Supplementary Information

Directly writing flexible temperature sensor with graphene nanoribbons for disposable healthcare devices

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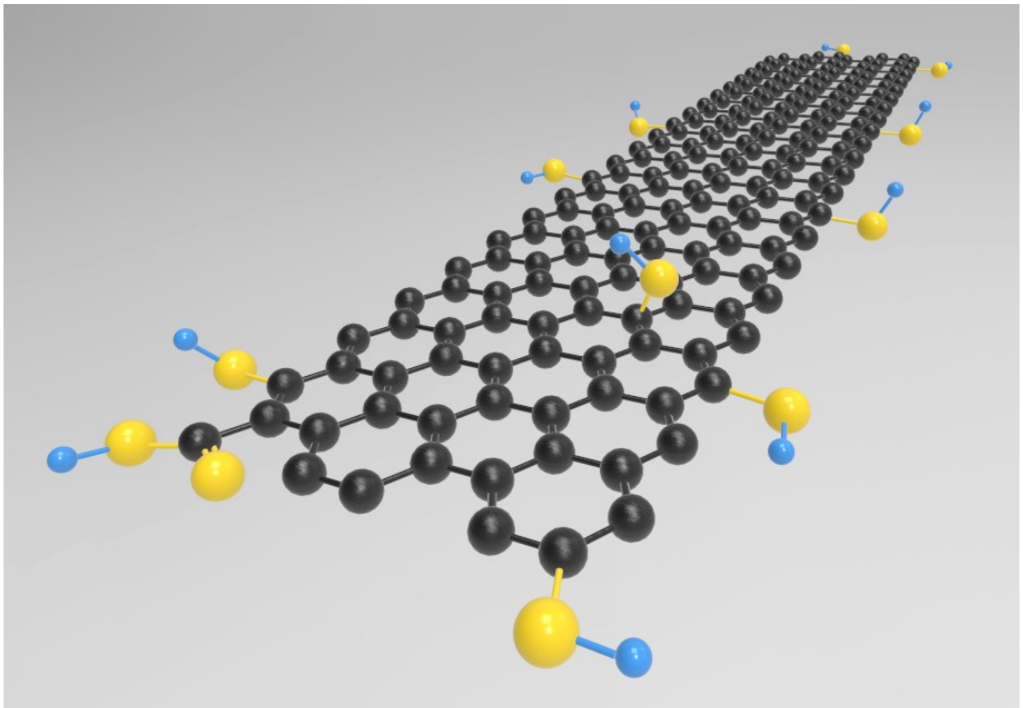

Figure S1. Structure diagram of graphene nanoribbon (GNR). The molecular structure of GNR is shown by ball-and-stick model. The black balls represent carbon atom, and the yellow and blue ones represent oxygen and hydrogen atoms, respectively.

The edges of GNR have higher reactive activation. The oxygen-containing functional groups introduced by longitudinal unzipping of pristine MWCNTs are mostly on the edges. As shown in the diagram, the oxygen functional groups in GNR are hydroxyl and carboxyl, which is demonstrated on the page 4-5 of main text and **Figure 3a** and **b**.

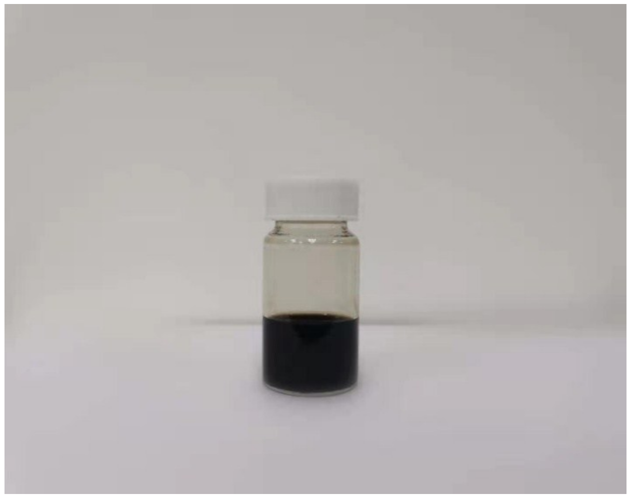

Figure S2. Photograph of the GNRs ink showing good dispersity in water.

The processes of longitudinal unzipping of pristine MWCNTs introduced some oxygen functional groups such as hydroxyl and carboxyl into the GNRs. These polar oxygen functional groups render it strongly hydrophilic. This gives GNRs good dispersity in many solvents, particularly in water [1,2]. It is of great significance to simplify manufacturing process and reduce cost. The resulting GNRs suspension can be subsequently deposited on the commonly-used paper in order to prepare thin conductive films by means of methods such as writing, spraying, painting or printing.

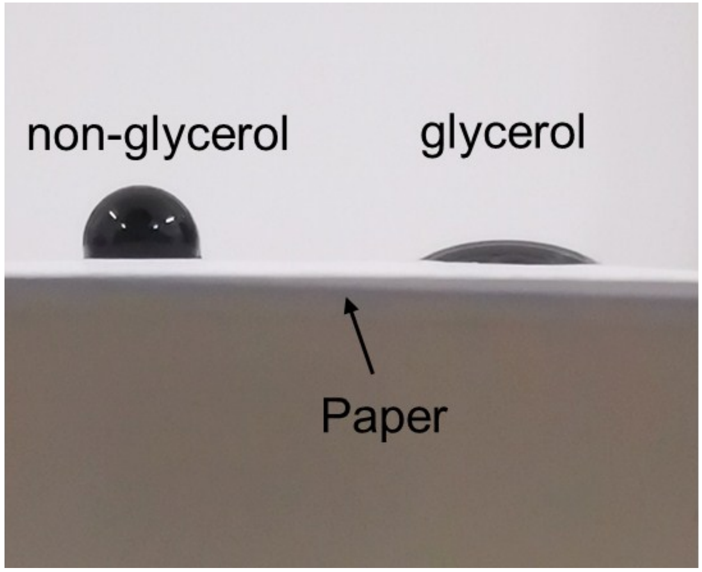

Figure S3. Photograph of the non-glycerol and glycerol GNR ink droplets on the paper shows remarkable difference of contact angles.

The water-based GNR ink does not soak the paper well. The contact angle on paper is about 90°, as shown in the left side of Figure S3. To improve wettability of the ink to paper, glycerol (5 wt%) was added into the GNRs ink, which significantly decreases the contact angle to about 30° (the right side of Figure S3).

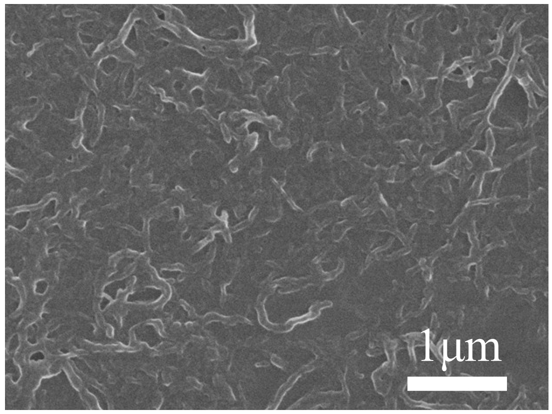

Figure S4. SEM image of the GNRs sensor with larger uniform and continuous active layer on the surface of paper

The directly written GNRs can form the uniform and continuous film on paper, and the charge thus transports continuously in the active layer, which is of great benefit to conductivity of the GNRs sensor.

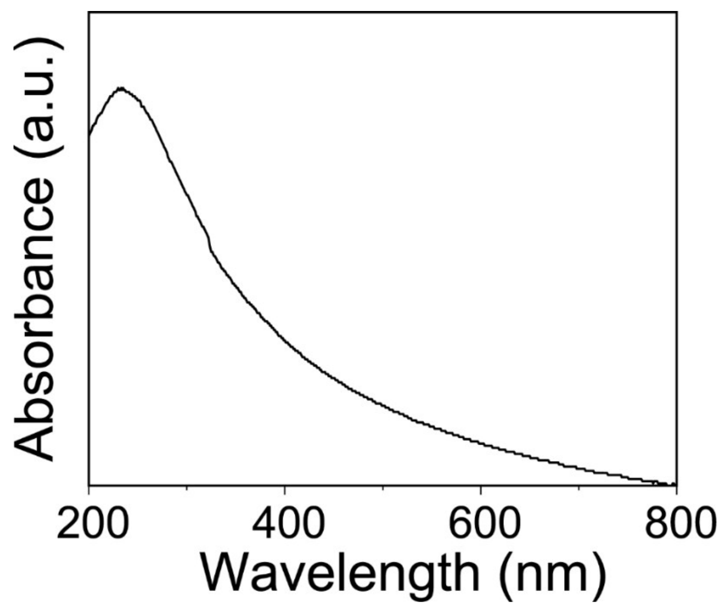

Figure S5. UV-vis absorption spectrum of GNRs film.

The UV-vis spectrum was used to investigate the band gap of GNRs. It had been reported that the gap nature of graphene gradually changes from direct to indirect with increasing accommodation of oxygen groups [3]. Therefore, the bandgap cannot be directly calculated from the absorption peak. The curve should be transformed into $(\alpha h\nu)^{1/2}$ versus photon energy (**Figure 3c**). From approximate linear extrapolation, GNRs display apparent energy gap between 1.5 and 1.8 eV for indirect transition, which means that intrinsic excitation could contribute to conductivity.

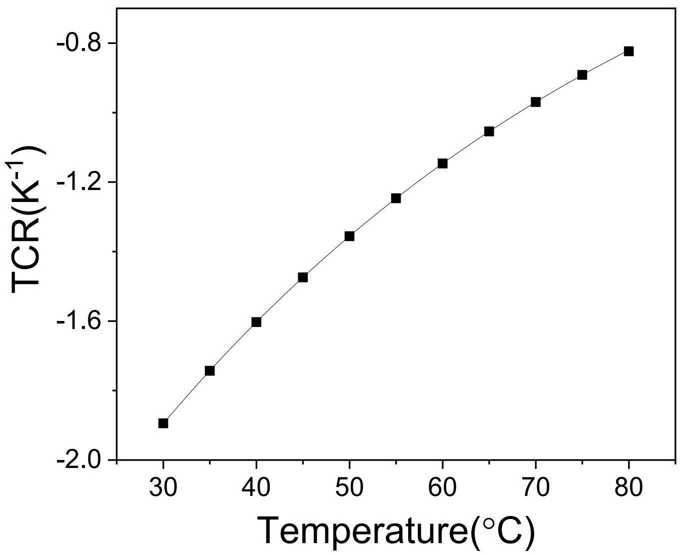

Figure S6. The TCR of the GNRs sensor as a function of temperature.

REFERENCES

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