Sub-100 nm channel length graphene transistors

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Supplementary Information

1. Micro-Raman spectroscopy of single-layer graphene.

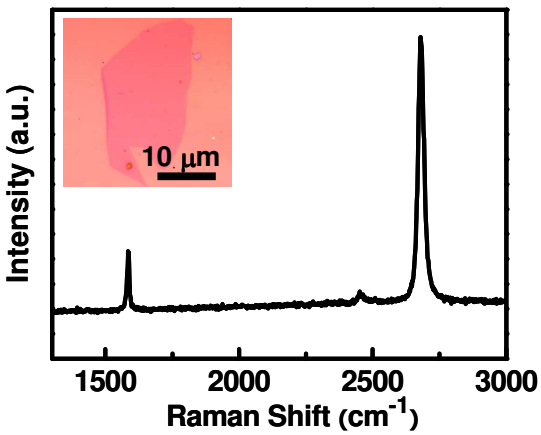

Fig. S1 Micro-Raman spectroscopy is used to identify single-layer graphene prior to device fabrication.

2. The characterization of GaN nanowires.

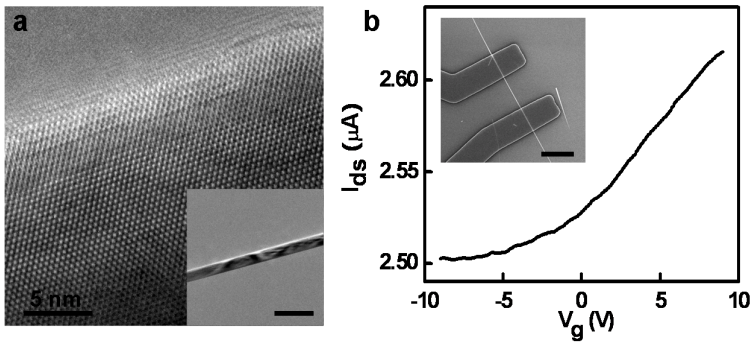

Fig. S2 The characterization and electrical property of GaN nanowires. (a) HRTEM image of a GaN nanowire. The inset shows a TEM image of single GaN nanowire, the scale bar is 200 nm. (b) The transfer characteristics of a typical GaN nanowires device at V_{ds} = 0.1 V with the channel length of 4.5 μm and the diameter of 80 nm, the scale bar is 4 μm.

3. Gate-leak current versus top-gate voltage.

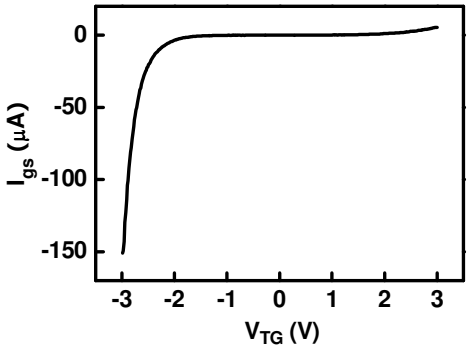

Fig. S3 Gate-leak current versus top-gate voltage I_{gs} - V_{TG}. With the self-aligned Pt source drain electrode, the gate–source leakage remain small compared to the channel current from V_{TG} = -2 to 3 V, and therefore would not significant affect the transistor characteristics.

4. The forward and backward I_{ds} - V_{TG} curves at V_{ds} = 0.1 V.

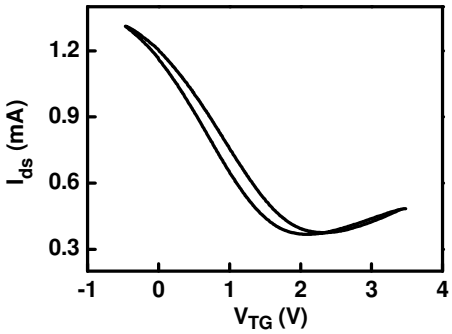

Fig. S4 The forward and backward I_{ds} - V_{TG} curves at V_{ds} = 0.1 V. The hystheresis of I_{ds} - V_{TG} is about 0.2 V under ambient condition.

5. I_{ds} – V_{ds} breakdown characteristics of the self-aligned short channel graphene devices.

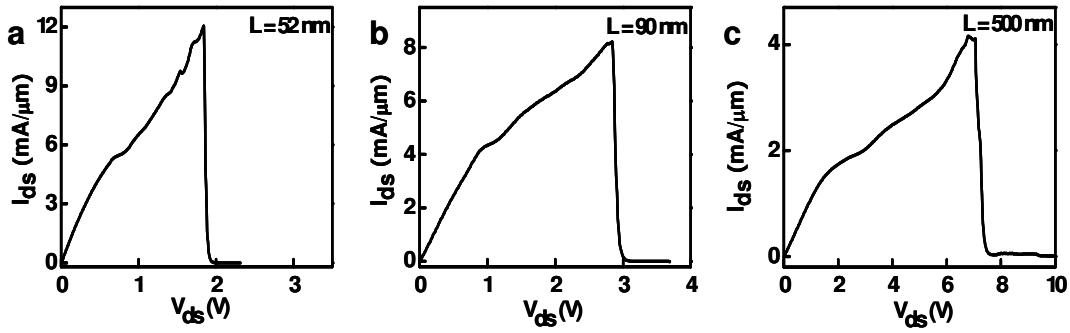

Fig. S5 I_{ds} – V_{ds} breakdown characteristics of the self-aligned short channel graphene devices. (a) 50 nm, and (b) 90 nm. (c) I_{ds} – V_{ds} data recorded of graphene devices on 72 nm Al_2O_3/Si substrate with ~ 500 nm length. The breaking down current density is 12.1 mA/μm, 8.22 mA/μm and 4.15 mA/μm for 52 nm, 90 nm and 500 nm channel length, respectively.

6. The channel length of graphene transistors vs. nanowires side width.

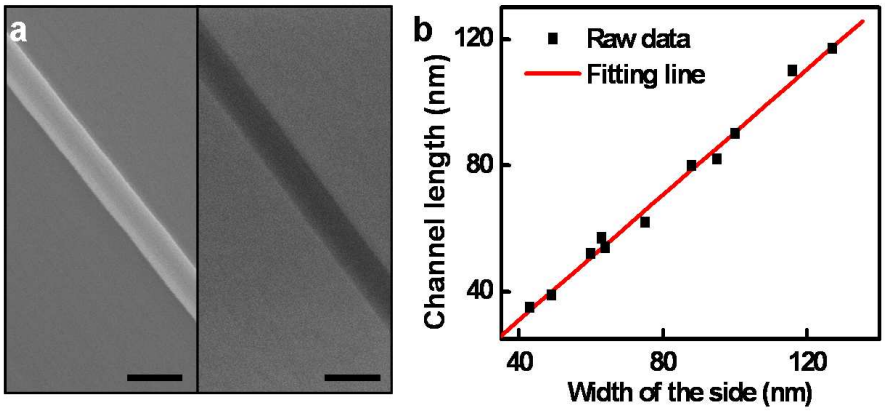

Fig. S6 (a) SEM images of a GaN nanowire lying on top of a graphene flake after 10 nm Pt deposition and the channel length after sonication removing the GaN nanowire, the scale bar is 100 nm. (b) Scaling of the transistor channel length with the nanowire side width.