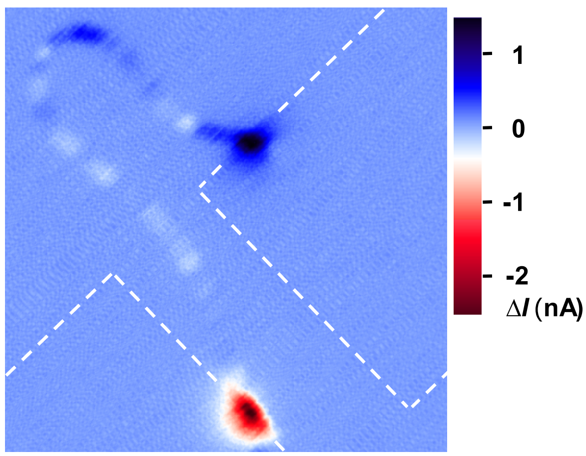

Figure S1. A.c. current image of D1 with $V_D = V_G = 0$ taken with standard lock-in.

S2: Comparison of d.c and a.c. measurements

An interpretation of our results may be difficult with the use of a.c. techniques, and so we discuss our measurement results taken at d.c., i.e. without laser modulation and lock-in. As an example, we show d.c. current images of device D8 taken at both positive and negative V_D (Fig. S2a). The circuit used in the measurement is overlaid for reference, as well as the electrode boundaries.

At positive bias (positive d.c. current in our circuit), the laser causes a relative current decrease in the device, while at negative bias (negative d.c. current), it causes a relative current increase. In both cases we detect an absolute reduction of current in the direction of d.c. flow whenever the laser is incident on the body of the nanotube. Since $\Delta G = \Delta I/V_D$ is negative regardless of bias polarity, the laser always causes device conductance to decrease. This effect is similarly observed for all devices reported.

To improve the signal-to-noise ratio, we modulate the laser and measure a.c. current via lock-in. In standard lock-in mode, V_D is held constant and current is measured at the laser modulation frequency of 20 kHz. In Fig. S2b, we show a.c. current images for D8 taken under the same bias conditions, but using standard lock-in detection for comparison with above.

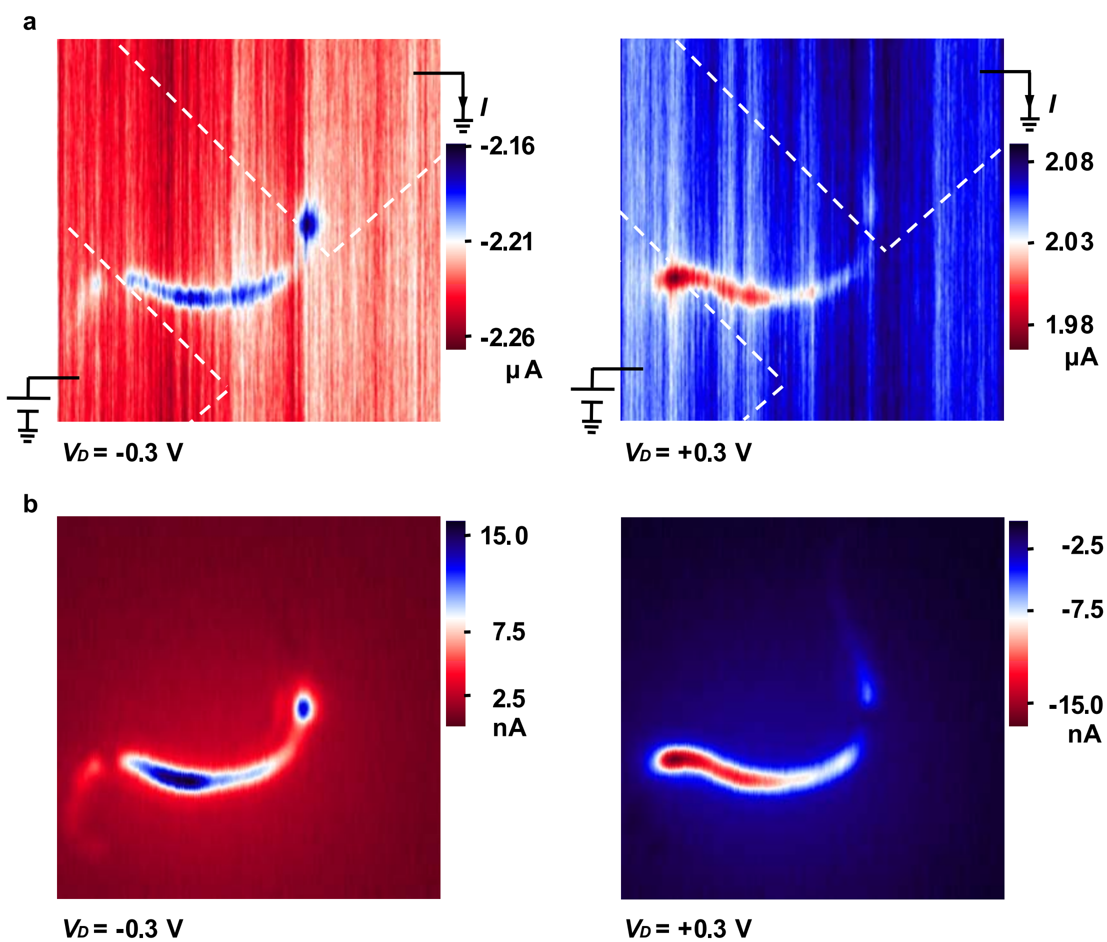

Figure S2. a, D.c. current images of D8 with V_D = -0.3, +0.3 V. **b,** A.c. current images of D8 with V_D = -0.3, +0.3 V taken with standard lock-in.

S3: Surface effects on PTC

We believe that PTC variations along the nanotube in almost all cases result from surface effects, for these variations disappear when the laser is driven at the much higher frequency of 11 MHz. For ease of comparison, we show a.c. current images of D1 taken with standard lock-in (Fig. S4a, 20 kHz laser modulation), as well as with heterodyne detection (Fig. S4b, 11 MHz), both at $V_G = 0$. We see that, apart from polarization effects, D1 appears much more uniform under heterodyne detection at 11MHz.

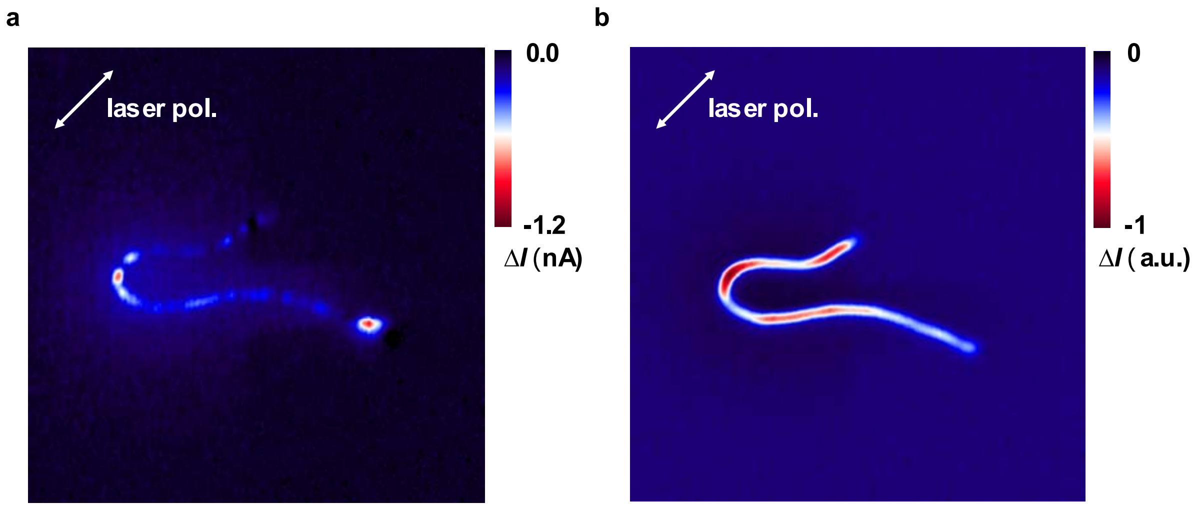

Figure S3. a, PTCM images of D1 with $V_G = 0$ taken using standard lock-in (20 kHz laser modulation) and **b**, heterodyne detection (11 MHz).

S4: Conductance enhancement at turn "off" in D7

At device turn "off," D7 does exhibit a non-zero current signal upon laser illumination. In Fig. S4, we plot the same data shown in the main panel of Fig. 3d, except we focus on the low conductance gate regime and show ΔG in log-scale. We can see that there is indeed a small conductance enhancement even at the conductance minimum (V_G ~ -2V). This signal, if real, is most likely due to photoconductivity in the bandgap regime as reported by *Freitag et al.*[12] .

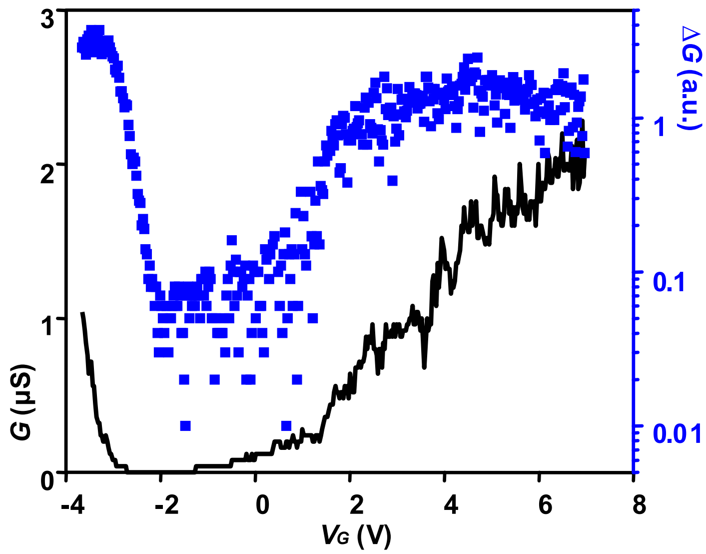

Figure S4. Data from the main panel of Fig. 3d replotted to emphasize regime of device turn "off." ΔG is shown in log-scale.