Supporting information for

Scalable Synthesis of Few-Layer Graphene Ribbons with Controlled Morphologies by a Template Method and Their Applications in Nanoelectromechanical Switches

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Content

1. Complete Ref. 4, Ref. 19a, Ref. 23, and Ref. 26.

(4) Berger, C.; Song, Z.; Li, X.; Wu, X.; Brown, N.; Naud, C.; Mayou, D.; Li, T.; Hass, J.; Marchenkov, A. N.; Conrad, E. H.; First, P. N.; De Heer, W. A. *Science* **2006,** *312,* 1191−1196.

(19a) Ferrari, A. C.; Meyer, J. C.; Scardaci, V.; Casiraghi, C.; Lazzeri, M.; Mauri, F.; Piscanec, S.; Jiang, D.; Novoselov, K. S.; Roth, S.; Geim, A. K. *Phys. Rev. Lett.* **2006,** *97,* 187401

(23) Campos-Delgado, J.; Kim, Y. A.; Hayashi, T.; Morelos-Gomez, A.; Hofmann, M.; Muramatsu, H.; Endo, M.; Terrones, H.; Shull, R. D.; Dresselhaus, M. S.; Terrones, M. *Chem. Phys. Lett.* **2009,** *469,* 177−182.

(26) Campos-Delgado, J.; Romo-Herrera, J. M.; Jia, X.; Cullen, D. A.; Muramatsu, H.; Kim, Y. A.; Hayashi, T.; Ren, Z.; Smith, D. J.; Okuno, Y.; Ohba, T.; Kanoh, H.; Kaneko, K.; Endo, M.; Terrones, H. *Nano Lett.* **2008,** *8,* 2773−2778.

2. Supporting Figures (Figure S1–S9)

Figure S1 (D. C. Wei, Y. Q. Liu, *et al.*)

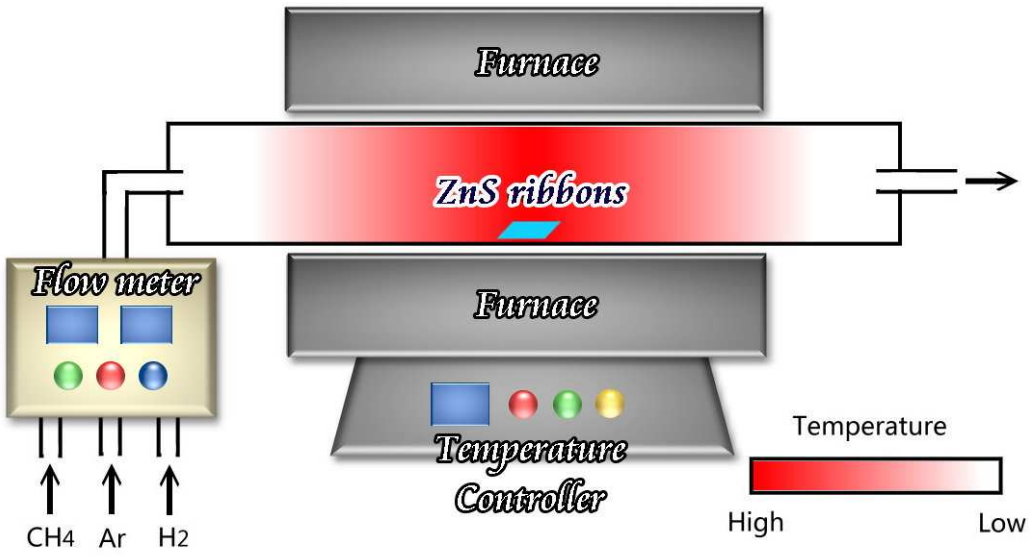


Figure S1. The experimental setup used in synthesis of the ZnS/G ribbons.

Figure S2 (D. C. Wei, Y. Q. Liu, *et al.*)

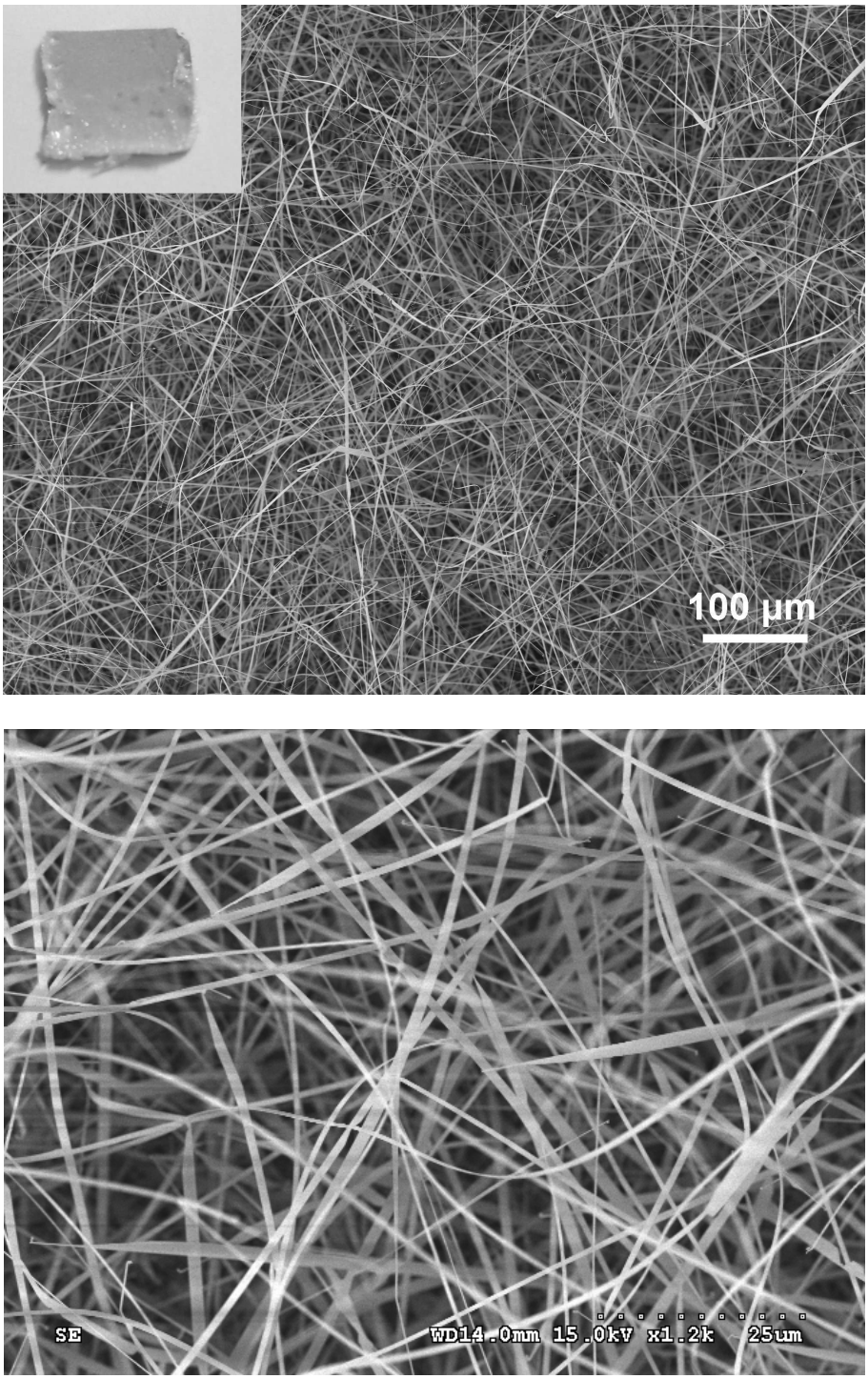
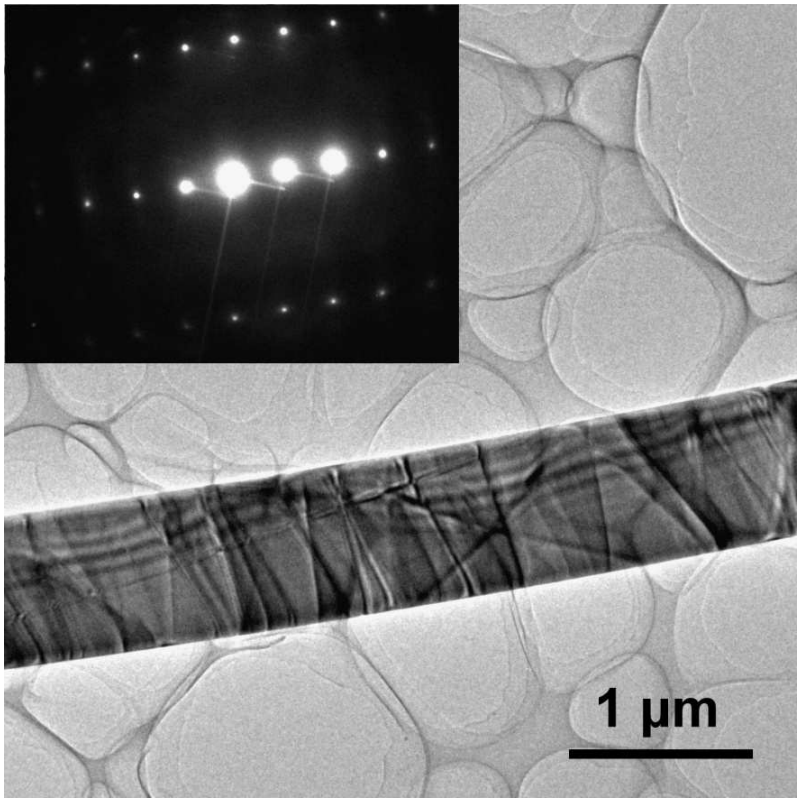
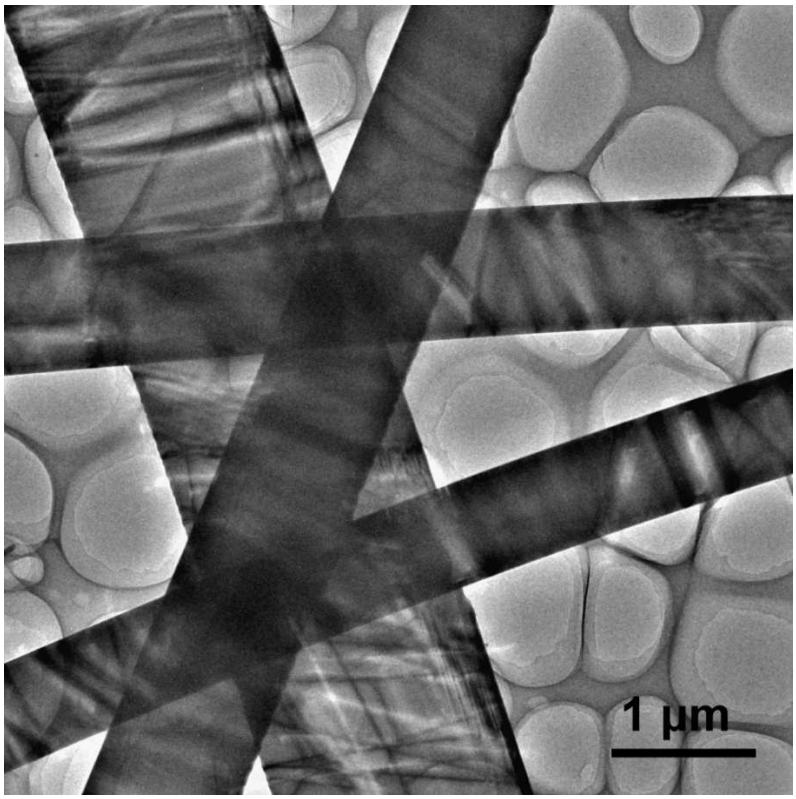


Figure S2. Large scale SEM images of the ZnS ribbons grown on a Si substrate. The inset is a photo of the sample.

Figure S3 (D. C. Wei, Y. Q. Liu, *et al.*)



(a)



(b)

Figure S3. TEM images of the ZnS ribbons, which were used as the template for growth of the few-layer graphene ribbons. The inset of (a) is a SAED pattern of the ZnS ribbon.

Figure S4 (D. C. Wei, Y. Q. Liu, *et al.*)

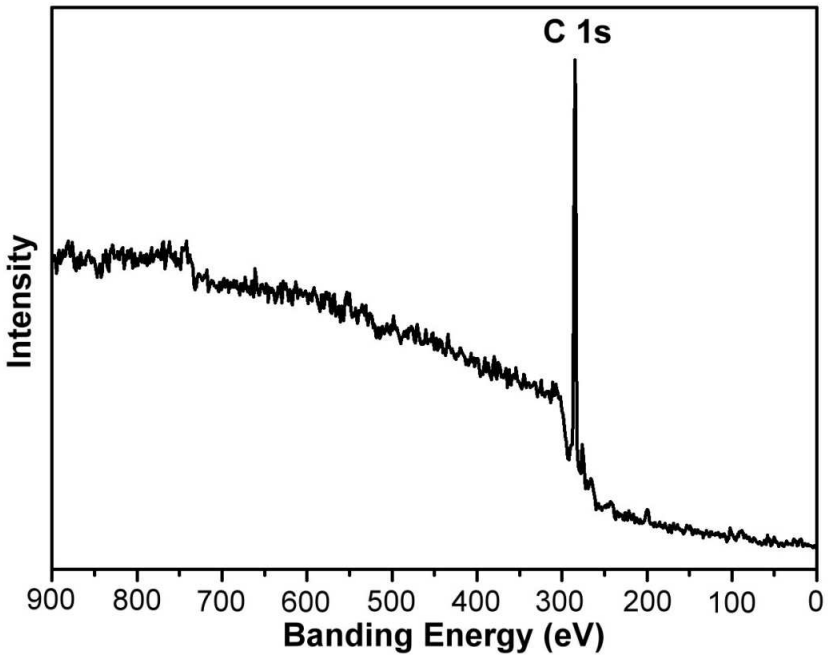
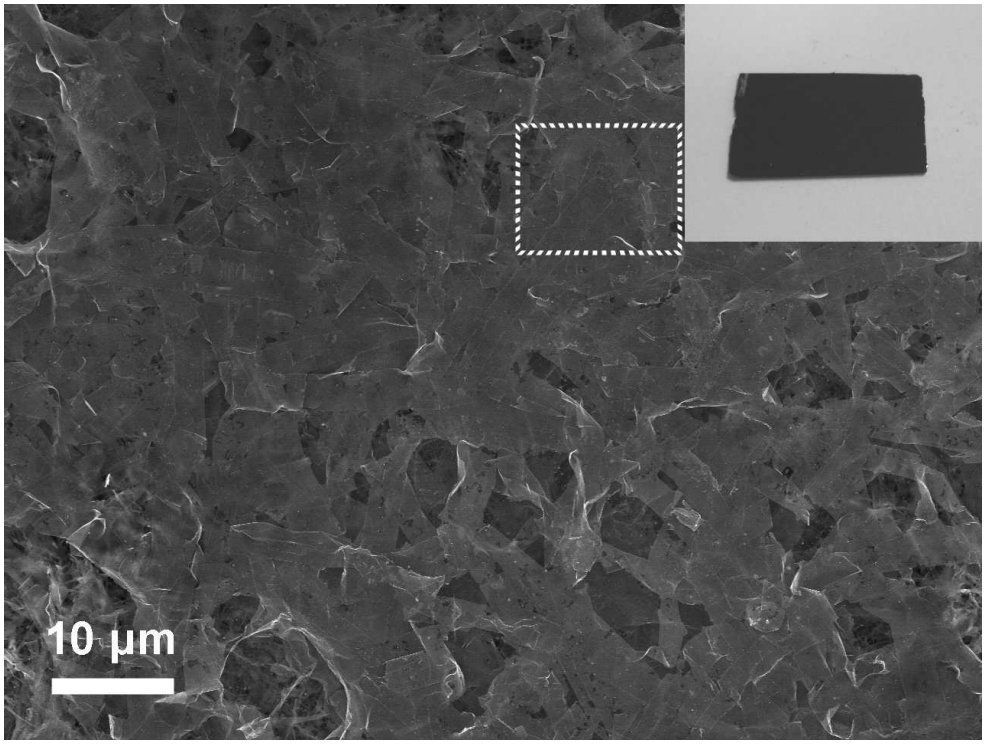


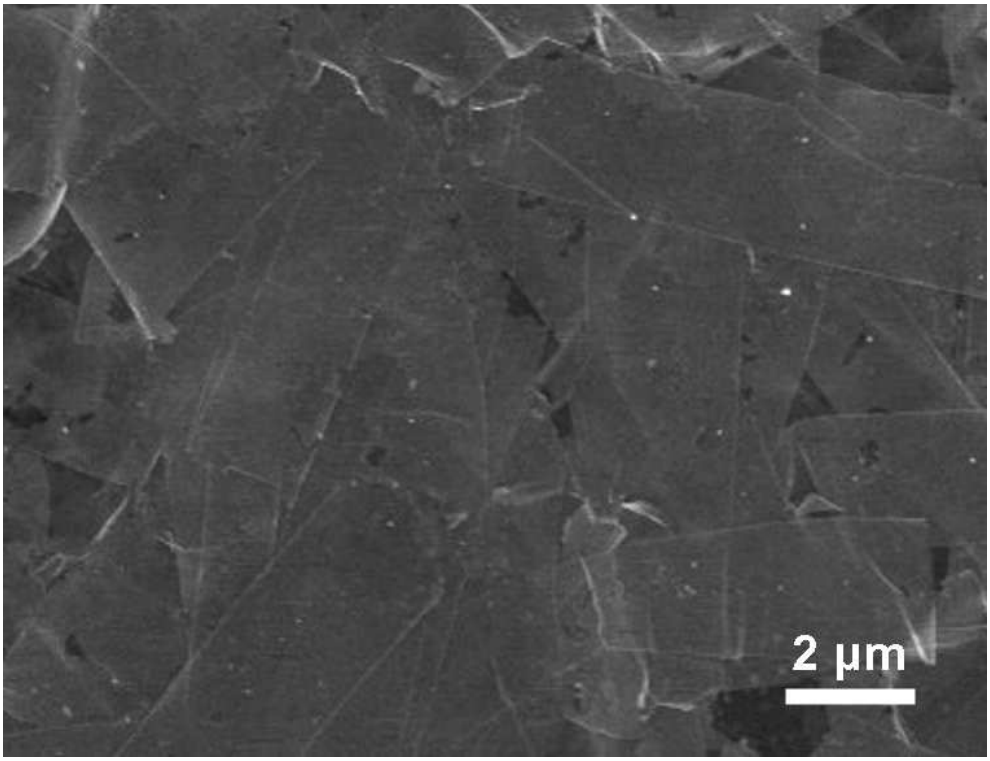
Figure S4. Wide survey XPS spectrum of the few-layer graphene ribbons.

Figure S5 (D. C. Wei, Y. Q. Liu, *et al.*)

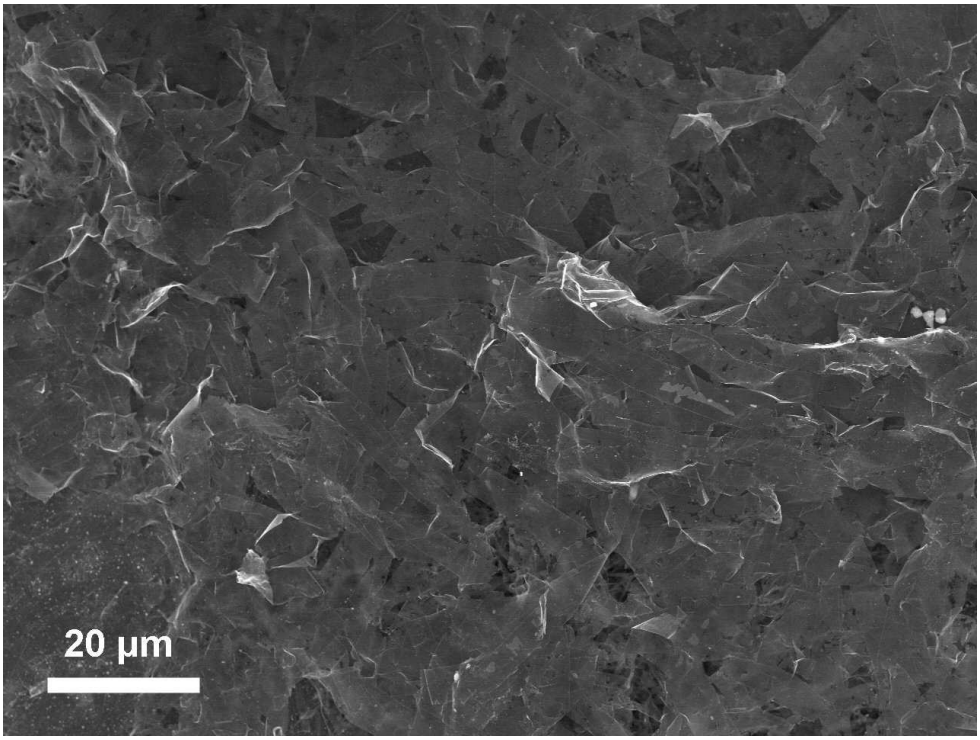
(a)



(b)



(c)



(d)

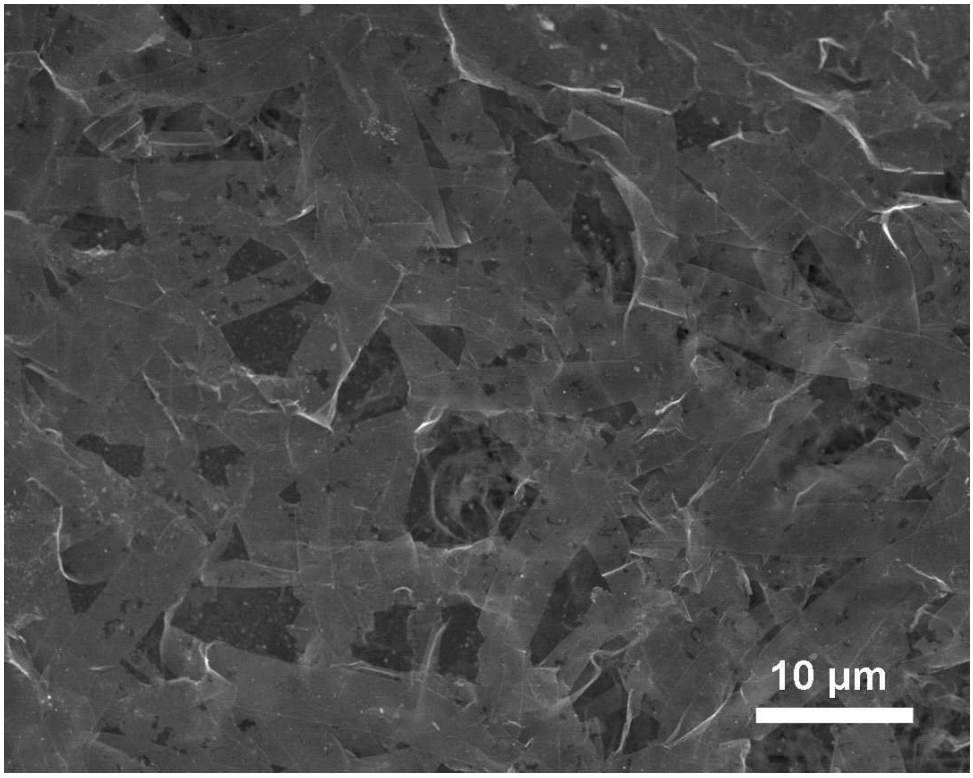
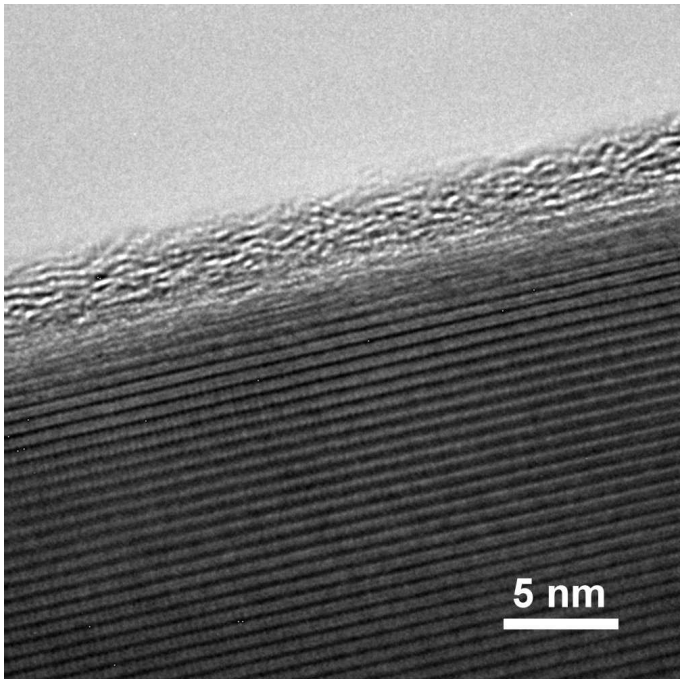


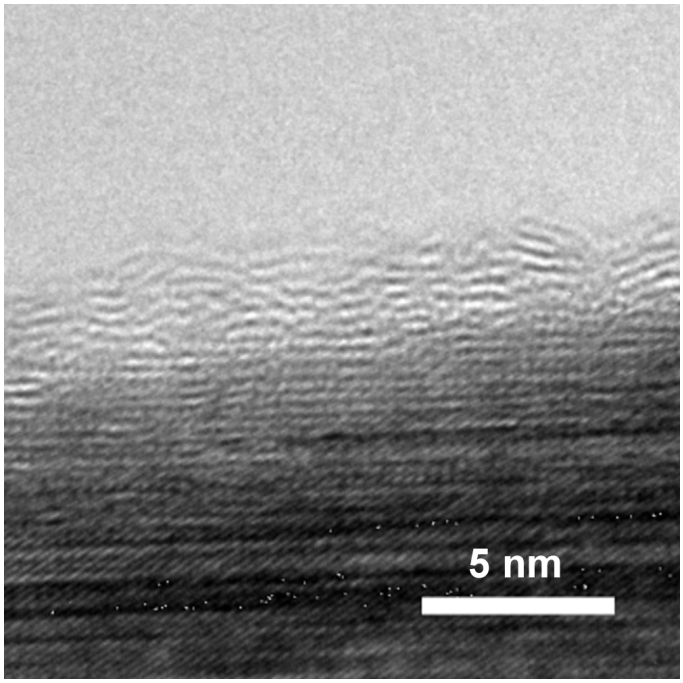
Figure S5. SEM images of the few-layer graphene ribbons grown on the Si substrates. The inset of (a) shows a photo of the sample. (b) is the enlarged image of the area indicated in the dashed frame of (a).

Figure S6 (D. C. Wei, Y. Q. Liu, *et al.*)

(a)



(b)



(c)

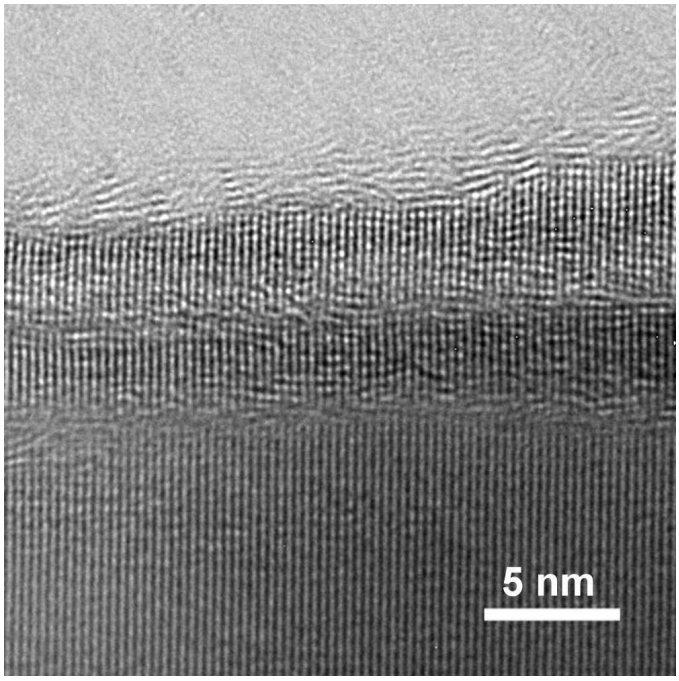


Figure S6. HRTEM images of the ZnS/G ribbons grown by using 50 sccm C_2H_2 (a), iron (II) phthalocyanine (b), and C_2H_5OH (c) as the carbon source, respectively.

Figure S7 (D. C. Wei, Y. Q. Liu, *et al.*)

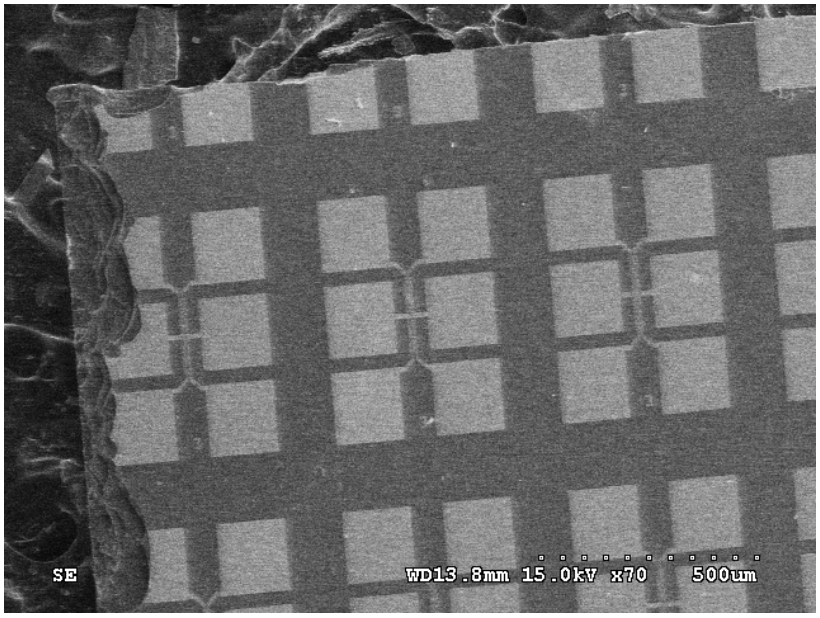


Figure S7. SEM image of the Au/Ti electrodes used in the few-layer graphene ribbon devices.

Figure S8 (D. C. Wei, Y. Q. Liu, *et al.*)

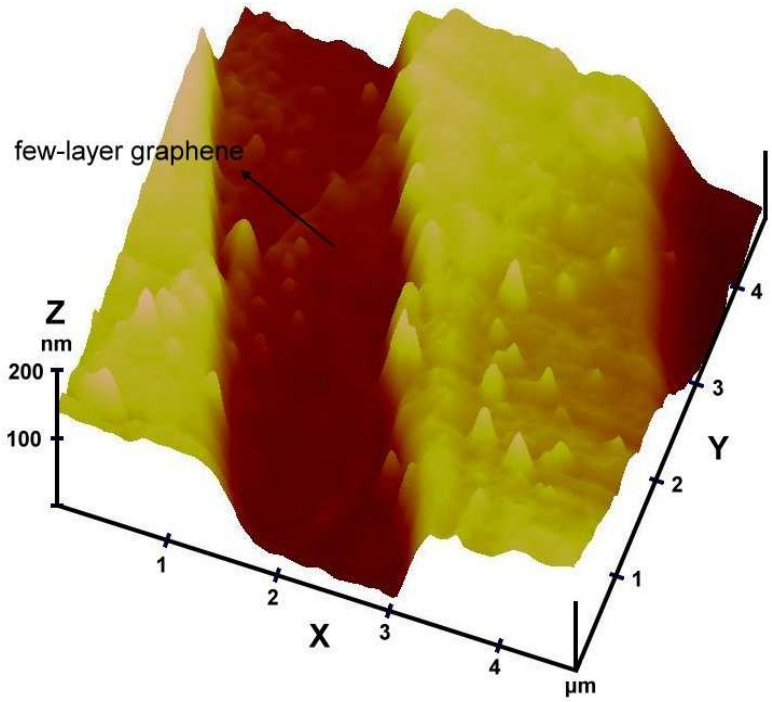


Figure S8. AFM image of a few-layer graphene ribbon device, which shows that the few-layer graphene ribbon attaches the substrate across the Au/Ti electrodes.

Figure S9 (D. C. Wei, Y. Q. Liu, *et al.*)

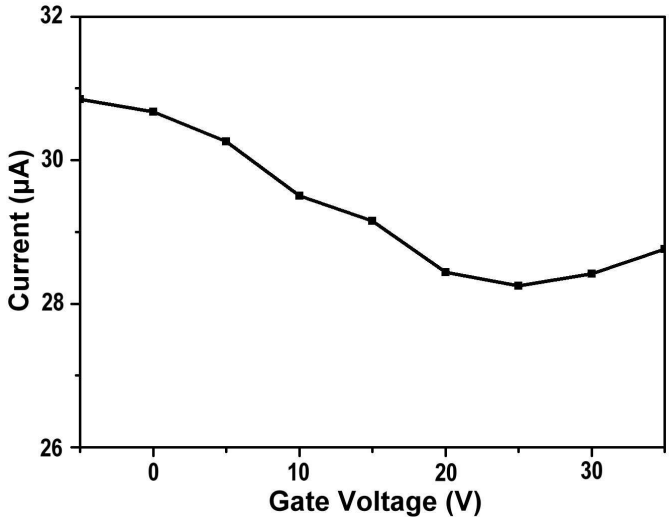


Figure S9. The transfer characteristics of the FLGR device (source-drain voltage is at 1.0 V).

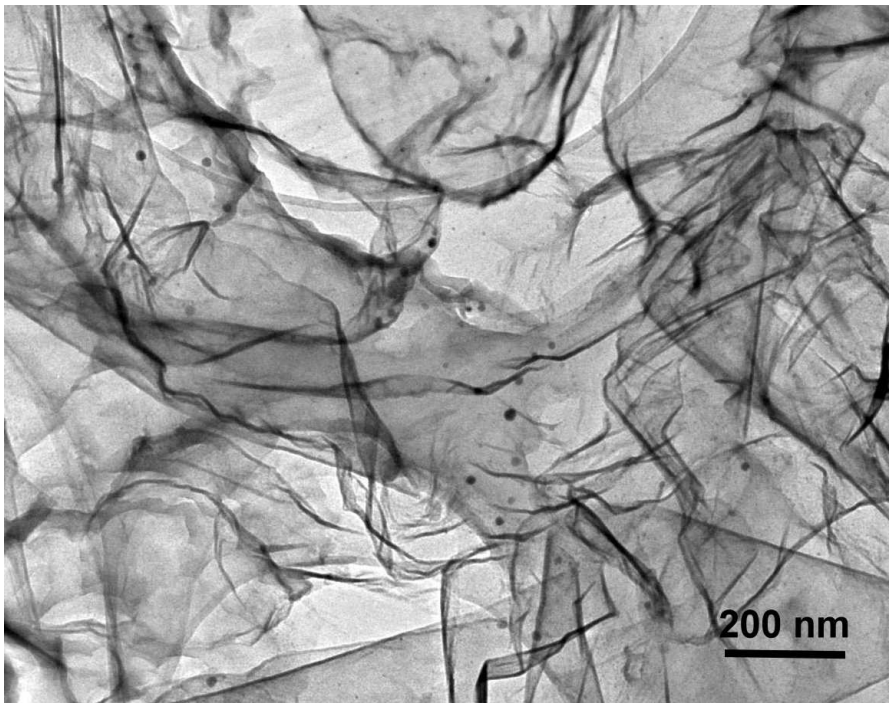
3. Detailed description of the preparation of ZnS ribbons:

ZnS ribbons were synthesized by a physical vapor deposition method, which was performed in a horizontal quartz tube mounted inside a high-temperature furnace. In a typical experiment, a 20 nm thick Au film deposited on a Si substrate was used as the catalyst for the ZnS ribbon growth. The Au film was deposited onto the Si substrate by high-vacuum evaporation at a rate of 10 Å s^{-1} at a base pressure of 10^{-4} Pa. An alumina boat contained 0.1 g of ZnS powder (Sigma-Aldrich, purity > 99.99%) mixed with 0.5 g graphite powder was placed at the center of the furnace, while the Si substrate with Au film was placed at the region 35 cm downstream. Before heating, 300 sccm high pure Ar was introduced into the system for 30 min to remove the air. After that, 100 sccm Ar mixed with 3–8% H_2 was introduced in the furnace, and then the furnace was heated. As the center of the furnace reached 1000 ˚C, the ZnS ribbons were grown on the Si substrate downstream with lower temperature. In the growth, the existance of 3–8% H_2 and graphite powder avoided the oxidation of ZnS by the residual O_2 in the physical vapor deposition system. The growth process lasted for 30 minutes, and then the furnace was cooled to room temperature under ambient H_2.

4. Detailed description of production of graphene membrane on ZnS films:

ZnS films (Figure 6a) were produced by physical vapor deposition on a Si substrate, and then the ZnS films were placed in the center of a horizontal quartz tube mounted inside a high-temperature furnace. 50 sccm Ar and 50 sccm H_2 were introduced as the carrier gas. When the furnace temperature reached 750 ˚C, and then 100 sccm CH_4 was introduced as carbon source. This process was performed for 8 minutes. Finnally, the furnace was cooled to room temperature under ambient H_2. SEM image (Figure 6b) shows that a uniform layer with light contrast was coated on the surface of ZnS. To remove ZnS, the products were scratched off and dispersed in 0.1 M HCl for 30 min, and then the samples were filtrated and washed by distilled water. At last, TEM images (Figure 6c, Figure SI) show that the final products were graphene membranes with morphologies like a large-area, crumpled paper.

(a)



(b)

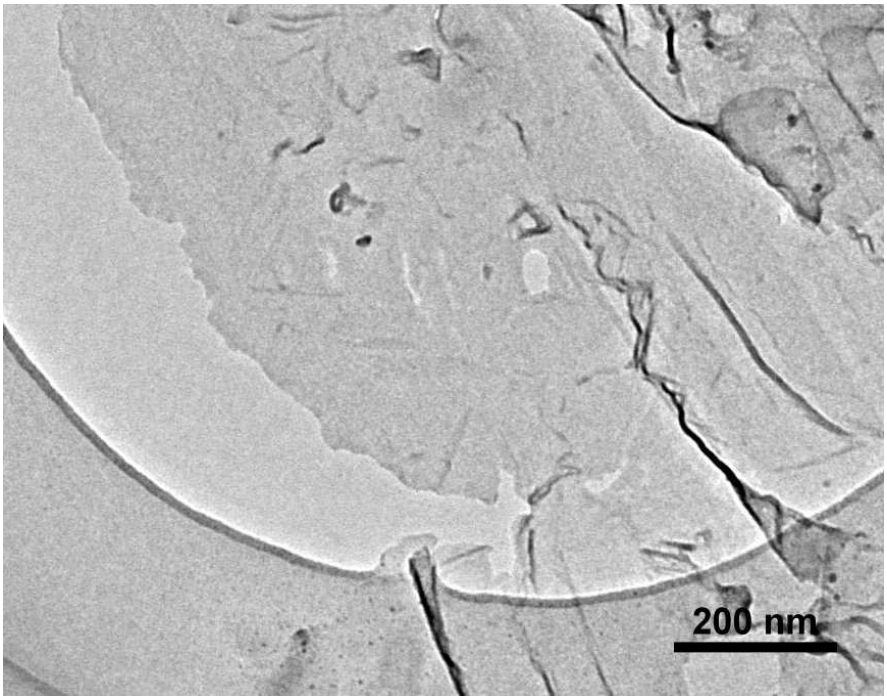


Figure SI. TEM images of the graphene membranes after HCl treatment.