Supplementary Data

Reduced Graphene Oxide Film with Record-High Conductivity and Mobility

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1. Compensation of structure changes

Figure S1 shows that the curved shape can compensate for the structural changes induced by the thermal treatment. The degree of bending of the curved RGO film becomes smaller after the Joule heating to 3000 K.

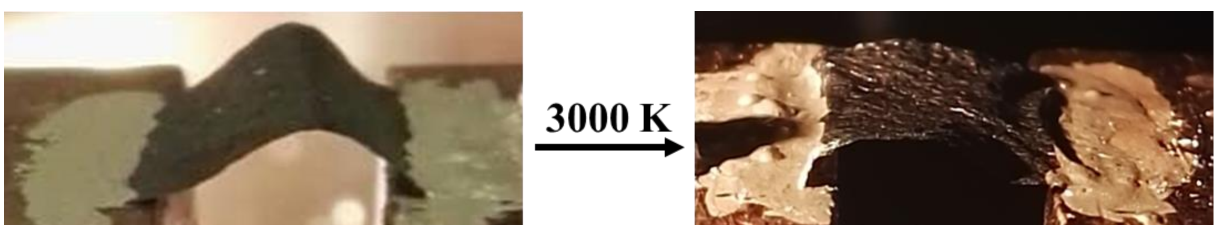

Figure S1. Pictures of the curved RGO film before and after Joule heating to 3000 K, showing that the RGO film didn't break while the degree of bending of the curved RGO film becomes smaller.

2. Factors that affect success rate of the Joule heating reduction method

One important factor that strongly affects the success rate is the size of the RGO film, especially the width of the RGO film. For the RGO film having a width of ~3 mm, the success rate is almost 100%. For the RGO film having a larger width of ~10 mm, the success rate decreases to ~90%, where uniformity is the most challenging issue. As shown in Figure S2, when running current through the large RGO film, the current will first pass along a certain path in the RGO film to heat a portion of the RGO film, later the heated area becomes larger, and finally the entire RGO film is heated. Another major factor that affects the success rate is the temperature of electrodes. The silver paste will be lost due to vaporization at a high temperature, and further causing breakdown of electrical connection through the RGO film, when most of the silver paste is lost at a very high temperature. If the RGO film is rapidly heated to a higher temperature from 2000 K without the cool down procedure, the temperature of the electrodes will reach too high of a value and the silver paste may be totally lost. In this case, the RGO film cannot reach 3000 K due to the breakdown of electrical connection. The cool down procedure before the rapid increase allows the electrodes to be cooled down in a few minutes to avoid too much loss of the silver paste, which is critical for maintaining the electrical connection through the RGO film.

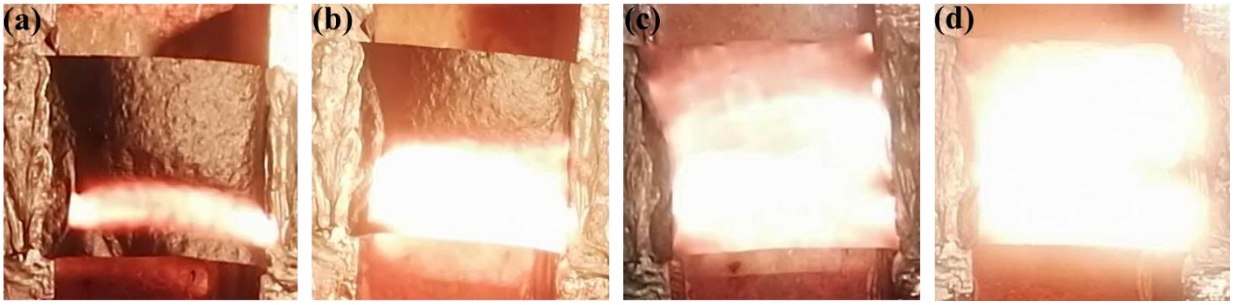

Figure S2. Gradual transition from non-uniform to uniform for reducing a large RGO film having a width of 10 mm. As the input power increases, the portion where the RGO film is heated becomes larger and finally the entire film is heated.

3. Flexibility of the high temperature reduced RGO film

The as-prepared high temperature (~3000 K) reduced RGO film is mechanically flexible. Figure S3 shows that the RGO film can be easily bent into a circle with a tweezer. Note that the RGO film recovers its original shape when released.

Figure S3. An optical image of a bent RGO film, demonstrating film flexibility after high temperature treatment.

4. High-resolution TEM image of the RGO film

A high-resolution TEM image of the 3000 K-reduced RGO film is shown in Figure S4. Even though clear atomic resolution of the TEM image is not achieved, we can still see some ordered domains to some extent, as circled by the red dotted lines. We ascribed these domains to the graphitic sp^2 domains, which have a roughly average size of ~8.2 nm. The graphitic domains revealed by high-resolution TEM are consistent with the calculated localization length of 8.7 nm.

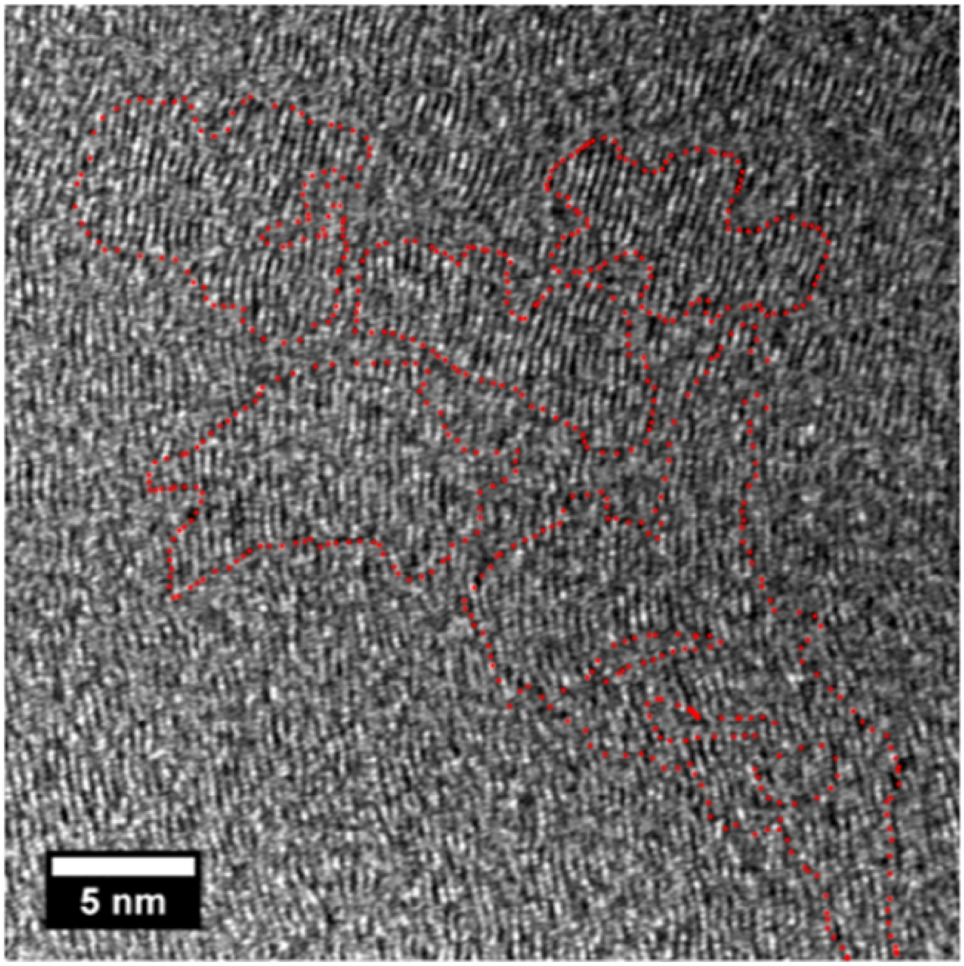

Figure S4. A high-resolution TEM image of the 3000 K-reduced RGO film.